CRITHINKEDU
Critical Thinking Across the European Higher Education Curricula

A European review on Critical Thinking educational practices in Higher Education Institutions

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Executive summary and key findings

Within the scope of CRITHINKEDU project, this report is directed to university teachers, pedagogical support teams and institutional leaders, providing an overall understanding on how European Higher Education Institutions (EHEI) foster Critical Thinking (CT), taking into account both the current educational intervention studies reported in the literature and teachers' educational practices. Adopting a mixed method research design, **46 papers** from the literature were reviewed and **53 interviews** with university teachers **from 9 European countries** were carried out. The analysis comprised both studies and teachers' interviews from **4 different professional fields**, namely **Biomedical Sciences**, **STEM** (Sciences, Technology, Engineering and Mathematics), **Social Sciences** and the **Humanities**.

This report provides an overall understanding on how European Higher Education Institutions (EHEI) foster Critical Thinking (CT)

The key findings are in line with previous reviews (Abrami et al., 2008; Behar-Horenstein & Niu, 2011; Tiruneh, Verburgh & Elen, 2014; Abrami et al., 2015):

1. **Research on CT Education is a growing field within the European Higher Education (EHE) landscape.** There is an increasing interest in how teaching strategies may influence the development of CT, although with scarce evidence on which characteristics of teaching strategies and learning environments better support the development of students' CT;
2. **CT dispositions are undervalued by EHE teachers.** CT intervention studies and educational practices mainly address the development of CT skills in students and seem to neglect the value of CT dispositions and the importance of considerable practice, effort and long-term interventions;
3. **CT instruction within subject-matter courses is the most used approach by EHE teachers.** The reported studies and practices tend to be based mostly on an Immersive CT approach (Ennis, 1997), in which CT principles are not made explicit to students, assuming that the skills will be acquired once they engage in the subject-matter instruction. However, the clear identification and definition of CT skills to be developed are critical elements for the effectiveness of CT interventions, to be recognized by the students and taught directly by the instructors;
4. **Active Learning methodologies, Teachers' training and Students' support are fundamental for CT development.** Lecture-Discussion Teaching (LDT) and Problem-Based Learning (PBL) are the most used strategies reported both in the literature and by the teachers, suggesting that engaging students with active learning methodologies seems to help achieving higher improvements on CT development. Furthermore, the use of real-world situations and/or workplace-based scenarios are commonly used to support teaching and

learning processes. Here, evidence points out that not only do CT-driven materials have a higher impact on students' CT outcomes, but that teachers' training on CT is also crucial aspects for effective CT development;

5. **EHE teachers have difficulties to assess their students' CT development.** Both literature and teachers reported several difficulties in relation to assessing students' CT progression. In particular, most of the studies and practices presented qualitative assessment methods, based mainly on students' and teachers' perceptions, and few adopted formal CT tests, rubrics or research designs with an experimental/quasi-experimental nature - in which the effect size of the intervention was measured. Besides that, it is clear that researchers and teachers have critical limitations to assess CT students' permanency (the capacity of CT skills and dispositions to remain active in students after the intervention) and generalization (the ability to apply CT skills and dispositions in other contexts, such as the labour market or everyday life). Also, different difficulties were detected at the pedagogical, methodological and organizational levels. These highlight the major role of EHEI in the provision of adequate structural settings and policies to nurture teachers and students in active learning and CT development.

Several implications for practice are outlined at three main levels: organizational, programme and course levels. Resulting in the main outcome and novelty of the current report, from the comparison between the first CRITHINKEDU' intellectual output - "**A European collection of the Critical Thinking skills and dispositions needed in different professional fields for the 21st century**" (CRITHINKEDU_O1, 2018) - and this review (CRITHINKEDU_O2), a preliminary proposal of guidelines for quality in CT education in EHEI is presented. The focus of this proposal is on quality assurance related to CT learning and teaching in higher education, including the overall process of designing, conceiving and delivering CT instruction (and relevant associations to research). This does not exclude the already existing institutional processes to ensure and improve the quality of teaching, learning and research activities, but instead it constitutes a specific and complementary path to ensure CT learning environments in which the content of programmes, learning opportunities and facilities are fit for this purpose.

Some issues were encountered when conducting this research, related to the research methodology (e.g., keywords used for papers selection), the research sample (e.g., teachers' background or experience on CT instruction), or even data analysis procedures (e.g., language barriers in the process of data translation). However, after overcoming these difficulties, this report sheds light on how the current educational interventions and practices foster CT skills and dispositions in European Higher Education (EHE) students, on the barriers and on what is now important to focus on to improve CT education.

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1. Introduction, goals and structure of the report

In the scope of the second intellectual output of the project **CRITHINKEDU 'Critical Thinking Across the European Higher Education Curricula'**[1], funded by the European Commission under the Erasmus+ Programme, reference number 2016-1-PT01-KA203-022808, the current report was elaborated by partners from 9 countries: Belgium, Czech Republic, Greece, Ireland, Italy, Lithuania, Romania, Portugal and Spain. It includes contributions from 11 European Higher Education Institutions (EHEI) and over 59 scholars and experts from different fields (Biomedical Sciences, STEM – Science, Technology, Engineering and Mathematics –, Social Sciences, and Humanities). It is part of the research developed for the second intellectual output of CRITHINKEDU (CRITHINKEDU_O2), led by the University of Santiago de Compostela (USC). It arises from the concern of improving the quality of learning in universities across the curriculum, which converges in a common need on how to better support the development of CT education according to the labour market needs and societal challenges.

Critical Thinking (CT) is pointed out as one of the main skills of the 21st Century to be promoted in Higher Education (HE)

There is an emerging consensus on the importance of **Critical Thinking (CT)** as a goal in Education, which derives primarily from initiatives like the "Partnership for 21st skills"[2], or the "21st century skills" Project[3]. Both reinforce the need of reforms in order to respond to the social and economic needs of students and society in the 21st century (Ananiadou & Claro, 2009). In response to this growing awareness, some generalist CT subjects have been included in university curricula, fostering new pedagogical methods, promoting a closer collaboration with experts and companies for forthcoming curricula reforms and redefinition of learning outcomes (McAleese et al. 2013). Even though underlined by educational policies, the opportunities to develop CT skills remain scarce and undervalued within the HE curricula, which mainly stress memorization, retrieval and a passive transfer of knowledge (DiCarlo, 2009).

However, trends in educational research indicate an increasing interest in how teaching strategies may influence the development of CT. Nevertheless, very little is known about what characteristics of teaching strategies and learning environments support the development of CT (Ennis, 2016). Research on intervention studies reinforces the need for good (empirically investigated) instructional approaches in CT (Abrami et al., 2008) and increasing teacher training and professional development on this matter. With this purpose, a literature review on CT educational intervention studies in HE was performed by each CRITHINKEDU partner in its own country; thereafter, interviews with university teachers from diverse fields were applied to gain

[1] For more information, please visit http://crithinkedu.utad.pt/en/crithinkedu/
[2] For more information, please visit http://www.p21.org/
[3] For more information, please visit http://www.atc21s.org

an insight on how CT is being promoted in HE. Finally, a comparison between the first CRITHINKEDU' intellectual output - the "**A European collection of the Critical Thinking skills and dispositions needed in different professional fields for the 21st century**"[4] (CRITHINKEDU_O1, 2018) -, and the second CRITHINKEDU' intellectual output (the current report; CRITHINKEDU_O2) is presented to investigate whether there is a gap between CT labour market/societal demands and CT university teaching. This report ends up with a preliminary proposal of guidelines for quality in CT education, to be improved in forthcoming reports, in CRITHINKEDU' third and fourth intellectual outputs (CRITHINKEDU_O3 and CRITHINKEDU_O4, respectively).

The resulting report seeks to stimulate, among other issues, further understanding and interest in how to promote CT in HEI. Its aims are:

1. To provide an international overview of the literature on CT educational intervention studies in EHEI;
2. To characterize the current CT educational practices adopted in EHEI, attending to the learning outcomes and difficulties identified;
3. To analyse the gaps between the current CT educational practices in EHEI and the needs expressed by the labour market professionals.

This report is divided in three main sections: 1) **the international literature review** (section 2); 2) **the analysis of HE teachers' interviews on CT** (section 3); 3) **the preliminary guidelines and recommendations**[5], based on the comparison between CRITHINKEDU_O1 and CRITHINKEDU_O2 (section 4).

The partners collaborating in this report are: Universidade de Trás-os-Montes e Alto Douro (UTAD), Portugal; Università degli Studi Roma Tre (UNIROMA3), Italy; University of Western Macedonia (UOWM), Greece; Technological Educational Institute of Thessaly (TEI THESSALY), Greece; University College Dublin (UCD), Ireland; Katholieke Universiteit Leuven (KU Leuven), Belgium; University Colleges Leuven-Limburg (UCLL), Belgium; Modern Didactics Center (MDC), Lithuania; University of Economics Prague (VŠE), Czech Republic; Bucharest University of Economic Studies (ASE Bucuresti), Romania; Universidad de Santiago de Compostela (USC), Spain.

[4] The "**A European collection of the Critical Thinking skills and dispositions needed in different professional fields for the 21st century**" is a technical report resulting from the first intellectual output of CRITHINKEDU (CRITHINKEDU_O1, 2018). Adopting a qualitative research methodology, with the delivery of 32 focus groups enrolling 189 professionals from 9 European countries and 4 different professional fields (Biomedical Sciences, STEM - Sciences, Technology, Engineering and Mathematics -, Social Sciences and Humanities), this report provides an overall analysis of the understanding of Critical Thinking (CT) by employers and establishes similarities and differences in its expression, need and practical application at the workplace. Available at http://bit.ly/CRITHINKEDUO1

[5] These preliminary guidelines will be improved and deepened in the CRITHINKEDU' fourth intelectual output, and transformed into the "**European guidelines for Critical Thinking education in EHEI**" (CRITHINKEDU_O4). These final guidelines are intended to orient EHE teachers, pedagogical support teams and leaders on how to adopt and promote CT educational practices, attending to a set of quality criteria that can drive educational change and innovation in this context.

2. Literature review on CT educational intervention studies

This section presents a European review of intervention studies on CT in HE across CRITHINKEDU partners' countries. Before starting the review, all partners adopted the **CT definition from APA Delphi panel** (Facione, 1990), aiming to provide an insight into good examples of research on CT interventions in HE in order to promote CT practices at the university. Despite the large body of research about teaching CT in HE, it is often claimed that there is a gap to be filled, related to the conditions under which instruction could result in greater CT outcomes (Tiruneh, Verburgh & Elen, 2014). There are a few relatively recent systematic reviews attempting to analyse the evidence on CT instruction in HE (Abrami et al., 2008; Behar-Horenstein & Niu, 2011; Tiruneh et al., 2014; Abrami et al., 2015). Previous reviews have however provided limited information on the conditions under which instruction could enhance students' CT in HE; therefore, this is one of the main contributions of the present report. **It is focused on the empirical research on CT interventions in EHEI in different fields**, with special attention to the examination of: the factors that make CT interventions successful, helping students to develop their CT skills and dispositions; the commonalities and differences among the studies in different fields regarding how CT practices are addressed. Theoretical studies on CT were not considered for this review, since the conceptualization of CT is not a goal of this report.

The current literature review focuses on the educational practices which could effective enhance students' CT in HE

2.1. Methods

A systematic literature search was conducted at national levels, in order to identify and retrieve empirical research about CT interventions in EHEI across the different CRITHINKEDU partner countries. Figure 1 provides a summary on how the papers were searched, selected and analysed. The methodological process was commonly adopted by each partner. It followed the steps of review methods (Bennet et al., 2005):

1) ***Database and Keywords identification***: papers were searched by the different partners in international and national databases: Web of Science, SCOPUS, EBSCO, etc. (Table 2). The following keywords, agreed between partners, were used in English and also translated to the native language of each partner country for searching the papers: "critical thinking skills" / "thinking" / "dispositions" / "attitudes" / "higher education" / "universities" / "faculties" / "programs" / "students" / "interventions" / "strategies" / "practice". These search keywords could be used in the title or descriptor/topic. **This search resulted in a total of 276 articles**. Table 1 shows the number of papers searched by each partner.

2) ***Selection of papers for analysis****:* Each partner assessed the papers to ensure they met rigorous selection criteria. The studies that seemed to meet the criteria were listed by means of electronic-database searching, and then the abstracts of the papers were screened to see if they met the inclusion criteria. The following inclusion/exclusion criteria were agreed by the partners: a) only peer-review articles concerning CT interventions in HE were included; b) only empirical-based research rather than theoretical-based research was included; c) articles which did not meet quality criteria in their methods, such as c.1) papers which did not present and describe an CT assessment method or c.2) papers that only included students' opinions as CT assessment method, were excluded; d) book chapters, proceedings or thesis were also excluded.

This filter narrowed the set of **analysed articles to a total of 46**. From those, 31 were published in the last seven years (2010-2017) and 7 papers were very recent publications (2016-2017), whereas 15 were published from 2000-2010. Papers distribution by database is displayed in Table 2. Fifteen of those papers were published in high impact international databases such as the Web of Science (Clarivate Analytics), ESCI (the Emerging Sources Citation Index by Thomson Reuters/Clarivate Analytics) and SCOPUS, while 31 papers were part of medium-low impact databases, such as Dialnet and SciELO (Scientific Electronic Library Online).

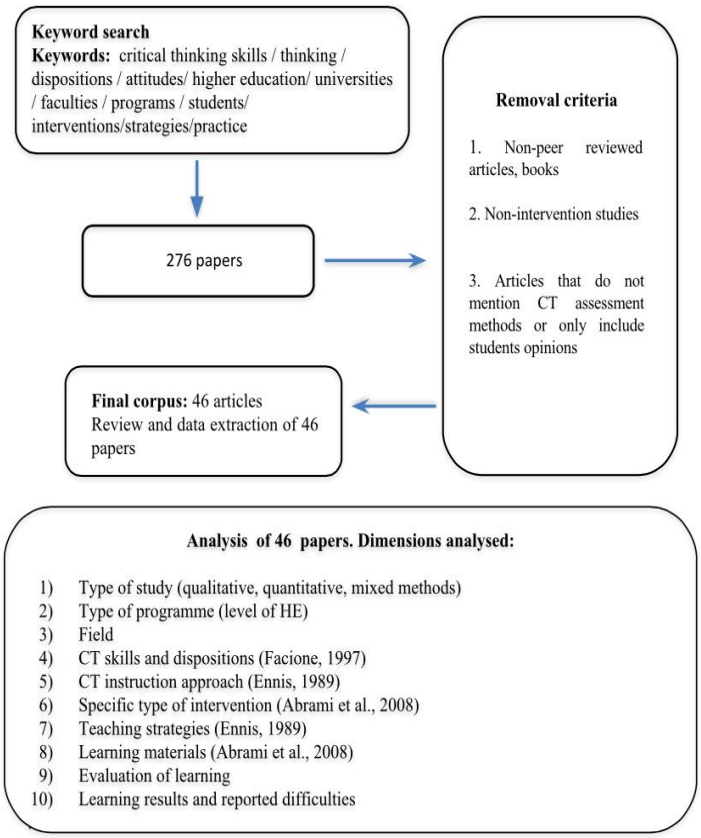

Figure 1. Summary of the selection of papers and the process of analysis

Table 1. Number of CT articles searched by each CRITHINKEDU partner

Partners	Coding	Articles retrieved using the keywords	Articles excluded
Belgium (UC Leuven and KU Leuven)	BE	100	100
Czech Republic (VSE)	CZ	16	16
Lithuania (Modern Didactics Centre)	LT	17	5
Greece (UOWM and TEI)	GR	2	2
Ireland (University College Dublin)	IE	11	11
Italy (UNIROMA3)	IT	42	36
Portugal (UTAD)	PT	72	49
Romania (ASE Bucuresti)	RO	7	5
Spain (USC)	SP	9	6
TOTAL		**276**	**230**

3) ***Review, data-extraction and analysis****:* the papers were examined by each partner according to a rubric (Supplementary document 1[6]), built together by the leading partners of the CRITHINKEDU_O2 and CRITHINKEDU_O4, considering the results from CRITHINKEDU_O1 and previous literature review studies on CT interventions (e.g., Abrami et al., 2008; Tiruneh et al., 2014; Abrami et al., 2015). Two main dimensions were included in the rubric: 1) information about the type of the study, in particular, the research methodology used, the field and level of HE addressed; and 2) the instructional methods and resources used to promote CT. The examination of this second dimension included six sub-dimensions: a) *CT aims* (skills and dispositions that are addressed or promoted); b) *CT overall approach*; c) the *type of intervention*, d) the *teaching strategies*; e) the *learning materials*; and f) the *learning assessment* and the *difficulties reported*. For the analysis, we drew from previously established categories provided by Facione (1990), Ennis (1989; 2016) and Abrami et al. (2015). Part of them are briefly described in the following paragraphs.

Table 2. Distribution of selected academic papers in databases

Database[7]	RCAAP	Web of Science	SCOPUS	ESCI	EBSCO	SciELO	Index Copernicus	RACO	DIALNET	LITHUANITISKA	C. E. E. O. L.	TOTAL
Number of papers	12	9	4	2	8	2	3	1	1	3	1	46

[6] For more information, please see http://bit.ly/Supplementary1-O2
[7] This list includes both medium/low international databases (RCAAP; SciELO; Index Copernicus; RACO; DIALNET; LITHUANITISKA; and CEEOL) and high-impact ones (Web of Science; SCOPUS; ESCI; and EBSCO).

a) *CT aims (skills and dispositions)*: There is a consensus that CT, as a broad concept, involves both skills and dispositions (Facione, 1990). In 1990, the American Philosophical Association funded a two-year research project to determine CT skills. They assembled a panel of 46 experts with US and Canada, representing disciplines in Humanities, Science, Social Science and Education, and conducted a Delphi study. The APA Delphi Report indicates (Facione, 1990, p.2): "*Critical thinking is the process of purposeful, self-regulatory judgment, attending to the evidential conceptual, methodological, criteriological, or contextual consideration upon which that judgment is based (…)*". Those experts stated that critical thinkers approach specific issues, questions or problems with "*clarity in stating the question or concern, orderliness in working with complexity, diligence in seeking relevant information, reasonableness in selecting and applying criteria, care in focusing attention on the concern at hand, persistence through difficulties encountered, precision to the degree permitted by the subject and the circumstances*" (Facione, 1990). The six core CT skills set by the experts are **interpretation**, **analysis**, **evaluation**, **inference**, **explanation**, and **self-regulation**. The definition of each one is presented below.

Interpretation: "*to comprehend and express the meaning or significance of a wide variety of experiences, situations, data, events, judgments, conventions, beliefs, rules, procedures, or criteria.*" (Facione, 1990, p.16)

Analysis: "*to identify the intended and actual inferential relationships among statements, questions, concepts, descriptions, or other forms of representation intended to express belief, judgment, experiences, reasons, information, or opinions.*" (Facione, 1990, p.17)

Evaluation: "*to assess the credibility of statements or other representations which are accounts or descriptions of a person's perception, experience, situation, judgment, belief, or opinion; and to assess the logical strength of the actual or intended inferential relationships among statements, descriptions, questions or other forms of representation.*" (Facione, 1990, p.18)

Inference: "*to identify and secure elements needed to draw reasonable conclusions; to form conjectures and hypotheses; to consider relevant information and to deduce the consequences flowing from data, statements, principles, evidence, judgments, beliefs, opinions, concepts, descriptions, questions, or other forms of representation.*" (Facione, 1990, p.19)

Explanation: "*to state the results of one's reasoning; to justify that reasoning in terms of the evidential, conceptual, methodological, criteriological and contextual considerations upon which one's results were based; and to present one's reasoning in the form of cogent arguments.*" (Facione, 1990, p.21)

Self-regulation: "*self-consciously to monitor one's cognitive activities, the elements used in those activities, and the results deduced, particularly by applying skills in analysis and evaluation to one's own inferential judgments with a view*

toward questioning, confirming, validating, or correcting either one's reasoning or one's results." (Facione, 1990, p.22)

Table 3 summarizes the CT skills and subskills reported in the Delphi Report that have been used for the analysis of CT in the literature review and in the teachers' interviews (*section 3* of this report).

Table 3. Summary of CT skills and subskills according to Facione (1990)

SKILL	SUBSKILL
INTERPRETATION	Categorize Decode significance Clarify meaning
ANALYSIS	Examine ideas Identify arguments Identify reasons and claims
INFERENCE	Query evidence Conjecture alternatives Draw logically valid or justified conclusions
EVALUATION	Assess credibility of claims Assess quality of arguments that were made using inductive or deductive reasoning
EXPLANATION	State results Justify procedures Present arguments
SELF-REGULATION	Self-monitor Self-correct

Using the findings of the APA Delphi Report (Facione, 1990), Facione & Facione (1992) identified further seven attributes/dispositions for CT. These attributes are defined below.

Truth-seeking: "*Being eager to seek the best knowledge in a given context, courageous about asking questions and honest and objective about pursuing inquiry even if the findings do not support one's self-interests or one's preconceived opinions.*" (Facione, Sánchez, Facione & Gainen, 1995, p.8)

Open-mindedness: "*Tolerant of divergent views and sensitive to the possibility of one's own bias.*" (Facione et al., 1995, p.6)

Analyticity: "*Prizing the application of reasoning and the use of evidence to resolve problems, anticipating potential, conceptual or practical difficulties, and consistently being alert to the need to intervene.*" (Facione et al., 1995, p.7)

Systematicity: "*Being organized, orderly, focused and diligent in inquiry.*" (Facione et al., 1995, p.7)

Self-confidence: "*Trust the soundness of one's own reasoned judgements and inclination to lead others in the rational resolution of problems.*" (Facione et al., 1995, p.8)

Inquisitiveness: "*One's intellectual curiosity and one's desire for learning even when the application of the knowledge is not readily apparent.*" (Facione et al., 1995, p.6)

Cognitive maturity: "*Approach to problems, inquiry and decision making with a sense that some are necessarily ill-structured, some situations admit of more than one plausible option and many times judgements must be made based on standards, contexts and evidence which preclude certainty.*" (Facione et al., 1995, p.9)

Table 4, presented below, summarizes the dispositions and sub-dispositions according to Facione & Facione (1992).

Table 4. Dispositions and sub-dispositions according to Facione & Facione (1992)

DISPOSITION	SUB-DISPOSITION
TRUTH-SEEKING	Eagerness to seek the best knowledge in a given context Courageous about asking questions Honest and objective about pursuing inquiry
OPEN-MINDEDNESS	Tolerance to divergent views Sensitivity to personal bias
ANALYTICITY	Application of the reasoning and the use of evidence to resolve problems Anticipating potential conceptual or practical difficulties and readiness to intervene
SYSTEMATICITY	Being organized, orderly, focused and diligent in inquiry Organized approaches to problem-solving and decision-making
SELF-CONFIDENCE	Trust of one's reasoned judgements Inclination to lead others in problem-solving
INQUISITIVENESS	Intellectual curiosity Desire to learn
COGNITIVE MATURITY	Concrete context based approaches Taking into consideration different opinions, ethical norms.

b) *CT instructional approach:* According to the Delphi panel experts, CT cannot be considered as a body of knowledge to be delivered to students as one more school subject along with others. CT can occur in programs rich with discipline-specific content or in programs that rely on the events of everyday life as the basis for developing one's CT. Ennis (1989, p1.) affirms that incorporating the CT in higher education curricula brings out what he called the curriculum question: "*Should we have a separate course or should we embed CT in the standards courses we are teaching*

anyway?". This author advocated for a third alternative that only few authors considered - the mixed approach. Therefore, the curriculum question is: "*Should CT be taught separately, embedded or both?*". Ennis (1989) categorized the various approaches to CT instruction as general, infusion, immersion, and mixed. Table 5 summarizes these four approaches:

In the **general approach**, CT is taught separately from the presentation of the content of an existing subject-matter.

The **infusion approach** is a "*deep, thoughtful, and well-understood subject-matter instruction in which students are encouraged to think critically in the subject*" (Ennis, 1985, p. 5). It attempts to integrate CT instruction in standard subject-matter instruction and makes the general principles of CT explicit to the students. This approach stems from debates concerning whether a generalist or specific method is the most effective way to teach CT in HE.

The **immersion approach** also tries to incorporate CT within standard subject-matter instruction. However, general CT principles and procedures are not made explicit to students.

The **mixed approach**, named by Sternberg (1986), consists of a combination of the general approach with either the infusion or immersion approach. In the mixed approach, there is a separate thread or course aimed at teaching general principles of CT, but students are also involved in subject-specific CT (Tiruneh et al., 2014).

Table 5. CT instructional approaches (Sternberg, 1986; Ennis, 1989)

CT Instructional Approach	Description
GENERAL	CT abilities and dispositions are taught separately from the content.
INFUSION	CT is integrated in subject-matter instruction. General principles of CT are made explicit. Course's content is important.
IMMERSION	Integrates CT in subject-matter instruction. General CT principles are not made explicit. Course's content is important. Instruction is thought-provoking.
MIXED	Subject specific CT instruction + teaching of general principles of CT. CT is taught as an independent track within a specific subject Content course.

We should keep in mind that a variety of practical and theoretical considerations exist, such as the recurring question whether CT is a specific domain or not. Controversy remains on whether CT includes a set of generic skills that apply across subject domains (Ennis, 1989; Siegel, 1992) or if CT can only be taught in the context of a

specific domain - assuming that a domain-specific knowledge is a precondition to CT development (Willingham, 2008). In this context, current research considers CT as a generic skill that is influenced by the culture of the discipline in which it is taught and/or practiced (Jones, 2009; Grace & Orrock, 2015; Sin et al., 2015). This is because what constitutes valid evidence, arguments and standards tends to vary across domains, depending upon the epistemological context (Jones, 2010).

c) *The type of intervention:* We have drawn from Abrami et al. (2015) categorization of instruction interventions. These authors expanded the analysis beyond a single instructional classification scheme and offered a fine-grained approach, which might explain more of the variability in CT outcomes, and may highlight especially effective instructional approaches.

d) *CT teaching strategies*: Ennis (2016) describes two basics teaching methods for promoting CT, the **Lecture-Discussion Teaching (LDT)** and the **Problem-Based Learning (PBL)**, which contrast with each other. According to Ennis, LDT is the most common approach to college teaching. There is a lecture (usually accompanied by some reading in a textbook) presenting one or more 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 method calls for dealing with a subject-matter issue, usually requiring investigating, developing, testing, and discussing of hypotheses or solutions and possible alternatives. Ennis (2016) proposes PBL as a strategy to impart lectures about CT in which the teacher can present, explain, challenge and interact with the students; engaging them in discussions with practical examples that foster argumentation and inquiry practices. According to Niu, Behar-Horenstein & Garvar, (2013) and Pithers & Soden (2000), PBL is one of the most widely-used learning approaches in CT instruction because it is motivating, challenging and enjoyable [e.g., since PBL might require more instruction skills, training, effort, and preparation time than LDT, the relative costs and benefits should also be explored (Ennis, 2016)].

e) *Synthesis and quantitative/qualitative data*: a summary of the analysis of all papers was presented in one table (Table 6) by each partner country, retrieving the patterns regarding the distribution of papers according to the research method used within each study, the field and level of HE addressed, as well as the aspects of the instructional practice (e.g., CT approach, intervention and teaching strategy). Tables 7 and 8 provide a general overview for these data.

All the papers were assigned into four larger categories representing different curricular areas, adapted from several European classifications (e.g., Erasmus Subject Areas Codes; DFG Classification of Scientific Disciplines, Research Areas, Review Boards and Subject Areas), namely: **Biomedical Sciences**, **STEM – Science, Technology, Engineering and Mathematics –, Social Sciences**, and **Humanities**. These categories, the same used in the "A European collection of the Critical Thinking skills and dispositions needed in different professional fields for the 21st century"

report (CRITHINKEDU_O1, 2018), were adopted for data analysis purposes since they are similar to the main study fields taught in the different EHEI. That takes in account the final aim of the project CRITHINKEDU: adapt the existing European university curricula in terms of CT skills and dispositions needed for the 21st century societal and labour market challenges. On the other hand, Tables 9 to 11 address the instructional approaches and resources used for promoting CT practices as well the assessment methods

The descriptive information about each CT paper and the analysis made according to the rubric developed is presented in Supplementary document 2[8].

2.2. Findings

2.2.1. An overview on CT educational interventions research

This section provides an overview on CT interventions in EHEI based on the analysis of the literature review carried out by each partner and consolidated by the USC team (see Supplementary document 2 for the full analysis of the literature review). Table 6 displays the distribution of papers within fields and a general overview of the analysis of CT interventions is summarized (refer to Table 7) and finally discussed.

CT intervention studies in EHEI were carried out in diverse fields (Table 6 and 7), although the majority were related to Social Science studies (18 out of 46 papers). Education was the most frequent domain within this field (15 out of 18 papers). STEM was the second most frequent field (n=9). Half of the studies in STEM corresponded to Engineering while the other half were distributed between Chemistry (2), Natural Sciences (1) and Physics (1). CT studies in Mathematics were not found in the literature review. Interdisciplinary papers corresponded to studies that used a multi and/or interdisciplinary model or that had been implemented in multiple university degrees.

Regarding the level of HE, most studies were mostly carried out in experiences with graduate students (21 out of 46 papers) and undergraduates (22 out of 46) and only two studies with both of them. One study did not specify the targeted level of HE.

With respect to the CT approach, the type of intervention or the teaching strategies (Table 8), it is possible that one paper is included in more than one category; therefore, the frequencies in each dimension may be higher than the total number of analysed papers (N=46).

[8] For more information, please see http://bit.ly/Supplementary2_O2

Table 6. Summary of the literature review on CT educational intervention studies in EHEI

Partner/ No. papers	Methods	Fields	Level	CT approach	CT intervention	CT strategies
UTAD (PT) N=23	Mixed (12) Qualitative (8) Quantitative (3)	STEM (6) Social Sciences/ Education (4) Biomedical Sciences (4) Several fields (7) Not mentioned (2)	Undergraduate (13) Graduate (8) Both graduate & undergraduate (2)	Immersion (13) Infusion (5) General (4) Immersion & Infusion (1)	Self-study & Dialogue (12) Self-study & Dialogue & Authentic situations (8) Self-study & Authentic situations (2) Self-study & Dialogue & Mentoring (1)	Lecture discussions (argumentation) (17) Subject-matter tasks (11) Problem solving (inquiry) (7) Explicit explanation (7) Peer review (5) Questioning (4) Project-based learning (3) Conceptual mapping (3) Analogies (1) Storyboarding (1) Hands-on learning (1) Case study (1) Tutorial orientation (1) E-learning (9) • Online peer review (3) • Online forums (5) • Online tool for argumentative discussion (1)
UNIROMA3 (IT) N=6	Qualitative (3) Mixed (3)	Social Sciences (4) Biomedical Sciences (2)	Undergraduate (5) Graduate (1)	Immersion (6)	Dialogue (3); Authentic situations (2); Mentoring (1)	Lecture discussions (4), Problem solving (2), E-Learning (2)
ASE BUC (RO) (N=2)	Qualitative (1) Quantitative (1)	Social Sciences (2)	Undergraduate (2)	Mixed & general (1) Infusion (1)	Dialogue & authentic situations & mentoring (1) Not specified (1)	Problem solving (inquiry) & Lecture discussions (argumentation) (1) Problem solving (1)
MDC (LT) N=12	Mixed (1) Quantitative (6) Qualitative (5)	Social Sciences (10) Humanities (1) Biomedical Sciences (1)	Graduate (11) Not defined (1)	Immersion (7) Infusion (3) Mixed (1) General/ infusion (1)	Self-study (8) Interview & (content) analysis & reflective diary & reflective essay & analysis (1) Experiment (2) Self-study & experiment (1)	Problem solving (1) Problem solving & lecture discussion/argumentation (2) Problem solving & E-learning (2) Metacognitive T/L strategies (1) E-Learning & lecture discussion/argumentation (1) Peer-observation & self-evaluation (1) Cooperative learning (1) Lecture & discussion/ argumentation (1) Not defined (2)
USC (SP) N=3	Mixed (2) Quantitative (1)	STEM / Science (3)	Undergraduate (1) Graduate (2)	Immersion (3)	Self study & authentic situation (1) Dialogue & self-study & peer-assessment (1) Not mentioned (1)	Argumentation (1) Problem-based learning (1) Problem-solving & argumentation (1)

Table 7. Distribution of CT educational intervention studies by fields

Fields	N	Specific domains
STEM	9	Engineering (5) Chemistry (2) Natural Sciences (1) Physics (1)
Social Sciences	20	Education (16) Psychology (4)
Biomedical Sciences	7	Health Science (3) Nursing (1) Veterinary (1) Biomedical Sciences (1) Agriculture (1)
Humanities	1	Ethics
Diverse fields	7	Interdisciplinary and/or multidisciplinary studies
Not specified	2	Field not identified

Most studies on CT interventions used a mixed (18 out of 46) or a qualitative methodology of research (17 out of 46). The most commonly adopted CT Approaches were Immersion (29 out of 46) and Infusion (9 out of 46) while General and the Mixed Approaches were the least used (4 and 1 studies, respectively). When analysing the Interventions and Teaching methods/strategies (according to Abrami et al., 2015), the most frequent intervention was Self-Study (34 out of 80), followed by Dialogue (25 out of 80). Real scenarios or Authentic situations were also quite common (13 out of 80) (Table 8).

The most commonly adopted CT approaches are Immersion and Infusion – both are subject-matter instruction

Following Ennis's (2016) categorization of CT instruction methods, we found that 22 papers reported LDT and 9 PBL methods. Eight studies used a combined method, namely PBL plus lecture discussions or argumentation. Five other papers were coded in other categories different from Ennis's (2016): subject-matter tasks (2); Metacognitive learning strategy (1); peer observation and self-evaluation (1) and cooperative learning (1). Two other studies did not explicitly mention the strategy used and were classified as "not mentioned". E-learning was used as a learning environment in 14 CT intervention studies (Tables 8 & 9). Most of those studies (11 out of 14) consisted in online forums where the students discussed and argued; two were related to the use of problem-

based teaching strategies while the rest combined both, argumentation and problem-based learning.

Table 8. Distribution of CT educational intervention studies by methodology of research, CT approach, type of intervention and teaching methods/strategies

Dimensions analysed	Totals	Methods	Quantitative results
Methodology of research	46	Mixed methods	18
		Quantitative	11
		Qualitative	17
CT Approach	46	Immersion	29
		Infusion	9
		General	4
		Mixed	1
		General + infusion	1
		General + mixed	1
		Immersion + infusion	1
Type of intervention	80	Self-study	34
		Dialogue	25
		Authentic situations	13
		Mentoring	2
		Not mentioned	1
		Peer-assessment	1
		Experiment	3
		Interview, reflective diary & reflective essay analysis	1
Teaching methods /strategies	45	LDT (lecture discussion, argumentation & peer review)	22
		PBL (inquiry)	9
		LDT+PBL	8
		Other categories	4
		Not mentioned	2
E-learning environment	14	Argumentation in e-learning (includes 2 online forum)	11
		Problem-based in e-learning	2
		Argumentation and PBL	1

Table 9 summarizes the analysis of CT interventions in the literature review according to the study fields. In some dimensions the frequencies are higher than the total number of analysed papers (n=46) since those can be categorised in several sub-dimensions.

Table 9. CT interventions in the CRITHINKEDU literature review by fields

	STEM	Social Sciences	Bio medical	Humanities	Not specified	Diverse fields
Type of study						
Quantitative	2	7	1	-	-	1
Qualitative	2	8	2	1	-	4
Mixed Methods	5	5	4	-	2	2
CT approach						
Immersion	7	12	6	1	2	1
Infusion	2	4	1	-	-	2
General	-	-	-	-	-	4
Mixed	-	1	-	-	-	-
General + Infusion	-	1	-	-	-	-
General + Mixed	-	1	-	-	-	-
Immersion + Infusion	-	1	-	-	-	-
Type of intervention						
Self-study	8	12	5	-	2	7
Dialogue	6	7	3	-	2	7
Authentic situations	4	1	6	-	-	2
Mentoring	-	1	-	-	-	1
Not mentioned	1	-	-	-	-	-
Other	Peer-assessment (1)	Experiment (3)	-	Interviews, reflective diary and reflective essay analysis (1)	-	-
Teaching methods/strategies						
LDT	4	8	1	-	2	7
PBL	1	4	4	-	-	-
LDT + PBL	2	4	2	-	-	-
Not mentioned	-	2	-	-	-	-
Other	Subject-matter tasks (1)	Peer-observation and self-assessment (1) Cooperative learning (1)	-	Metacognitive learning strategy (1)	-	-
E-learning						
LDT (includes online forums)	3	3	1	-	-	4
PBL	-	1	-	-	1	-
LDT + PBL	-	-	1	-	-	-

2.2.2. CT learning outcomes and difficulties

This section presents the current CT educational practices in EHEI according to the teaching methods and strategies reported in the 46 analysed CT intervention studies. Tables 10, 11 and 12 compare these results amongst fields, regarding the learning materials, assessment methods, CT outcomes and difficulties.

A total of 46 CT intervention studies from 9 European countries were analysed

PBL (N=10): Problem-Based Learning studies were carried out in three fields: Biomedical and Social Sciences (both with 4 out of 10), and STEM (2 out of 10). These studies provide diverse contexts and learning scenarios to promote CT. Most of them use real-world experiences (e.g., authentic situations) or workplace-based scenarios (e.g., clinical cases) that engage students in problem-solving and decision-making. Teacher's role consists mainly in guiding the activity as a facilitator, providing support and feedback. For the CT skills assessment, diverse type of tests, questionnaires and interviews were performed, but also rubrics were built for assessing students' level of competency in CT. Although positive results were found in general (e.g., better understanding of CT notion, improvement in terms of self-reflection and self-knowledge, clinical reasoning, reflexive thinking, creativity, autonomy, etc.), the majority were based on teachers' and students' perceptions - lacking other assessment methods or research designs needed to measure the effect size of the educational intervention.

In some of these papers, the authors reported difficulties related to students' lack of motivation and/or the workload of the teacher, whereas others did not report any difficulty and only provided information about the research limitations. Among the identified limitations, the small number of participants and constraints with the assessment instruments were included. In particular, the limitations of the rubrics used for CT skills assessment and the lack of standardized questionnaires were mentioned. For instance, one study reported in STEM (P45) that students worked collaboratively to reach to an agreement on what CT was and how to measure it. A rubric for peer-assessment and a questionnaire (open questions) for self-assessment were applied to measure overall students' CT competencies using 4 criteria (number of arguments, quality of arguments, explain yourself, and listening to the others); nevertheless, when compared, no significant differences between the pre- and post-intervention scores were found.

PBL in Biomedical Sciences studies used authentic situations consisting in clinical cases and/or workplace-based scenarios (applied to nursing and/or veterinary medicine) to engage students in clinical reasoning and diagnosis processes. Most of the studies were carried in Nursing degrees. For instance, P13 proposes the recreation of problem situations requiring the application of nursing care standardized processes (according to Murphy, 1997), in which students should be able to structure

the initial evaluation of a patient and family, elaborate the appropriate diagnosis, identify the main objectives and actions, and define the resulting criteria. Based on a survey assessing the students' perceptions and a participatory observation, studies such as P13 defend that, by using problem situations, students were abler to transfer and contextualize knowledge. This strategy helped students to develop dispositions through the enhancement of their self-confidence, empowering them to become more reflexive and querying professionals. Moreover, students were able to identify and mobilize previous knowledge and integrate it with new one. The skills and dispositions developed were critical, analytical and reflexive thinking when confronting different ideas, respecting the other's opinion as well as creativity, autonomy, motivation and decision-making. One paper (P28) consisting in an experimental study with 1 control group and 1 intervention group was analysed. It reported positive results in terms of CT skills development with students in Biomedical Sciences (Nursing). In P28, with an Immersive approach supported by the analysis of a case study with diagnostic tasks and patient's history, students increased their inference skills. Through the application of a standardized evaluation, researchers assessed the mistaken diagnosis hypotheses made by students using the same case history, and found that those who had intensive tutorial strategies aimed at developing CT skills formulated fewer wrong hypotheses.

Problem-Based Learning (PBL) was the most common strategy in the Biomedical and Social Sciences, and STEM fields

PBL in STEM studies used different group dynamics techniques and peer-assessment to promote CT. They defended their usefulness in helping students to understand better what CT is and to reflect on the need of backing-up their opinions with evidences. One study (P1) engaged students in a Product Design Development project for the promotion of healthy eating habits. Based on the Cornell Critical Thinking Test (CCTT) – Level X (Ennis & Milman, 1985) and the TAEC Creativity Test (De la Torre, 1991) data, the intervention contributed to develop the enhancement of students' creative performance and metacognitive reflection (the ability that students developed to perceive the thinking styles they should/should not activate when generating ideas). It also promoted students' self-reflection and self-knowledge while helping them manage and guide their own course of action through the project.

PBL in Social Sciences studies were developed in Education. Despite the fact that the studies were not solid on their conclusions, they pointed out to students' use of certain abilities related to CT, such as comparing and analysing, as shown in paper P31.

Table 10 summarizes the results of PBL studies in each field in terms of Learning materials, CT Assessment, CT results, Difficulties and limitations.

LDT (N=20): This category includes studies engaging students in argumentation; most of them corresponded to argumentation studies in the context of critical evaluation. They were implemented in Social Sciences (8 out of 20), STEM (5 out of 20), but also across diverse fields (7 out of 20) such as Biomedical Sciences and Humanities. Table 11 summarizes the results for this category in STEM and Social Sciences. LDT studies used opinion texts or Socio-Scientific Issues (SSIs) information and/or articles from media to involve students in the critical analysis of information and argumentative discussions. Students had to express their own opinions and arguments orally and/or in writing. The learning materials included mainly texts on scientific or socio-scientific topics retrieved from diverse sources (journal articles, textbooks, internet, books, etc.). For instance, in Social Science studies, they addressed texts from classic authors (e.g., Galileo, Descartes).

Lecture Discussions (LDT) was not only implemented in Social Sciences and STEM, but also in Biomedical Sciences and Humanities

LDT studies provided different *argumentative contexts* in order to enhance CT skills, being argumentation for decision-making and for critical evaluation the most frequent context appearing in those papers. For instance, in one study (P19) students debated in groups about a problematic and/or dilemma (e.g., studying outside in a foreign country – yes or not? Working outside in a foreign country – yes or not? etc.) in which they had to assume their own point of view. Students exchanged arguments in order to consider the most relevant alternatives and then each student had to explain his/her process of decision making, justifying it based on Nosich's CT elements (2011). Another study (P44) analysed the critical capacity of students when provided with texts written by "experts": their argumentation skills, capacity to reflect and to defend a position regarding the SSIs.

Most LDT studies showed that fostering argumentation had a positive effect on other CT skills. They reported students' improvement on the CT skills related with "analysis", "evaluation" or the ability to make judgments on texts, as well as other cognitive skills. CT dispositions were also reported to be promoted in some of these studies. In P15, students recognized to have gained CT dispositions and skills during the activities. P7 and P8 reported an increase in students' individual responsibility and autonomy; P9 highlighted students' accountability for their own learning. Interpersonal skills and applicability in other courses (transference) (P15) as well as active listening (P26) were also cited as findings. Difficulties were not reported in the majority of the studies. However, some studies identified limitations of the development of the activities, namely the availability of institutional resources, the workload of students, the differences in students' background, among others. CT assessment methods included questionnaires, interviews (open or semi-structured), tests (pre- and post-test) and rubrics. Also, content analysis was used to assess students' arguments.

Table 10. Summary of PBL studies in Biomedical Sciences, STEM and Social Sciences

Fields	Learning materials	CT Assessment	CT results (skills/dispositions)	Difficulties & limitations
Biomedical Sciences (4) (P12, P13, P25, P28)	Clinical cases (P12, P13) FRISCO guidelines (Ennis & Goldman, 1991) (P12) Authentic situations (P28) Conceptual maps/algorithms (P12) Not reported (P25)	Interviews (P25) Learning artifacts based on FRISCO grid (Ennis & Goldman, 1991) (P12) Participatory observation (P13) Learning artifacts and statistical analysis (P28)	Diagnostic reasoning, interpretation, analysis, inference, evaluation (P28) Critical, analytical and reflexive thinking (P13) Creativity (P13) Autonomy (P13) Confidence (P13) Decision making abilities (P13) Questioning (P13) Good acceptance of the activity by students (P12) Explicit explanation improved analytical skills (P12) Lack of interpretation and evaluation skills (P12) Engagement in innovative teaching approaches (P25)	Small number of participants (P25) The lack of standardized questionnaires (P25) High number of students in the classroom (P12) Lack of proactivity by the students (P12) Need of more explicit instruction (P12) More intensive training (P28)
STEM (2) (P3, P45)	Group dynamics (P45) Logbook (P3)	CCTT Level X (Ennis & Millman, 2005), statistical analysis, and Teachers' perceptions (P3) Rubric developed by authors (P45)	Better understanding of CT notion (P45) Self-reflection & self-knowledge (P3) Not significant effect in CT performance (P45)	Related with the assessment instruments or the rubric used (P45).
Social Sciences (4) (P31, P32, P37, P43)	Scientific Poster (P31) Textbook materials (P32, P37) Weblogs (P43)	Quality of artefacts (P31, P37) Exams (P32) Students reflections (P43)	Ability to analyse, to compare, to share personal, experience. (P31) Students used certain capacities characteristic of CT (P31) Improvement of CT skills in general (P31) CT increased students' engagement with content and can be applied in learner centered activities (P37) Authentic students reflections in weblogs have value to develop CT skills (P43)	Students unable to self-evaluate and self-regulate their own skills (P43) Not mentioned (P31, P32, P37)

Three papers (P4, P16 & P18), consisting in different intervention studies reporting similar teaching strategies with students from Biomedical Sciences, STEM and Social Sciences, were analysed. With an Infusion approach, students engaged in a peer-review activity by analysing an article and reviewing the analysis of their peers (counter arguing them when applied), using the FRISCO guidelines and/or the SWOT analysis grid. Through the application of the CCTT (pre- and post-test), researchers found a positive increase in CT skills such as synthesis, analysis, inference and evaluation. Moreover, they found that explicit instruction and specific support to students are of utmost importance for the success of this type of CT activities - in which peers' feedback and rewriting tasks are powerful tools for CT skills and dispositions (such as open-mindedness) development.

Table 11 summarizes the results of LDT studies by fields in terms of Learning materials, CT Assessment, CT results, Difficulties and limitations.

PBL + LDT studies (N=8): Eight papers were included in this category. They were developed in 3 fields: Biomedical Sciences (2 out of 8), STEM (2 out of 8) and Social Sciences (4 out of 8). They used Problem-Based and Cooperative Learning techniques to engage students in argumentation and collaborative work. Learning tasks included, amongst others, interdisciplinary projects, reading and analysis of texts and articles from different sources and problem-based tutorials, among others. In all these studies, CT outcomes were positive. Reference was made to an increase on students' CT skills, particularly critical analysis in STEM and Biomedical Sciences fields.

Jointly, the combination of both PBL and LDT were used in 3 fields: Biomedical Sciences, STEM and Social Sciences

Those studies applied a variety of CT assessment instruments: formal CT tests (e.g., Cornell Critical Thinking Test [CCTT (Ennis & Milman, 1985)]; and other instruments, e.g., FRISCO guidelines (Ennis, 1987), or the SOLO Taxonomy (1982), for the evaluation of the learning assignments given to students. As already commented upon for the PBL and LDT studies, the main difficulties reported were related to the research and assessment methods.

Table 11. Summary of studies on application of LDT according to fields

Fields	Learning materials	CT Assessment	CT results (skills/dispositions)	Difficulties & limitations
STEM (N=5) (P4, P5, P6, P44)	SSIs controversial articles from media and literature review, diagrams and open-ended questions (P44) Lecture and laboratory sessions' resources; online forums in Moodle (P5, P6) Economic articles, FRISCO guidelines (Ennis & Goldman, 1991), SWOT analysis, N&S feedback model (Nelson & Schunn, 2009) (P4)	Pre-/Post-test about the course content and learning materials (P44) Survey on students' perceptions, CCTT Level X (Ennis & Milman, 1985), statistical analysis and quality of the artifacts based on FRISCO guidelines and N&S model (P4) Interviews & focus groups (P5, P6)	Students improve CT skills, but problem-solving skills were the most difficult ones to acquire (P44) Articles on controversial SSIs facilitate the understanding of the relationship between science and society (P44) Questioning information helps the development of CT skills such as inference and evaluation (detecting fallacies) and values such as democratic participation on science and technology (P44) Specific support, guidance, andexplicit instructions are of utmost importance for the success of this type of activities promoting CT and Students felt that their CT skills had increased in various domains (synthesis, evaluation, relating reasons and onclusions), confirming that the inclusion of feedback and the rewriting is a powerful tool for CT development (P4) Negative results in terms of students' participation and engagement in questioning due different learning design limitations and technical issues (P5, P6)	Lack of teacher training on giving feedback and students' understanding of FRISCO guidelines (P4) CCTT seems confusing, too long and the type of questions (multiple choice) seems to be too far from daily life problems and not suitable to assess accurately the bachelor students' CT skills (P4) Course duration is too short to trigger effective differences on CT level (P4) Assessment methods, learning design limitations and technical issues (P5, P6) Not mentioned (P44)
Social Sciences (N=8) (P7, P8, P9, P24, P26, P27, P29, P41)	Online forums (P27, P29) Online tool for argumentative discussions (P9) Texts from classic authors (Galileo, Descartes) (P24, P27, P29) and podcasts (P24) Scientific paper (P7, P8) Multimedia laboratories (P26) E-Learning materials (texts, tasks, case studies, etc.) (P41)	Assessment grids (P24) Semi-structured questionnaire (P26) Survey on students' perceptions (P7, P8) Students discussion' assignments based on Ennis (1987) or SOLO taxonomy (Biggs & Collis, 1982) (P9) Essay assessment grid to evaluate students' essays written by hand or using keyboard (P24) Semi-structured questionnaire to evaluate and assess students' changes and improvements in reflexive skills between the textual analysis of narrative logbooks and the use of laboratory experiences (P26) Pre-test in a form of essay, lexicometric analyses using a specific content analysis method to measure CT (Newman, Webb & Cochrane, 1995) (P27) Short essay and a survey to indicate the descriptive data of participants (P29) Students' self-evaluation, participatory observation (P41)	The online tool for argumentative discussions promotes a systematic reflection of students' questions and arguments, enabling the communication of results, questioning and argumentative levels of students (P9) CT increase in all categories, particularly the ability to argue (P27, P29) Students' development of deeper cognitive and analytical skills, the ability to make judgments about texts and to create texts (P41) Students' perceptions are positive in relation to cooperative learning activities in terms of CT development (synthesis, argumentation, respect for different perspectives), responsibility and autonomy (P7, P8) Students were satisfied with the use of multimedia laboratories and acquire a practice that gradually leads to an experience first-hand awareness of listening Positive results on CT development, particularly in argumentative skills (P27) Not reported (P24, P29)	Technical problems with the online tool (P9) Not reported (P7, P8, P24, P26, P27, P29 P41)

Papers P10 and P30 consisted in different experimental studies with control and intervention groups. In P10, using the Immersive and Infusive approaches in a Social Sciences teachers' training course, the effect of CT oriented Questioning using the FRISCO guidelines and other CT-driven strategies was compared to the the effect of Questioning not oriented towards CT and other non-CT driven strategies. Applying the CCTT (pre- and post-test), researchers found a statistically significant difference of CT level among the students subjected to strategies oriented to CT, who got higher results/performance (compared to the others). Similarly, in P30, different CT approaches were analysed and compared - an experimental group using a mixed approach (in which students were provided with internet articles, movies and philosophical essays about the subject' topics within a workshop format) and a control group using a general approach (in which students were only provided with lecture notes within a lecture-based format). Thus, applying the Ennis-Weir CT Test, researchers found that the experimental group, which practiced essay writing and questioning statements, showed better results in terms of reflexive and argumentative skills, than the control group. Another standardized test was applied, namely the LSAT[9] and results showed no significant difference between the two groups, although this might be due to the unfamiliarity of students regarding the test and the need for guidance as to when to apply it (as pointed by the authors).

LDT and PBL in STEM studies: These studies used texts from SSIs or laboratory resources as a way to engage students in problem-based solving and argumentation. One paper (P46) reported the application of Ennis, Paul and Lipman's ideas on CT as guidance to select the CT skills to be taught, and the respective operationalization. The tasks were embedded in a pedagogical cycle as follows: 1) students' chose a daily life problem related to physics; 2) they checked its theoretical basis; c) they read a text about Physics or current topics, and identified which arguments and reasoning the authors were providing; d) they carried out a personal essay expressing their own opinion; e) they presented solutions to solve the problem. The learning quality in the study was measured through two tests during the course, as well as a non-standardized pre- and post-test (used by the teacher only within the context of the intervention). The results revealed that skills related with critical analysis raised a total of 94% at the end of the intervention.

PBL and LDT in Biomedical Sciences studies: the two studies in this field used different learning tasks, as displayed in Table 12. Paper P11 proposed a multicultural experience, with two open-ended problem situations based on authentic and real scenarios, which students had to analyse and discuss in groups constituted by different European peers. They had to present the hypothesis and solutions that would best fit the situations in order to find the best one on a consensual basis. The main difficulties reported were related to the adoption of those new strategies by teachers

[9] LSAT (Law School Admission Test) was conceived and designed by the Law School Admission Council, USA, and adapted for Romania by the National Institute of Magistracy. The first part (50 items) is best suited for the assessment of one's abilities for logical reasoning. See more at https://www.lsac.org/jd/lsat/about-the-lsat

and also to the lack of transversal assessment criteria in order to effectively evaluate the learning of the different students. Paper P14 used a Multi-Method Learning Approach (MALA) with film- and problem-based tutorials to motivate students to start studying biochemical metabolic pathways and develop higher order thinking skills. Results showed the MALA approach was very successful and advantageous both in terms of grades and individual motivation to learn. Other dispositions such as creativity, accountability, autonomy and decision-making abilities were just found in one paper that addressed diverse fields.

Table 12 summarizes the results from studies using PBL + LDT according to fields regarding the Learning materials, CT Assessment, CT results, Difficulties and limitations.

2.3. Conclusions and implications for practice

The systematic literature review, with a sample of 46 empirical studies, provided an insight into the ongoing applied research on CT in EHEI within different fields. Overall, results showed that **research on CT interventions in EHEI has gradually increased** from 2000 onwards, reflecting the growing teachers' commitment and interest with the implementation of CT teaching and learning practices. Nevertheless, the data were often inconclusive and scarce evidence was found on the specific way(s) that CT interventions helped promote CT skills or dispositions. In particular, which were the main characteristics, criteria and principles supporting the effectiveness of educational interventions towards students' effective development of CT?

There is a preference for integrating CT instruction within subject-matter courses

The **majority of the studies reported CT aims that were limited to the cognitive level** (e.g., analysis, evaluation, argumentation, reflection, reasoning, etc.), underrating the importance of CT dispositions and the fact that CT is only developed with considerable practice and effort (Halpern, 2014; Saiz & Rivas, 2017). The theoretical frameworks underlying those interventions were mostly based on Ennis CT abilities and dispositions taxonomy (Ennis, 2016). Besides Ennis´s, other frameworks were used, namely: the CT elements of though (Paul, 2005); the Nosich´ s CT elements (Nosich, 2011); the SOLO taxonomy (Biggs and Collis, 1982); the Nelson & Schunn' s feedback model (2009), among others. It is surprising that there is no mention of the 'critical pedagogy' (Freire, 2000; Giroux, 2007) despite its importance and presence over the past 40 years and the fact that it is one of the main references within the CT movement (Paul, 2011). The undervaluing of CT dispositions is a major concern, suggesting that educators may be neglecting teaching and modelling them in the classroom. It is thus possible that European HE teachers are not educating their students to be critical thinkers, independently of their intellectual skills (Hamby, 2015).

Table 12. Summary of studies reporting the aplication of PBL + LDT according to fields

Fields	Learning materials	CT Assessment	CT results	Difficulties and limitations
Biomedical Sciences (N=2) (P11, P14)	Real-world problems (P11) Multi Method learning approach (MALA) with film & problem based tutorials (P14)	Statistical analysis of students' perceptions (P11, P14)	Critical, analytical and reflexive thinking, among other skills improved (P11) Students' positive motivation for engage with MALA approach in the development of CT (P14)	Related with the assessment methods (e.g., lack of transversal assessment criteria) (P11) Adoption of strategies by teachers (P11) Number of participants (P14)
STEM (N=2) (P3, P46)	Interdisciplinary project using a problem-solving technique (P3) Texts from several sources (textbooks, books, internet, etc.) (P46)	Statistical analysis of students' perceptions (P3)	Students found the role of tutor crucial to develop CT learning activities (P3) CT skills such as critical analysis were improved (P46) Problem-solving skills was the most difficult to develop by the students (P46)	Not reported (P3, P46)
Social Sciences (N=4) (P10, P30, P38, P42)	Internet articles about movies (P30) Philosophical essay (P30) Textbooks, articles, handouts, etc. (P38, P42) Hands-on activities and debates (P10)	LSAT-type testing and Ennis-Weir Critical Thinking Test (Ennis & Weir, 1985) (P30) CCTT Level X (Ennis & Millman, 2005); Statistical analysis (P10) Reflective essays and interviews (P38, P42).	Statistically significant differences at the CT level students subjected to strategies oriented to CT and those that did not have this orientation (P10) Positive and high results on students' CT level in the experimental group (with an integrated program of CT about everyday life problems) comparing to the control group (with a general course of CT) (P30) CT can be easily applied in teaching and learning processes through learner centered activities; CT makes academic and professional content interesting (P38, P42)	Related with the methodology (sample was not randomized) (P30) Not reported (P10, P38, P42)

Most studies reported CT aims limited to students' CT skills, underrating the importance of dispositions

Knowing that CT dispositions are so much valued by the business world and organizations (Dumitru, 2017; CRITHINKEDU_O1, 2018), we need to particularly reflect on how to bridge CT education in EHEI curricula to the societal and/or labour market needs. Are we, in EHEI, promoting a CT education that is able to cope with societal and labour market needs? If skills are to be developed through curricula, dispositions are to be developed through pedagogy. This is a crucial issue: what kinds of pedagogical strategies are likely to help develop CT dispositions? What is the relationship between CT skills and CT dispositions? Even in the studies using CT interventions with authentic situations and learning resources based on real world scenarios, it is not clear how CT dispositions were addressed and if the improvements in terms of CT were transferred to other contexts and trigger any type of critical action (Barnet, 2015).

Although the overall analysis indicates that **there is a preference for integrating CT instruction within subject-matter courses** (with the use of Infusion, Immersion or Mixed approaches), as found in previous reviews (Tiruneh et al., 2015), the reported studies tend to be **based mostly on an Immersive CT approach** (Ennis, 1997), in which CT principles are not made explicit to the students, assuming that the skills will be acquired once they engage in the subject-matter instruction. However, according to Saiz & Rivas (2017), the clearly identification and definition of CT skills to be developed is a critical element for the effectiveness of CT interventions, to be recognized by the students and taught directly by the instructor. The European HE teachers should be prepared today to implement and develop strategies fostering in a continuous, intentional and direct way, CT skills and dispositions in their students. Different reasons might explain this situation, including the lack of institutional support (Ennis, 2016), the educational culture persisting in European HEI (relying on short-term memorization, focused in getting high grades) (DiCarlo, 2009), or the lack of teachers' training for CT development and research across the curricula (Franco & Almeida, 2017), among others.

Studies that combined PBL with LDT strategies had a positive impact on students' motivation to engage in CT activities, as well as on CT skills development

The **majority of the CT interventions and teaching strategies reported were student-centred**, requiring active learning approaches and the students' deep engagement during the process. Here prevailed self-study and dialogue using authentic situations as well as a combination of different strategies, namely PBL, LDT, among others. Many studies engaged students in CT practices with argumentation regarding the evaluation of information from different sources (e.g., scientific articles, internet articles, texts, etc.). In the studies that combined PBL with LDT strategies, the educational interventions had

positively impacted upon students' motivation and engagement to learn, as well as upon the development of CT skills, such as analysis and argumentation. PBL studies seem to promote skills such as analysis in all the fields (Biomedical Sciences, STEM, Social Sciences), whereas LDT studies foster mainly argumentative skills and the ability to make judgments or question the information provided in texts. Few differences between the fields were found and they only existed in respect to the learning materials - in Biomedical Sciences, students were normally provided with real scenarios or authentic situations corresponding to clinical situations, while in STEM they were provided with SSIs texts or articles from diverse sources and learning activities in the lab, among others tasks. It seems that strategies oriented to CT (e.g., direct instruction, explicit explanation or guidance), the use of CT-driven materials (e.g., real-world or workplace-based situations), and teachers' support and feedback were crucial factors for the effectiveness and success of students' CT development. In this context, the teacher's role as a facilitator, guide and monitor of students' learning, together with his/her pedagogical knowledge is of utmost importance (Abrami et al., 2015). Nevertheless, the majority of studies presented some limitations and did not take into account important design principles for CT development - occasionally, it was not clear which CT skills were targeted during the instruction and why; what kind of learning activities were designed and how they were sequenced; and what type of role students and teachers assumed during the process. Furthermore, in relation to PBL and problem-solving, there was no clarification between these two concepts and how they effectively supported students' CT development. Is it possible that problem-solving has precisely the opposite effect of diminishing the space for freedom and authenticity that are part of genuine CT? In turn, is PBL used for further opening up questions (and no 'solutions'), and is it much more desirable to help promote CT?

Several studies failed to assess the results of CT interventions and ther impact in terms of students' CT improvement

In relation to CT learning assessment, some studies **failed to present a clear link between the reported interventions/strategies and the results in terms of CT outcomes**. This is a common limitation across the fields. While teachers reported having difficulties in assessing students' CT, the methods used to describe and assess CT results were limited or just slightly commented in some of the publications - most of them were based on teachers' and students' perceptions. On the other hand, the lack of evidence regarding how the strategies, used for short periods of time, would help promote specific CT skills and dispositions. **It seems possible that EHEI fail to recognize the limitations of short-term courses.** Either because they do not perceive the limitations related to the short-term specific CT course units or because they do not create the conditions to develop integrated CT practices across curricula, which together with few interventions in scattered subjects within a course, may constitute a serious obstacle to the reform of HE instruction (Paul, 2005). This study did not found any research finding related to permanency or generalization of CT skills

and dispositions, an important question according to Saiz & Rivas (2017). Also, only few papers reported experimental or quasi-experimental studies using control groups or standardized measures to assess the effect size of their interventions (9 out of 46; P1, P4, P9, P10, P12, P16, P18, P28 and P30). Therefore, the reported differences in CT were mainly based in a pre/post statistical assessment or the analysis of the learning artifacts produced by students, excluding other possible explanations for the reported improvements, e.g., maturation, academic experience, social interaction, dropouts, familiarity with the test, desire to improve (Ennis, 2016). Thus, we need **to keep mapping the impact of other variables in students' CT**, some of them already explored in previous literature (Franco & Almeida, 2017), as gender, academic performance, teaching experience and type of CT measuring (Tiruneh et al., 2014). Further studies should pay attention to these and other variables (e.g., social class, ethnicity, etc.). Also, different research (and interventions) designs (e.g., longitudinal and experimental studies with control groups) are desirable, along with the adoption of adequate assessment instruments other than the CCTT - Level X (Ennis & Milman, 1985) or the Ennis-Weir Test (Ennis & Weir, 1985), including the evaluation of situations requiring decision making or problem-solving processes, preferably related to the students' everyday life (Franco & Almeida, 2017).

Several difficulties were identified at three main levels: methodological, pedagogical and organizational

Finally, several difficulties were reported, such as Methodological [e.g., the study design or the data collection process and the need for more intensive and thorough studies; the use and application of the CCT Test to measure CT skills (which presents out of everyday context scenarios and is excessively long); or technical issues with the use of online tools], Pedagogical (e.g., concerning the difficulty to change and encourage the students' habits and dispositions for active learning approaches; the lack of teachers' pedagogical knowledge in assessing CT; the activity design and its perceived utility; or the need for additional resources to support learning), and Organizational (e.g., related to the increased workload to design, develop, manage and evaluate CT interventions). Thus, it is important to understand to what extent the reported difficulties can be overcome and what are the roles of the different stakeholders in the whole process of pedagogical, cultural and organizational change. Here, major concerns were related to the lack of time, teachers' workload, students' motivation and learning assessment. Development of active learning strategies, in particular targeting CT skills, are time-consuming and demand an increased workload from teachers whether to prepare the activities, assess students' performance or give timely feedback.

Several topics need further discussion and require a deep analysis of learning environments, e.g., "*What are the conditions that could enhance a classroom atmosphere of equity and openness between teacher and students*?"; "*How can teachers, with lack of time and excessive workload, start implementing CT practices and interventions ?"; "How can teachers promote students autonomy?*"; "*How can*

students be motivated to engage in CT development and to what extent can the use of different materials or the adoption of different CT strategies positively impact motivation?"; "*How can teachers align specific CT aims with different CT approaches, interventions, strategies, and assessment instruments?*"; "*How do teachers help students to live in a world where there are no answers or even perceptions that command a consensus?*"

As far as we are aware, this report represents one of the most recent systematic literature reviews on CT educational practices adopted by European Higher Education teachers (after Abrami et al., 2008; Tiruneh et al., 2014; Abrami et al., 2015). It provides a comprehensive summary of the practices used by educators and contributes to the characterization of strategies to promote CT education; it also results on a set of important considerations to be taken into account for any future agenda. Still, different research limitations were found, as the inability to access some of the publications initially selected. Also, other empirical studies reporting CT interventions in the European Higher Education context may have eluded the initial search pool because of the use of different field-related concepts and terminology, typical to a particular knowledge field (e.g., "clinical judgment" or "medical reasoning" in the Biomedical Sciences field), suggesting the need for field-driven literature reviews, as well as the inclusion of research papers from other European countries reporting CT practices in higher education (we only analysed published research attending to the partners' countries). Besides, a further thorough analysis may be performed to better understand the relation between CT specific dimensions and their effectiveness on students' CT development (e.g., CT approaches with Learning Results; CT materials with Learning Results; CT strategies with Learning Results). For a deeper analysis, different interviews to higher education teachers at national levels were carried-out. Their results are presented in the following section.

3. Teachers' interviews on CT educational practices

This section presents the results of the interviews applied to university teachers and carried out by all CRITHINKEDU partners. It intends to identify current CT interventions in EHEI and to get an insight on: a) how CT is being promoted in different fields of HE; b) what type of interventions, teaching strategies, and evaluation methods are being used to promote CT; and c) what challenges and limitations do teachers have to face nowadays in their CT instruction. According to Paul (2005), more evidence is needed on which strategies and interventions are the most effective for promoting CT (Paul, 2005). This analysis aimed to make a contribution to this point (see Supplementary document 3[10] for the full analysis of the teachers' interviews).

[10] For more information, see http://bit.ly/Supplementary3-O2

3.1. Methods

The procedures followed to design the interview protocol, along with the criteria used for the selection of participants and data analysis, are presented in the following paragraphs.

1) ***Design of interviews***: The interviews were designed to capture what CT interventions are currently promoted by university teachers in diverse fields of HE. Open-ended questions were formulated, covering a number of CT dimensions previously addressed in the literature review (section A of the present report). The dimensions addressed are: CT own concept, intent CT aims, overall approach, type of intervention, teaching strategies, learning materials, assessment, challenges, teacher training/instruction on CT and institutional barriers while promoting CT.

The content of the interview protocol was built upon Paul, Elder and Bartell (1997) interviews on teacher preparation for instruction in CT. These authors conducted interviews with education and subject-matter faculty in private and public colleges and universities, addressing a number of key aspects of teaching practices in CT. Some of these questions were adapted and used in this protocol.

Table 13. Interview' questions for teachers on CT educational practices

Interview questions
1. How would you explain to me your concept/idea of CT?
2. What particular aspects of CT do you believe are most important for your students to develop? And why?
3. Could you describe the practices (approaches/strategies/interventions) that you use in your classroom to foster CT? Please, give an example
4. Which learning materials do you use to promote CT in your classroom?
5. Do you assess CT abilities of your students? And how?
6. What challenges do you experience when developing CT in your students? How do you try to address them?
7. What type of instruction (or other) do you think should be provided to your colleagues to support the development of their CT teaching practices?
8. Are there any institutional barriers that limit the promotion of CT education?

2) ***Sampling design and procedure*****:** CRITHINKEDU partners discussed the criteria and procedures used for the selection of the participants during the process of planning the interviews in CRITHINKEDU_O2. A decision was made to select 5 university teachers from diverse fields, using the categorization already presented in the previous literature review (section A of the current report), underlying the fact that this would allow to get an integrated perspective on CT instruction at the university

level and the connection and possible comparison between CRITHINKEDU_O1 and CRITHINKEDU_O2 results.

3) *Conduct of interviews*: To facilitate the scheduling of interviews, CRITHINKEDU partners contacted in advance potential participants in their universities or in other universities. In this contact, the potential interviewee was informed about the project, the purpose of the interview, as well as on the procedure followed during its implementation. As soon as all participants were contacted and confirmed, dates for the interviews were settled.

4) *Data collection*: 53 protocol interviews were collected. Table 14 shows the distribution of interviews by fields within each partner country. All interviews were audio and video recorded, and then transcribed for posterior analysis). Each one was numbered randomly (I*n*).

Half of the interviews were carried out with teachers from Social Sciences

5) *Data analysis*: the transcriptions of interviews were submitted to qualitative content analysis (Mayring, 2010). All teachers' responses were analysed, question-by-question following these 4 stages:

5.1) Decontextualization (Break down the text into smaller meaning units): researchers got familiarized with the data and read through the transcript to obtain the sense of the whole, before it could be broken down into smaller meaning units. By "meaning units" we refer to the constellation of sentences or paragraphs containing aspects related to each other, covering different dimensions of CT addressed in the interview.

5.2) Recontextualisation: after the meaning units were identified in the transcript, we confirmed whether all aspects of the content had been covered.

5.3) Coding in pre-established categories: teachers' responses were coded into the main categories and subcategories defined previously (see Supplementary document 3). The rubric used for the analysis of the literature reviewed served this goal, although two more dimensions were added: CT instruction in teachers' training and institutional barriers. This process of responses categorization was based through deductive reasoning and was carefully reviewed.

5.4) Description of the results and quotes: results were illustrated with quotes from interviews in order to provide readers with a clear idea about how university teachers promote CT in their classes.

Table 14. Distribution of the interviewed teachers by fields and partner countries

Country	Domain	N	Field Categorised	TOTAL	TOTAL per Country
Belgium (KU Leuven & UC Leuven)	Education	2	Social Sciences	**6**	**10**
	Social Work	4			
	Medicine	1	Biomedical Sciences	**1**	
	Geology	1	STEM	**1**	
	History & Art	1	Humanities	**2**	
	History	1			
Czech Republic (UEP)	Education	4	Social Sciences	**5**	**5**
	Finance	1			
Greece (TEI of Thessaly & UOWM)	Biomedical Sciences	4	Biomedical Sciences	**4**	**10**
	STEM	1	STEM	**3**	
	ICT	1			
	Science	1			
	History	1	Humanities	**1**	
	Psychology	1	Social Sciences	**2**	
	Education	1			
Italy (UNIROMA 3)	Health	1	Biomedical Sciences	**1**	**5**
	Computer Science	1	STEM	**1**	
	Education	3	Social Sciences	**3**	
Romania (ASE Bucuresti)	Archeology	1	Humanities	**3**	**5**
	Philosophy	1			
	Business Ethics	1			
	Architecture	1	STEM	**2**	
	Chemistry	1			
Spain (USC)	Education	5	Social Sciences	**5**	**5**
Portugal (UTAD)	Engineering	2	STEM	**2**	**5**
	Social Science	2	Social Sciences	**2**	
	Biomedical Sciences	1	Biomedical Sciences	**1**	
Lithuania (MDC)	Philosophy	2	Humanities	**3**	**5**
	Culture	1			
	Social Work	1	Social Sciences	**2**	
	Education	1			
Ireland (UCD)	Nursing	2	Biomedical Sciences	**2**	**2**
	Engineering	1	Engineering	**1**	**1**
TOTALS per field			**STEM**	**9**	**53**
			Biomedical Sciences	**9**	
			Social Sciences	**26**	
			Humanities	**9**	

3.2. Findings

3.2.1. An overview on CT educational practices used by university teachers

Table 15 summarizes the quantitative results of the interviews analysis by fields. Half of the interviews (26 out of 53) were carried out with teachers from Social Sciences, the others coming from Biomedical Sciences (9 out of 53), STEM (9 out of 53), and Humanities (9 out of 53). However, frequencies presented in each dimension, as CT definition, can be higher than the total number of interviews, since the respondent could have mentioned different categories. For instance, CT as a set of skills. As shown in Table 15, regarding the CT dimensions, a category called "other" was added. It compiles all responses that did not fit into the definition of the pre-established categories included in the rubric used in this analysis. A clear example is when teachers provided a definition of CT different from the Facione's (1990). The category "not mentioned" corresponds to the absence of responses.

In the following paragraphs, findings are discussed in relation to each CT dimension.

***Definition of CT**:* The majority of the interviewees (50 out of 53) define CT as a "set of skills and/or dispositions" in line with Facione´ definition (1990). They explicitly mentioned them during the interviews. It needs to be noted that the interviewees do not provide a literal definition according to these authors, but the coding fits into the pre-established categories, summarized in Table 15. An example is reproduced below:

"*I think CT is a thinking attitude and also a skill that might consists of several sub-skills or processes that characterizes this (…)*" (I26).

CT aims (skills/dispositions): In general, more skills than dispositions were mentioned by interviewees (152 to 136, respectively). Interviewees from all fields made reference to "analysis" as a CT skill, being the most frequently mentioned skill in general (31 references). Regarding CT dispositions, open-mindedness and analyticity were the most frequent, being mentioned in 27 and 22 occurrences respectively. Interviewees from all fields mentioned analyticity, which is coherent with the CT skill they referred, analysis. If we compare fields, there were some differences in the skills that teachers seem to value more. STEM teachers mentioned more frequently "interpretation" and "analysis" (6 references out of 32) and "self-regulation" (5 references) while Social Sciences teachers mentioned "evaluation" (16 quotes out of 75), followed by "analysis" (15 quotes), "explanation" (12 quotes) and "inquisitiveness (10 quotes). In Biomedical Sciences, teachers made reference mostly to "analysis" and "interpretation" (5 instances out of 21) and then "inference (4 instances)" skills. In Humanities, "analysis", "inference" and "explanation" were the most frequently mentioned skills (5 quotes out of 24). Other skills mentioned included "questioning" (which the interviewees associated with the process of evaluation), "synthesis", "comprehension" and "comparison".

Table 15. Summary of the analysis of interviews by field

CT dimensions/fields	STEM (N=9)	Social Sciences (N=26)	Biomedical Sciences (N=9)	Humanities (N=9)	Total (N=53)
CT definition					
CT as a set of skills and/or dispositions	9	26	9	6	**50**
CT (other classification)	0	0	0	2	**2**
CT not mentioned	0	0	0	1	**1**
CT aims					
Interpretation	6	10	5	3	**24**
Analysis	6	15	5	5	**31**
Inference	4	10	4	5	**23**
Evaluation	3	16	2	4	**25**
Explanation	3	12	3	5	**23**
Self-regulation	5	8	1	1	**15**
Other skills (e.g., synthesis, comparison, comprehension, problem-solving, creativity)	5	4	1	1	**11**
Truth-seeking	2	9	3	2	**16**
Open-mindedness	4	12	5	6	**27**
Analyticity	3	11	4	6	**24**
Systematicity	-	4	2	2	**8**
Self-confidence	3	6	1	3	**13**
Inquisitiveness	4	10	1	5	**20**
Cognitive Maturity	4	6	3	4	**17**
Other dispositions (e.g., autonomy, accountability for students' own learning, motivation)	0	10	1	2	**13**
Overall approach					
General	0	3	0	1	**4**
Immersion	6	10	3	2	**21**
Infusion	2	10	1	1	**14**
Mixed	1	10	3	0	**14**
Not mentioned	1	0	2	5	**8**
Other	0	1	0	0	**1**
Type of intervention					
Self-study	3	11	3	2	**19**
Dialogue	8	21	7	7	**43**
Authentic situations	6	18	6	4	**34**
Mentoring	5	7	3	4	**19**
Not mentioned	0	0	2	1	**3**
Other categories	0	2	0	0	**2**
Teaching strategies					
Problem solving (inquiry)	5	9	5	4	**23**
Lecture discussions (Argumentation)	7	19	4	7	**37**
Not mentioned	1	1	0	0	**2**
Other categories (e.g., Group work, role-play, self and peer-assessment, context-based learning)	8	16	4	6	**34**
Teacher training-instruction on CT					
General	0	2	2	0	**4**
Immersion	1	7	3	1	**12**
Infusion	0	6	1	0	**7**
Mixed	3	10	1	2	**16**
Immersion or infusion	1	0	1	0	**2**
Not mentioned	1	7	0	4	**12**
Other categories (e.g., Incorporate new teaching methods/approaches, to present successful practices, to join a Community of Practice, involve teachers in professional development actions)	5	11	1	4	**21**

One example for “Analysis” is the following: "*The analysis of the problem explains everything, in the sense that the analysis of the problem allows to identify what are the actually relevant aspects and that can be formalized (in the domain of computer science) compared to aspects that may not be considered because they do not lead to the solution.*" (I7).

Regarding “Evaluation”, one instance is: "*It is also important for students to learn to defend their ideas with good arguments, to learn to clearly state and explain their own views, to learn to evaluate others’ opinions and to identify errors in their arguments. Being curious and eager to know are other two things that critical thinking can encourage.*" (I23).

The most mentioned CT skills by teachers were analysis and evaluation. Open-mindedness was the most referred CT disposition

The CT dispositions that interviewees mentioned and explained are diverse and include all categories from Facione (1990). “Open-mindedness” was the most frequently mentioned CT disposition in all fields, for instance: "*In relation to everyday’s problems such as energy consumption, I try to push their thoughts to alternative views.*" (I19). After this disposition, the most frequent is “Analyticity”: "*Questioning: First: is the source fake or falsified? Or is it a true source? Second: do we have the source in its original form or is it copied? Third: to know who has made the source, when and where [...] The last thing is to know how original the author or the maker of the source was?*" (I40).

On the contrary, “Systematicity” seems to be the least frequently considered or mentioned disposition (8 occurrences out of 136). Nevertheless, there is not a common pattern in all fields of study. In Biomedical Sciences other dispositions were less mentioned by teachers such as “Self-confidence” and “Inquisitiveness”, quoted only once. Regarding STEM teachers, they did not make reference to this disposition (systematicity), which we consider a surprising finding, since STEM activities do usually engage students in organized approaches to problem-solving and decision-making. Regarding other fields, such as the Social Sciences and Humanities, this disposition is the least frequently mentioned (4 and 2 quotes, respectively). One instance for this disposition is: "*I organise myself, my thinking, using a meta-language, I discipline my thoughts so that I can present them and persuade students to think in an organized way.*" (I18).

Another aspect that needs to be highlighted is the fact that “emotions” were considered important by some of the interviewees as an aspect that might negatively affect the development of CT, as considered in the reviewed literature (P19, P20). One example that illustrates this issue is I17: "*Justification should be based on arguments from research that supports the relationship between those variables and not according to stereotypes which are probably accompanied by emotions.*". Another

interviewee (I18) makes reference explicitly to "Emotional intelligence" as a disposition for being a critical thinker, reinforcing the relation of it with CT. STEM and Social Sciences interviewees also identified Self-awareness as an important disposition, what we consider within the "Self-regulation" skill.

Creative thinking was mentioned by two interviewees (I18, I49) as a disposition to be developed, which is in line with two papers analysed in the literature review (P1, P11). A representative quote is presented next (I18): "*At this point the concept of creative thinking arises, which means that instead of digging a deep hole, that is, applying critical thinking, I dig somewhere else to find something else, another solution which is the unexpected, the symbolic, the subversive*".

Motivation also can be found in both the literature review and the HE teachers' interviews. P9 and P11 showed an increase in students' motivation after the intervention, which both involved an argumentation task. The importance of students' motivation so they are engaged in the subject is brought up by I30: "*To motivate students you have to stimulate them, just so you will get their compromise with the subject [...]*". The analysis also revealed other dispositions (out of the Facione' framework): Moral development (I18), Intercultural sensitivity (I18), Self-awareness (I24), the development of an Ethical perspective in students (I26), Mature epistemological standards (I36), Awareness (I36), Group work (I49) and Adaptability (I50).

It should also be mentioned that some interviewees tend to mix skills with dispositions as this quote exemplified: "*CT is about skills (especially analytical skills and systematicity)*" (I1).

Overall Approach: As shown in Table 15, the number of instances regarding this dimension is higher than the number of interviewees in some of the fields (STEM and Social Sciences), meaning that some participants mentioned more than one method. The immersion approach was the most frequently mentioned method in STEM (6 quotes out of 10), while in Social Sciences an even frequency appeared for the immersion, infusion and mixed methods (10 out of 34). Regarding Biomedical Sciences, the immersion and mixed methods approaches are the most cited (3 quotes out of 9). In Humanities, the most mentioned approach was immersion (2 quotes out of 4), but it needs to be highlighted that there is a high number of interviewees (5 out of 9) who did not mention explicitly the overall approach. These results do not allow us to draw any sound conclusions.

Most interviewees apply more than one CT approach

Dialogue was the most frequente type of intervention used to promote CT in all the fields

Type of intervention and teaching strategies: The Dialogue was the most frequent type of intervention used to promote CT in all the fields (43 quotes out of 120); argumentation and lecture discussions were the teaching strategies

most commonly found (37 and 23 quotes out of 96, respectively). These results are in line with the literature review.

Teachers' CT instruction: regarding this dimension, data did not highlight commonalities among fields. Furthermore, we did not find any tendency within fields. STEM interviewees mentioned most frequently the mixed methods approach (3 quotes out of 11) as well as different interventions coded as other categories. In Social Sciences the same categories were the most mentioned but with higher frequency. Furthermore, to other approaches were referred, such as immersion (7 quotes out of 43) and infusion (6 out of 43). In Biomedical Sciences, the teachers mentioned the immersion approach as the most frequent (3 quotes out of 9) one, whereas in Humanities the most frequent approach are examples corresponding to other categories (4 quotes out of 11).

3.2.2. CT interventions in different fields

This section addresses the analysis of CT interventions in the four fields (STEM, Biomedical Sciences, Social Sciences and Humanities). In particular, the examination of *learning materials*, *assessment methods*, *difficulties and challenges*, and *institutional barriers* are presented. Tables 16, 17, 18 and 19 summarize the results in each field. Each dimension (e.g., learning materials) includes diverse categories (open-coded categories) that are built in interaction with data, and also excerpts from transcriptions to illustrate them.

Learning materials provided to students are diverse, although context-based activities related with everyday's life and workplace-based situations involving case studies or real-world scenarios were the most frequently used in all the fields. These kind of tasks tend to promote discussions as well as cooperative and active learning, important aspects that are in line with Niu et al. (2013), who showed that students are required to assume an active role in solving real-life problems. Furthermore, interviewees mentioned the use of texts to promote "analysis" among their students, as well as of videos followed by a discussion or questioning. Online activities are the least common, they only appear in STEM (3 out of 53) and in Social Sciences interventions (2 out of 53).

Context-based activities and workplace-based scenarios were the most frequently used learning materials

Table 16. CT interventions in STEM

STEM		
Learning materials	*Exercises* *Critical reports* *Authentic situations* *PowerPoint presentations* *Discussion activities* *Role-play* *Seminars*	Authentic situations: "*I give the students a written text. For example, it could be a text about the companies that won the COTEC awards in the previous year and then each group, within the class, has a different text about a different company. They have to read the text, and then have to tell the main ideas orally to the other groups, and the last part is to write a summary. But this summary is limited to 100 words*" (I46) Discussion activities: "*The use of multiple examples for multiple purposes [...] for example to think about the consumption of lignite that contributes to the greenhouse effect: which are the alternatives or what mild forms of energy mean?"* (I7)
Assessment	*Summative* *Summative & Formative* *Formative*	*Summative & Formative* "*We use that tool [referring to the self and peer assessment after activities] for each student to evaluate their own contribution within the various assignments during the semester and the contribution of their group colleagues.*" "*I have to confess that normally I don't evaluate it specifically (…). However, I see this works as a preparation to the final assessment* (…)." (I46)
Difficulties & Challenges	*Students* - Attitudes and skills in CT - Motivation	"*They [students] are attached to the dominant discourse, thus claim that things are made in this way because they happen in this way. They do not examine why they happen in this way or how they could happen*" (I19)
	Teachers - Not willing to change - Teachers' mindset for CT - Assessment of CT skills	*"(...) have a perception of being much more available for what is truly happening in the classroom and not following a script completely ... isn't it? And take advantage of all the interactions that are coming up in the class, and that allow (…) and that requires from me a new way of doing things (...)"* (I47) "*I can't put critical thinking tasks into an exam. In class, you have to find the right moment with well selected examples*" (I25)
	Classroom setting & Organization - Lack of time - Organization of the school year	
Institutional barriers	- Institutional culture - Lack of connection with society and labour market - Inadequate funding - Number of students in the classroom	"*Because most of the curricular units on the institutions that I have worked with do not address these issues (...) It is fundamental to be a component of all curricular units, not only in curricular unit A or B. It should be implicit, and it is found in many curricular units (...)" (*I46)

Table 17. CT interventions in Biomedical Sciences

Biomedical Sciences		
Learning materials	*Authentic situations (clinical cases)*	Authentic situations: "*They have the situation to analyse, and they have to analyse it, they have to consider it, they have to verify if the whole history is given to them or if it is incomplete, or if they need ny additional information that was not given*" (I50) "*Usually in the classroom I use cases from my own clinical background. Cases, which were real incidents when I was a practising nurse. I relate the cases and tell them: What is your opinion? How would you do in this case? At the time when we do such clinical cases, a lot of discussion is generated*" (I11)
	PowerPoint presentations	
	Role-play activities	
	Discussion activities	
	Other: textual description	
Assessment	*Summative* - Discussion and dialogue on authentic situations - Judgement questions during the development of the class - Various tests - Assessment on the spot	"*I use a grid…That grid has the elements that will be assessed and graded at the end of the activity. At the end they have to give me a document that is a report of how they approached the case, how they reached the diagnosis, justifying everything*" (I50) "(…) *Of course, during all these groups sessions, each student is evaluated so that we can see what skills s/he has acquired, how he develops it, in the sessions*" (I12)
	Formative - Multiple-choice test based on authentic situations - Formative assessment with feedback - Final test of the module	"*And then, they'll have to discuss and argue with me if they're thinking that the information they will get from that kind of answer is important or not to get to the final evaluation* (…)" (I50)
Difficulties & Challenges	*Classroom setting & Organization* - Size of the classroom - Duration of the classroom - Organization of the setting - Course structure	"*Especially because I have about 70 students and it is difficult at one time to manage the whole process (…) I always have 13 to 15 groups, there are 5 students per group. It's a lot of people! The duration of the class is too short!"* (I50) *"The classroom does not help first. The classrooms are too big. And it's not that they are big. It does not help desks are fixed*" (I13)
	Students - Lack of CT attitude - Lack of instruction on CT - More preparation on content than on reasoning skills	"*The biggest difficulty is that students have not learned what critical thinking means and do not know how to develop their thinking, because what most have learned is parroting (learning by rote)* (…)" (I14) "*They have not learned to use their judgement in the lessons, they have learned to reproduce knowledge*" (I11)
	Teachers - Lack of willingness and openness to a new pedagogical situation	"*It's something new. A lot of professors are afraid that students will be stronger than they are*" (I37)
Institutional barriers	*Institutional culture* - Lack of institutional support - Lack of autonomy in the departments. - Number of the students	"*And also as a department we do not have autonomy. That is, the interdependence that exists from the other disciplines at an academic level and the interference from the other disciplines is an important barrier* (…)" (I13)

Table 18. CT interventions in Social Sciences

Social Sciences		
Learning materials	*Articles & texts*	Articles & texts*:* "*Fundamentally, I use articles that are not orthodox, that is, they are not the most used by other teachers. I try to look for those things that another teacher would say 'this is not worth anything' and then based on that, see if students would also have considered them useless or if that is the beginning of something we can use to develop critical thinking*" (I27)
	Authentic situations	
	Discussions	
	Narratives, storytelling.	
	Brainstorming	
	Online & media activities	Brainstorming*: "Free association practices, brainstorming practices…"* (I18)
Assessment	*Summative* - Essays - Presentations - Research projects - Case study solutions - Posts and feedback	"*Students have to write an individual opinion paper in which they analyse a newspaper article from the theory and look at the practice from theory and formulate an opinion about it*" (I34) "*Evaluation of written documents (case studies solutions)"* (I2)
	Formative - Bloom's taxonomy (Bloom et al., 1956) - Exam - Opinion paper	*"I give many questions that require reasoning. I evaluate how well reasoning is built on arguments. I evaluate their arguments according different levels of thinking (Bloom taxonomy)"* (I43)
Difficulties & Challenges	*Teachers* - Not to impose teachers' opinion - Don't use the school textbook - Assessment of CT skills transfer. - Proper tests to assess directly CT - Teachers' commitment - Assessment methods and tools for the evaluation of CT - Teachers' limitations to students being critical - Lack of common approach	"*A personal challenge is taking the evaluation as something more rigorous also for this question, to have […] to design tools that allow me in a systematic and a bit more reliable way to assess CT" (I27)* "*I am cautious not to impose my opinion. I don't want to convince them of my opinion, I want them to build up their own*" (I32) *"(…) It is not one person's, but all team's work. Talking about our department, I can find a colleague and may succeed to explain why it [critical thinking] is needed; to argue that it is beneficial for students. But we have other departments also. And come to a common agreement it might be difficult. It is the most difficult part – to unify our understanding. To agree on what we all are seeking for" (I44)*
	Students - Students' attitudes for CT - Focus on the results rather than on the processes - Students' motivation - Promoting independent thinking - Students' reflection - Students' background	*"(…) They are not really used to think critically, they are more used to follow/obey what you tell them and they are not get used to question, which in a subject such as Sociology is fundamental"* (I29) "*To stimulate students to be critical enough*" (I35) "*At the end of the course, when the examination is approaching, students want certainty and tend to comply the norm rather than CT*" (I31)
	Classroom setting & Organization - Lack of time - The load of tasks	"(…) *The first one (difficulty) is related with the excessively fast pace we do our job*" (I26) "*This is because I do not believe that the classes' duration is enough to develop CT. Can give you time to develop some things, not CT*" (I48)
Institutional barriers	*Strong hierarchical structure* *Examination system* *Access to quality resources* *Deontology* *Open curriculum* *Number of the students in the classroom* *Teachers' individual work rather than in cooperation with other teachers* *Institutional culture* *Investigation duties* *Bureaucracy burden*	"*There exists a very strong hierarchical structure in the school* (…)" (I35) "*There are organizational constraints, as numbers of hours available, lessons calendar, desks disposition in the classroom, high number of students in the classroom*" (I8) *"We are all involved in processes we are requested to do with a fundamentally bureaucratic character that not only doesn't help to promote these reflective, critical and self-conscious models but they difficult them because the time and energy we do are directed towards these processes. Thus, people who try to go a step further from these bureaucratic reports, developing professional practices in other directions, they claimed to be tired, people don't have time to meet and talk about these things…"* (I26)

Table 19. CT interventions in Humanities

Humanities		
Learning materials	*CT textbooks & articles* *Media tasks & visual arts* *Oral debate activities* *Case studies* *Analysis of projects*	Media tasks*: "(…) I try to evoke them, to get interested in a topic using media, they like and use – YouTube, social media. And then I try to address them, as personally as possible, to provoke them – I react myself and encourage them to react. I try to model free conversational situations, as I don't see any other possible way to evoke them"* (I42) Case studies: "*My manual is the theory, illustrated by case studies in the class*" (I40)
Assessment	*Summative* - Class interventions - Argumentative skills - Communicative skills - Writing reports - Presentations - Assignments - Essay	"*The grading system that I use in order to assess students' performance is not focused on memorizing information, but rather on arguing points of view on analysing cases from different ethical perspectives*" (I23) "*A course with a permanent assignment, I make them clear that participation is important, to get into dialogue with each other* (…)" (I39)
	Formative - Exam	"*The first year, they get at the exam a source, which is similar to the case study we saw during the classes but it's different. (…) They have to be able to transfer what they have learned to other sources, to new sources* (…)" (I40)
Difficulties & Challenges	*Students* - Attitudes towards learning & CT - Absence of students' CT basic skills - Stereotypes - Having an independent opinion	"*Students don't find it always necessary to develop critical thinking. Students are very satisfied if they have clear learning material that they can elaborate on. […] I try to make them clear that is not just knowledge; they're here to develop certain important skills […]. Students sometimes do not appreciate the transferability of critical thinking*" (I39) *"Students come to university with a huge block [blocked thinking]. It has to do with traditional teaching at school and overall tradition of education. They come with a fair to express their opinion independently and freely"* (I42)
	Teachers - Not willing to change	*"Teacher, a professor, who has his/her position, deserved, is not changing remarkably. Swollenness comes with an age; it becomes more difficult to incorporate new things. One has steady skills, routine, one misses ability to adapt, change thinking, point of view, tactics"* (I41)
	Others - Textbooks full of myths - Dominant discourses	"*Textbooks full of myths made stand for the truth*" (I21)
Institutional barriers	*Number of students in the classroom* *Not enough contact with students* *Borders among lectures, seminars, etc.* *Lack of library resources* *Constant changes in curriculum* *Impossibility to integrate all disciplines in one department* *The evaluation system* *Understanding that anybody can teach a CT course*	*"If we want to work in modern way, we have not to make strict borders between lectures, seminars, workshops. We have to work authentically (…)"* (I45) "*I already referred to the points gaining system, as deadly for critical thinking*" (I39) "*Yes, the vague understanding of the importance of the development of the 'critical stance' for our students and generally for our people, and the idea that anybody can teach such a CT course*" (I22)

Assessment methods: The methods used by HEI teachers fall into three categories: summative assessment, summative plus formative assessment, and only formative assessment. Most interviewees (24 out of 53) make reference to formative assessment, although they do not specify the assessment instruments for CT. They mention assessment instruments in general, for the formative and summative evaluation of activities that they carry out in their classes. For instance, multiple-choice tests based on authentic situations as a formative assessment in Biomedical Sciences and discussions about authentic situations as a summative assessment (refer to Table 17). Most of the interviewees (47 out of 53) do not make reference to the use of specific evaluation rubrics and criteria for the evaluation of CT skills and there is a lack of data regarding how they measure the diverse skills of CT. Six interviewees out of 54 cited the use of standardized tests or specific criteria for the CT evaluation, in particular, the FRISCO guidelines (Ennis & Goldman, 1991), the CCTC - Level X (Ennis & Milman, 1985), the Bloom's taxonomy (Bloom et al., 1956), the evaluation model of Newman et al. (1995), as well as other rubrics were mentioned. Furthermore, part of the interviewees (9 out of 53) pointed out explicitly the fact that the focus in the assessment is on the process, sharing many features with a non-formal assessment. For instance, an interviewee states this issue declaring what kind of assessment he carries on: "*Assessment on the spot [...]*", whereas another one provides more information about his/her focus on this process: "*The grading system that I use in order to assess students' performance is not focused on memorizing information, but rather on arguing points of view and on analysing cases from different ethical perspectives*" (I23).

Most teachers do not specify the instruments used for CT assessment

Difficulties and challenges: They are distributed in four categories (classroom settings and organization, teachers, students and other categories). In general, we can assert that the lack of students' positive mind-set and motivation for CT learning was present in the three fields, except in Humanities. Some of the interviewees (Social Sciences, STEM), point out the assessment of CT skills and the unwillingness that teachers present to change and innovate their practice (Humanities, STEM) - this is a crucial concern because what is at issue here is a 'pedagogy of risk' (Levinson et al., 2012), where teachers are reluctant to abandon their authority and are unwilling to risk themselves in an open pedagogical situation. A few interviewees from the STEM and Social Sciences fields mention also lack of time as a difficulty.

The most frequent institutional barrier is the high number of students in the

Institutional Barriers: A wide variety of institutional barriers were mentioned. Due to this variety, it is difficult to cluster the responses into general categories. The most frequent institutional barrier is the number of students in the classroom, being

present in all fields. Social Sciences and Biomedical Sciences interviewees mention the institutional culture as a barrier to promote the development of CT skills in the university and among teachers and students.

3.3. Conclusions, limitations and implications for practice

The analysis of the interviews shows that CT is considered as a set of skills and/or dispositions by most interviewees, although sometimes they interchange dispositions with skills and vice versa. Understanding what CT is and the difference between CT skills and dispositions is crucial to promote them among the students. Furthermore, the fact that HE professionals interchange skills and dispositions can favour the learning of students. However, the acquisition of CT dispositions requires their practice for a sustained period of time (Saiz & Rivas, 2017). CT dispositions take a long time to be developed and nurtured, for which it would be decisive to work them throughout the academic journey. It is apparent from the teachers' interviews that **most interventions are not longitudinal, but short time-based**. That is, in line with Saiz and Rivas (2017), not long enough to develop CT skills and/or dispositions. Therefore, this is one of the main challenges to overcome. Furthermore, in line with Abrami et al. (2015), **teachers' training, experience and background on CT** appears to be as a crucial factor to promote CT skills and dispositions. Although teachers mentioned some CT skills and dispositions, most of them do not provide particular cases or examples to explain how they promote them. This is an important aspect and can be seen as a limitation in terms of teachers' Pedagogical Content Knowledge (PCK) (Gudmundsdottir & Shulman, 1987) on CT. Further research is needed in order to get a clear idea on teachers' PCK on CT, as well as on how do they integrate CT practices in their instruction.

CT dispositions take a long time and effort to be developed. They should be promoted systematically across the curricula and throughout the academic journey

The most frequent skills mentioned by the respondents were *Analysis* and *Evaluation*, especially in Social Sciences; and the most frequent dispositions were *Open-mindedness* and *Analyticity*. We see *Open-mindedness* as an important disposition for being a critical thinker, as the Facione' CT framework presents (Facione, 1990), but also to promote CT. Some of the difficulties teachers mentioned in CT instruction are related with their own disposition, particularly with *Open-mindedness*, such as the unwillingness and lack of motivation to change their practice.

Other skills such as *Self-regulation* are not frequently mentioned by teachers, especially in Biomedical Sciences and Humanities fields. This skill is for teachers, one of the most complex and difficult to enhance, since it is related with the individual monitoring of cognitive activities and with correcting one's reasoning or results.

LDT/Argumentation, *dialogue* and *authentic situations* were the most representative/notable teaching strategies and type of intervention teachers mentioned in the interviews. These results are coherent with the CT skills and dispositions that respondents valued more. *Analysis* and *Evaluation* skills are needed to present a sound argument. These skills can be trained and/or practiced through the dialogue and/or daily-life contextualized problems, for instance through argumentation on SSIs (Franco & Almeida, 2017). Furthermore, these results are consistent with the type of interventions identified in the literature review. CT interventions and strategies identified in the literature review were mainly based on active learning approaches (Niu et al., 2013), in which LDT/Argumentation and dialogue predominated.

Interviewees, particularly in Social Sciences, pointed out *immersion* as the most used approach to integrate CT in their daily classroom practices. This suggests that **CT is not being taught explicitly, sometimes even without a purposeful intention.** HE professionals might have not a clear idea on how to merge CT in their professional practice, as well as in their curricular design. These findings may be related with the fact that the institutional culture and the educational system do not value or promote the development of CT, as teachers mentioned in the interviews. Moreover, as Tiruneh et al. (2014) pointed out, the immersion approach requires an adequate training and preparation for a better CT improvement, but the reported results show a lack of training in this matter. For that reason, CT teachers' training becomes another great challenge to overcome.

Teachers commented that they do not have suficiente pedagogical knowledge on how to assess their students' CT development

The examination of interviews also revealed several difficulties or barriers that students face, being the *assessment of CT* the most frequently mentioned. The formative and summative assessment appeared in all fields. The summative assessment usually consists in an exam. In the formative assessment, CT is evaluated in an informal way ("assessment on the spot") or through essays, presentations, etc. Teachers commented that they do not have sufficient pedagogical knowledge on how to assess the CT development of their students, and when using formal CT assessment tests (e.g., CCTT), they face several challenges in their application. These results are relevant and coherent with the analysis of the literature review. A big proportion (53%; 130 out of 246) of CT papers identified in the literature search were excluded because they did not assess CT development or they did not do it in a rigorous way. This points out to the need for further research on CT assessment. Providing teachers with specific tools for assessing CT may help and stimulate the incorporation of CT in their teaching practice. Guiding CT activities requires not only that they have a clear understanding on CT skills and dispositions, as previously mentioned, but also on how to scaffold and assess them.

The absence of students' CT basic skills and their low motivation were mentioned by the interviewees as difficulties in promoting CT. Students' lack of independent thinking, which we relate with the social emancipation element of CT (Jiménez Aleixandre & Puig, 2012) – a capacity to develop one's own opinion as opposed to the mainstream ideas of a community or society – seems to be another point of concern for teachers. Here, the role of self-confidence and intellectual courage is of crucial matter, especially in a changing world where we can not assure that even generic skills suit past or current situations in helping students to engage with the future world in a meaningful way (Barnett, 2012). To face this reality of 'strangeness', we **need to muster the confidence and courage to question received wisdom and convention** (Kreber, 2016).

Regarding the organizational difficulties and challenges, teachers stressed the large number of students in the classroom and its organization (settings). Both aspects raise the difficulties in the implementation of some activities, as debates or PBL activities. Most interviewees consider the duration of the classes to be too short for the development of students' CT skills and dispositions, which is in line with Saiz & Rivas (2017). Institutional duties such as the lack of organizational culture, support and the existence of a huge amount of bureaucracy were also mentioned by the teachers. These duties consume most of professional's time and energy, minimizing their commitment to improve the pedagogical practice and the quality of their teaching.

4. Preliminary guidelines for quality in CT education

This section presents the key findings both from the literature review and the interviews to university teachers carried out by all CRITHINKEDU partners. It intends to compare them with the first intellectual output (CRITHINKEDU_O1) - the "A European collection of the Critical Thinking skills and Dispositions needed in different professional fields for the 21st century" proposal (CRITHINKEDU_O1, 2018). As a result, a preliminary proposal of guidelines for quality in CT education is presented[11] (Table 20). The focus of this proposal is on quality assurance related to CT learning and teaching in higher education, including the overall process of design, conception and delivery of CT instruction (and relevant associations to research). This does not exclude the already existing institutional processes to ensure and improve the quality of teaching, learning and research activities, but instead it constitutes a specific and complementary path to ensure a CT learning environment in which the content of programmes, learning opportunities and facilities are fit for this purpose.

[11] These preliminary guidelines will be improved and deepened in the **CRITHINKEDU' fourth intelectual output** (CRITHINKEDU_O4), during the implementation of deployment scenarios in all the partners' institutions, and transformed into the "European guidelines for Critical Thinking education in EHEI. These final guidelines are intended to orient EHE teachers, pedagogical support teams and leaders on how to adopt and promote CT educational practices, attending to a set of quality criteria that can drive educational change and innovation in this context.

4.1. Synthesis from the literature review and teachers' interviews

CT aims: literature mainly reports skills whereas teachers refer also to dispositions and both are more balanced in terms of importance and value.

CT definition: in the literature review, generally, it is not possible to clearly identify the theoretical background sustaining the CT educational interventions. Similarly, from the interviews, teachers do not identify the theoretical background that supports their CT intervention, although it is possible to categorize it/them according to Facione's definition (skills and dispositions).

CT approach: the larger majority of reviewed studies present essentially the immersive approach (in which CT principles are not made explicit to students) which is also emphasised by the teachers. However, some teachers tend to use the infusion approach or the mixed one, suggesting that they are aware of the importance to promote CT within the subjects, using specific background knowledge.

Type of intervention: the information retrieved from the literature review was similar to the obtained from teachers' interviews. The most used interventions were dialogue, self-study, mentoring and the use of authentic situations. This might suggest that teachers recognise the importance of student-centered learning, and the use of significant contextualised settings. It seems like there is no difference between study fields due the unevenly representativeness of the sample (mainly constituted by research papers and/or teachers from STEM and Social Sciences, and fewer from the Biomedical Sciences and Humanities field).

Strategies: Lectures with discussions and problem-solving were the most used learning strategies, reported by both literature and teachers. Regarding the literature review, studies that combine both strategies seem to lead to better CT outcomes. However, the extent to how the teaching strategies are articulated with the learning materials, tasks and the design of the activities needs further analysis.

Learning materials: the learning materials are reported in the literature and by the teachers as being diverse and from different formats (textbooks, scientific articles, clinical cases, FRISCO guidelines, etc.). Slight differences could be found by study field - clinical cases in Biomedical Sciences, while scientific texts and on-line activities were more used in STEM. Evidence suggests that CT-driven materials have higher impact on students' CT outcomes. Limited analysis was performed on this topic in the teachers´ interviews.

Assessment: Both summative and formative assessments were mentioned in the literature and by teachers. However, from the interviews, it is not clear if the summative assessment is oriented to the evaluation of CT outcomes or to domain-specific knowledge, even though the teachers assume to evaluate higher level of thinking. Moreover, the literature review shows that teachers often use students´ perceptions (questionnaires) to evaluate the students' progress in CT, which is insufficient. Interviews and the literature review show that the use of formal assessment CT tests

and evaluation rubrics are scarcely used. This could be related also with the difficulties found in the use or design of such instruments, and the adequacy between them and the CT learning goals (it could also be related to the fact that when CT is infused within a subject domain/matter, the major outcome for the teacher may be to reach subject-matter knowledge, being CT development a secondary goal).

Difficulties: Similar difficulties were detected from the literature review and the teachers' interviews, and covered essentially 3 levels: pedagogical, methodological and organizational. These highlight the major role of EHEI in the provision of adequate structural settings and policies to nurture teachers and students in active learning and CT development.

4.2. Gaps between labour market needs (CRITHINKEDU_O1) and CT educational practices in EHEI (CRITHINKEDU_O2)

From the comparison between the first intellectual output of CRITHINKEDU (CRITHINKEDU_O1, 2018), and the review on CT interventions in EHEI presented above in the current report (CRITHINKEDU_O2), we identified different gaps. Those should be reflected upon and addressed within the future agenda of the CRITHINKEDU project:

1) Dispositions are highly emphasized by the professionals and seem to be the key point to reinforce CT skills (CRITHINKEDU_O1, 2018). Although teachers seem to be worried about dispositions – which might relate to the lack of students' motivation -, it is clear that those are not the focus of the teaching activities. Moreover, to nurture CT dispositions, it would be important to define long term goals and interventions across the curricula - in contradiction with the results of the literature review and teachers' interviews (CRITHINKEDU_O2), which show that CT skills are most valued and reported short-term interventions.
2) Professional representatives mostly value the self-regulation CT skill and the analyticity CT disposition (CRITHINKEDU_O1, 2018). However, teachers seem to focus their interventions in the development of other type of skills, such as analysis and evaluation, while self-regulation is seldom reported in the literature review or mentioned by teachers (CRITHINKEDU_O2). On the other hand, analyticity is also targeted as one of the most valued CT disposition by the teachers, although with few mentions in the literature review.
3) In CRITHINKEDU_O1 (CRITHINKEDU_O1, 2018), other skills and dispositions out of the Facione' framework (used for the analysis) were identified as needed by professionals, such as proactiveness, adaptability, emotional maturity, communication and teamwork. However, these were not so emphasized in the literature review or by the teachers' interviews (CRITHINKEDU_O2).
4) It is clear that CT skills and dispositions are considered of utmost importance for current and future graduate students in their successful transition to the

labour market (CRITHINKEDU_O1). However, researchers and teachers seem to not be sufficiently aware of this concern, since the most reported CT approach, both in the literature review and in the interviews (CRITHINKEDU_O2), is the 'Immersive' one, thus tending to not make the CT principles explicit to students.

4.3. A preliminary proposal of guidelines for quality in CT education

Higher Education (HE) plays a major role in supporting CT development in order to attend to the new challenges of an increasingly knowledge-based society, economic growth, social cohesion and global sustainability. This depends on a continuous and interdependent cooperation between institutional leaders, teaching staff and all the other stakeholders, such as public/private companies and NGOs. Meanwhile, an increasing demand for CT skills and dispositions requires that higher education responds in new ways at the organizational, curriculum and course levels.

New implications due the diversity of learners and growing expectations for European Higher Education Institutions (EHEI) entail a critical reflection and reform, already promoted and guided by a collective effort of different authorities, institutions and relevant stakeholders (Bologna Declaration, 1999; ESG, 2015). The role of quality assurance is essential to support European Higher Education Institutions (EHEI) in engaging with these reforms while ensuring that learning outcomes and experience achieved by students remain at the core of institutional missions. Thus, a key goal of the current preliminary guidelines for quality assurance in CT education[12] is to afford a common understanding of quality assurance for CT learning and teaching across different EHEI, professional fields and business organizations. It will not only be useful to demonstrate quality and increase transparency, but also to maintain mutual trust and better recognition of higher education CT programmes, qualifications and the provision of other important aspects like the promotion of students' mobility and a suitable transition to the labour market among different European countries.

The proposed guidelines (Table 20) are based on the CRITHINKEDU_O1 (CRITHINKEDU_O1, 2018) and CRITHINKEDU_O2 comparison, taking into account the identified gaps between the need of CT in the labour market and the CT higher education practices. They are not prescriptive standards that show how the quality assurance processes are to be implemented, but they are descriptive in nature - providing guidance and covering three crucial levels for the successful quality provision of CT education in EHEI: organizational, programme and course levels. These must be considered in a broader context that also includes the **European**

[12] These preliminary guidelines will be improved and deepened in the **CRITHINKEDU' fourth intelectual output** (CRITHINKEDU_ O4), during the implementation of deployment scenarios in all the partners' institutions, and transformed into the "European guidelines for Critical Thinking education in EHEI. These final guidelines are intended to orient EHE teachers, pedagogical support teams and leaders on how to adopt and promote CT educational practices, attending to a set of quality criteria that can drive educational change and innovation in this context.

Inventory of Critical Thinking skills and dispositions for the 21st century (CRITHINKEDU_O1, 2018, pp.57-58), a common and agreed understanding of the CT concept, on the need to design principles associated with high-quality environments fostering CT, and a long-term and holistic approach at organizational and programme levels. For these reasons, they are presented at a moderately generic level in order to ensure that they are applicable and can be used or implemented in different ways in a variety of institutions and countries.

The term '**quality assurance**' is adopted to describe all activities within a continuous improvement cycle and takes into account the following principles (ESG, 2015): 1) Quality assurance responds to the diversity of higher education systems, institutions, programmes and students; 2) Quality assurance supports the development of a quality culture; and 3) Quality assurance takes into account the needs and expectations of students, all other stakeholders and society.

Table 20. A preliminary proposal of guidelines for quality in CT education

1. ORGANIZATIONAL LEVEL *Foster an Organizational Culture for CT Education and Research*
1.1. Define CT as an integral part of teaching and learning activities; 1.2. Incorporate into existing review process systems how CT is embedded in the programmes; 1.3. Value research on CT education; 1.4. Promote professional development for teachers to support CT in students; 1.5. Encourage the creation of communities of practice and dissemination events on CT education with different stakeholders, such as teachers, institutional staff, students, professionals, etc.; 1.6. Encourage provision of institutional teams and resources to support teachers' engagement with CT practices; 1.7. Engage teachers in self and peer-assessment, exchanging perceptions, needs and expectations related to CT.
2. PROGRAMME LEVEL *Support CT education reforms across the curriculum*
2.1. Provide different and progressively complex activities and opportunities to foster CT throughout the curriculum, ensuring students can transfer what is learnt in one part of the curriculum to other areas; 2.2. Involve relevant stakeholders in the design of the curriculum and in the reflection on the suitability of learning outcomes, attending to different CT skills and dispositions in professional fields; 2.3. Value CT assessment and monitorization at the curriculum level; 2.4. When designing CT teaching and learning activities, be aware that CT encompasses personal and interpersonal skills and dispositions, such as proactiveness, adaptability creativity, emotional maturity, communication and teamwork
3. COURSE LEVEL *Engage with effective instructional practices to design, deliver and assess CT development in the classroom*
3.1. Define the course objectives with explicit description of the expected learning goals and outcomes in terms of CT; 3.2. Evaluate students' CT needs using different methods such as diagnosis/assessment (according to academic level and previous background; labour market needs); 3.3. Align the CT course objectives with the programme/curriculum objectives; 3.4. Design a set of engaging learning activities that attend to the defined CT learning goals and outcomes; 3.5. Provide CT learning activities as opportunities to transfer different skills or dispositions in a variety of situations and/or subjects; 3.6. Provide CT learning resources that relate to the future professional needs of students; 3.7. Promote students' self-regulation through learning-activities, formative assessment and opportunities of self evaluation; 3.8. Present to students, at the beginning of the course, explicit guidelines on how assessment of CT will take place; 3.9. Put in place adequate CT assessment instruments according to previous defined learning goals and outcomes; 3.10. Integrate CT assessment in the assessment of the course outcomes

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7. Supplementary documents

Supplementary document 1. Available at http://bit.ly/Supplementary1-O2

Supplementary document 2. Available at http://bit.ly/Supplementary2_O2

Supplementary document 3. Available at http://bit.ly/Supplementary3-O2