Critical Thinking Practices in Teacher Education Programmes: A Systematic Review

Hana Lorencová[a], Eva Jarošová[a], Sofia Avgitidou[b] and Catherine Dimitriadou[c]

[a]Department of Managerial Psychology and Sociology, University of Economics, Prague, Czech Republic; [b]Department of Early Childhood Education, University of Western Macedonia, Greece; [c]Department of Primary Education, University of Western Macedonia, Greece

Correspondence: Hana Lorencová, Department of Managerial Psychology and Sociology, Faculty of Business Administration, University of Economics, Prague, W. Churchill Sq. 4, 130 67, Prague 3, Czech Republic, Tel.: +42022409863, E-Mail: hana.lorencova@vse.cz

Hana Lorencová is an Assistant Professor and Deputy Head of the Department of Managerial Psychology and Sociology, UEP, Czech Republic. She is focused on adult education, activating teaching methods, work motivation, training of social and managerial skills and team work. Gained academic, research, publishing and training experience.

Eva Jarošová is an Associate Professor at the Department of Managerial Psychology and Sociology, UEP, Czech Republic and Head of the Academic Centre, which promotes and enhances the professional development of university level instructors. She is active in individual counselling and coaching. Gained academic, research, publishing and training experience

Sofia Avgitidou is a professor of Pedagogy and Teacher Education at the University of Western Macedonia, Greece. She has published books and edited volumes on children's social relationships, play and co-operative learning, teaching practice and professional learning as well as a number of papers in international journals.

Catherine Dimitriadou is a Professor of Teaching Methodology at the University of Western Macedonia. Her teaching and research interest focuses on teacher training in formal and non-formal education, as well as on educational practices in school settings, covering various thematic areas, such as differentiated instruction, moral education, intercultural education, visual literacy and CT in instruction/education.

Critical Thinking Practices in Teacher Education Programmes: A Systematic Review

Promoting students' critical thinking is an important task of Teacher Education. This is a review paper of 39 research papers regarding the critical thinking practices that are utilised in Teacher Education programmes, including instructional approaches and strategies, ways of assessment, their results, and the factors that affect their success. Both the description and the results of the studies, as well as researchers' interpretations/discussion of their findings, are content analysed based on the construction of an analysis chart. A critical analysis of the characteristics of interventions according to the results and researchers' opinions shows that a variety of factors affect their success. Thus, the personal (i.e. students' learning style and motivation), methodological (i.e. methods, tools, duration, feedback), and contextual (i.e. classroom climate, supportive initiatives) features of the intervention are important for effective CT instruction and the improvement of student teachers' CT skills and dispositions.

Keywords: Teacher Education, Critical Thinking, Teacher Education Programmes, Strategies, Interventions, Teaching

Introduction

The concept of Critical Thinking (CT) has been employed in a variety of disciplines and concerns issues of logical, ethical, pedagogical, and epistemological domains (Fawkes et al. 2005). Aiming at organizing the vast amount of CT aspects, specialised foundations and centers have occasionally undertaken the mission to define, construct, assess, improve, and advance the principles and best practices of fair-minded critical thought in education and society (Anastasiadou and Dimitriadou 2011). A considerable number of theorists have attempted to define the term CT, emphasising various concepts, such as "the ability to engage in purposeful, self-regulatory judgement" (Abrami et al. 2008, 1102), "the use of those cognitive skills or strategies that increase the probability of a desirable outcome" (Halpern 1996, 31), or "that waste of time

between seeing something and knowing what to do about it" (De Bono 1985, 11). According to the 46 experts from the American Philosophical Association Delphi Committee (1990), CT has been acknowledged as "a purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based."

The higher level competencies that articulate the various definitions given for CT over the past four decades (De Bono 1985; American Philosophical Association 1990; Halpern 1996; Abrami et al. 2008) reveal the importance of this conceptual structure – as both content and process – for teacher education (TE): both teachers and learners as good thinkers can be better equipped to compete for educational opportunities, jobs, and recognition; to perform effectively in the workplace; to be good citizens; and to attain well-being and the full expression of humanity (Hager and Kaye 1992). Priority should be given to education, since CT is considered to be the basis of a rational and democratic society (American Philosophical Association 1990). The importance of the development of CT regarding pupils and students during their education process is also supported by the outputs of the CRITHINKEDU project (CRITHINKEDU O2 2018). Teacher education programmes (TEP) should be permeated by CT in all fields and specialisations, since it is a "sine qua non" prerequisite for knowledge creation and is linked to human inventiveness and innovation (Anastasiadou and Dimitriadou 2011). Emphasising CT in TEP will increase the prominence of CT at schools and within society, thus potentially promoting effectiveness in complex problem solving at the societal level (Williams 2005).

Promoting students' CT is an important task of TEP since it achieves a good link between teaching and learning. Teachers need to prepare for their responsibilities

concerning the education of the new generation within the contexts of change, fluency, and flexibility. What is therefore unique in the field of TE is the fact that student teachers are assigned to teach CT to their pupils, but do not limit its applications only to the context of their profession. Thus, it is essential for them to have these CT skills regarding the organisation, practice, and evaluation of their work at school and to turn their students into good critical thinkers. To foster CT in students, it is first necessary to cultivate teachers' CT (Elder and Paul 1994). Hence, it would be of major interest to have evidence-based awareness of the methods and strategies used in TEP for the enhancement of student teachers' CT.

Teachers also need to be convinced about the importance of encouraging students' CT as well as confident about their capability to do so. In other words, to gain a sufficient level of their self-efficacy (Bandura 1995). Teacher self-efficacy relates to the beliefs teachers hold about their own perceived capability in undertaking certain teaching tasks. The findings from the meta-analysis (Klassen and Tze 2014) on teacher effectiveness in relation to teacher self-efficacy and personality reveal that teachers' self-efficacy is strongly associated with evaluated teaching performance and moderately but significantly associated with the achievement levels of students. Therefore, fostering teacher self-efficacy in various competencies, including CT, should be an integral part of TEP.

Research findings have pointed out that CT is comprised of components that can be learned, developed, and improved through purposefully designed education (Halpern 1996). These findings have led various attempts to promote CT abilities in Higher Education Institutes (HEI). Although several reviews have been conducted regarding the teaching of CT in HEI (Abrami et al. 2008; Allen, Berkowitz, Hunt, and Louden 1999; CRITHINKEDU O2 2018; Gellin 2003; Niu, Horenstein and Garvan 2012; Tsui

1998), we have found only one review focusing solely on TE (Mpofu and Maphalala 2017). In addition, the focus of the reviews has been determined by goals that were either to study the effectiveness of CT instruction, compare the impact of the teaching interventions, or provide a quantitative synthesis of the research results. This paper is based on a review of studies that examine how CT is taught in TEP mainly through teaching interventions and what we can learn from these regarding the factors that affect their success. An explanatory framework useful to TEP administrators, teachers, and researchers can hopefully be provided.

The Ways of Teaching CT and the Findings of Reviews Regarding the Teaching of CT in TEP

Much debate has been conducted among scholars with regard to a convergent view of CT as a synthesis of cognitive skills and dispositions (Facione 1990), the domain generic, or subject-specific character of CT (McPeck 1984), and a typology was established to classify different instructional interventions. These interventions aim at CT development within general, infusion, immersion, and mixed approaches (Ennis 1989), as these are described in Appendix 2 of the paper. Empirical research on CT in HEI usually refers to categories of strategies that are mainly focused on individual study, dialogue, authentic or anchored instruction, mentoring and reflection, problem-based learning, computer-assisted instruction, case studies, hands-on activities, and scenario-based learning (Abrami et al. 2015).

According to a review of the research literature conducted by Pithers and Soden (2000), the enhancement of CT in all sectors of education is related to the adoption of novel practices, the redefining of the concept of "truth," an emphasis on the learner's self-regulation and independence over his own learning, as well as the students' reflection, metacognition, and analysis of their ideas. The development of problem-

based learning, scaffolding, which is the support given to learners during the learning process, interdisciplinary approaches, and staff development initiatives should be combined with a student-centered orientation that promotes understanding, conceptual change and intellectual development (Pithers and Soden 2000).

We already have reviews that focus on teaching CT in HE generally. Having reviewed the data of 117 studies, Abrami et al. (2008) found that instruction generally had a positive impact on students' CT skills in HE. The variability identified in CT outcomes was attributed to the type and the pedagogical grounding of the interventions explored, which means that CT skills and dispositions are related to the way that CT instruction is provided. The largest effect has been observed in the mixed method, where CT was taught as an independent track within a specific content course, whereas the smallest effect was observed in the immersion method, where CT was not taught explicitly. Moreover, the impact of the interventions was greater in cases where teachers had attended a special training course on teaching CT or had applied observation techniques focused on the development of CT practices (Abrami et al. 2008). In addition, other reviews suggest that educators should make CT objectives explicit in their courses and integrate them into the HE curricula (Pithers and Soden 2000).

Based on the analysis of 33 empirical studies examining the effects of interventions aimed at the development of CT in HE, Tiruneh, Verburgh, and Elen (2014) have found that, despite clear progress in the effort to include CT instruction within academic instruction, it is still not possible to support particular instructional strategies to foster the acquisition and transfer of CT skills. Behar-Horenstein and Niu (2011), who analysed 42 empirical studies of teaching CT skills in HE, have pointed out that the same instructional interventions can lead to different results, depending on the implementation of the interventions. Nevertheless, their results show that improvements

in students' CT are more likely to occur when the teaching of these skills is explicit (where learning goals and explanations of knowledge and skills are clearly outlined for the students), rather than implicit (where such explanations are not made overtly). They also accentuate the relevancy of exogenous factors to the course, such as the learning environment, the training that instructors receive, the preparation and length of instructors' experiences, and the student-instructor and student-student interactions that can affect the results of various interventions, while also stating that "to what degree these factors influence changes in CT is unknown" (Behar-Horenstein and Niu 2011, 36).

Empirical research on technology-supported courses in TEP focusing on virtual educational settings has assumed that practices of social interaction, scaffolding, peer collaboration, and experiential learning can be integrated in both face-to-face and distance learning, thus combining aspects of both the theoretical and the practical understanding of CT (Keengwe and Kang 2013). Moreover, it is maintained that teaching CT should contain a transcultural approach to global knowledge domains about the context and culture in which the learning is situated (Song 2016).

In a comprehensive review of literature, Mpofu and Maphalala (2017) found that strategies for fostering CT in initial teacher education were both explicit and implicit, based on lecture delivery, assessment techniques, questioning, modelling, and learning activities. They suggested focusing on exploring the means for fostering CT before focusing on the impact analysis of these strategies and methods. They also pointed out that CT development should be "fostered across the curriculum to provide student teachers with a holistic knowledge construction process" (Mpofu and Maphalala 2017, 9256).

According to the aforementioned framework, it would be of major interest to identify the characteristics of TEP in CT instruction interventions and the factors that either promote or hinder the effectiveness of CT instruction to student teachers. Due to a current lack of studies that focus on TEP exclusively, we will map out the prevailing approaches and instructional methods that appear in TEP and the reasons for their effectiveness.

Method

Systematic review was used in the creation of this research. In the process of writing this article, a structured approach that follows the different stages of systematic review was employed. These stages or steps are presented by Uman (2011) as the following:

(1) Formulate the review question, (2) Define inclusion and exclusion criteria, (3) Develop a search strategy and locate studies, (4) Select studies, (5) Extract data, (6) Assess study quality, (7) Analyse and interpret results, and (8) Disseminate findings.

(1) Formulate the review question

In the first step, the overall focus of the review paper in terms of its contents was formulated. Specifically, we looked for practices and factors fostering CT and its development in TEP.

The research questions are therefore:

a) What are the characteristics (duration, approaches, strategies, assessment methods, results, etc.) of the interventions applied in TEP for the instruction of CT?

and b) What are the factors that researchers claim to influence the outcomes of CT instruction in TEP?

(2) Define inclusion and exclusion criteria

The following keywords and their combinations were used in the searches: Teacher education/programmes/ curricula; Critical thinking (skills/dispositions/attitudes /approach); Interventions/strategies/practices. The combinations of keywords were searched using the "AND" operator. The search was limited to the last 20 years (January 1998-April 2018), during which this area received a lot of attention. To double-check, a rough search of the past 30 years (1988-2018) was performed, with the conclusion that the number of displayed articles is only marginally higher and that they are often quite dated, which in turn was not going to enhance the findings of this review. The following were added to the keywords and time period search criteria: peer-reviewed journals (dissertations, conference papers, and books were excluded), English-language articles.

The main exclusion criteria were that the target area of the studies was not "higher and teacher education" and not "teaching interventions." After a detailed examination, one article was excluded due to its unclear intervention process, and four other articles were excluded due to their unclear connection to teacher education.

(3) Develop a search strategy and locate studies

The EBSCO, ERIC, Web of Science, and Google Scholar databases were used for the search. There were no restrictions on the location of the study.
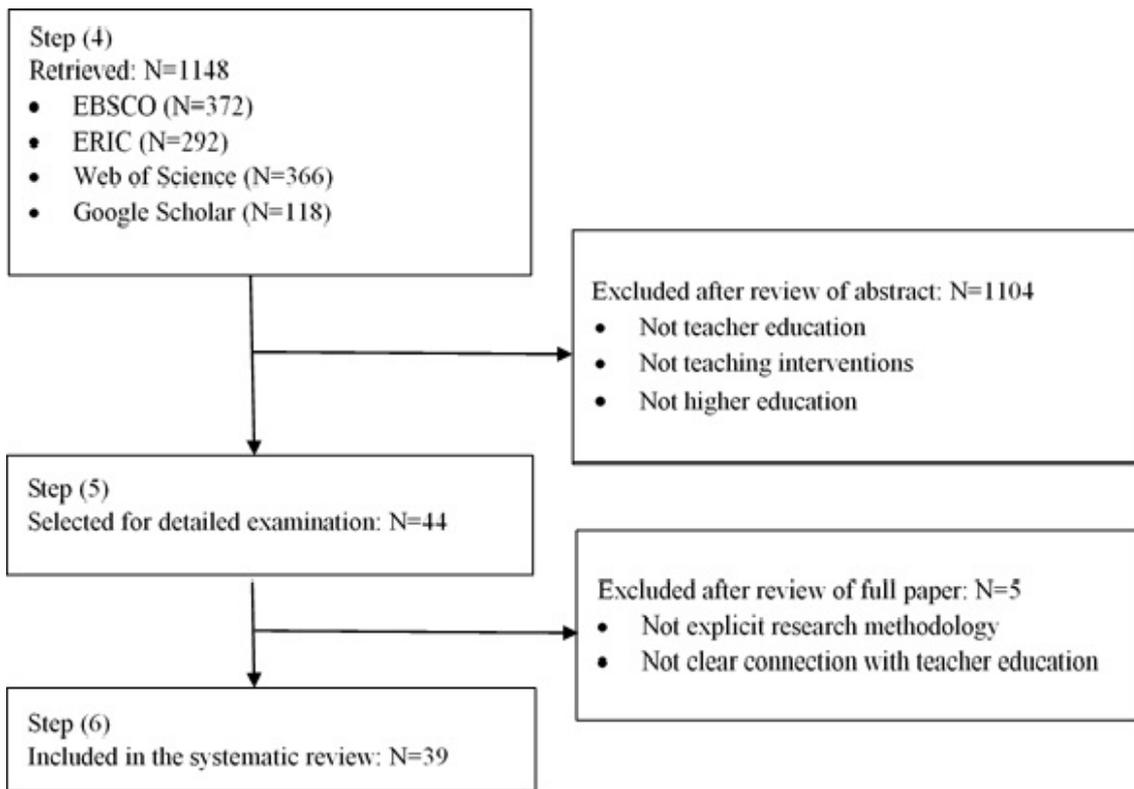
```
Step (4)
Retrieved: N=1148
  • EBSCO (N=372)
  • ERIC (N=292)
  • Web of Science (N=366)
  • Google Scholar (N=118)
```

```
Excluded after review of abstract: N=1104
  • Not teacher education
  • Not teaching interventions
  • Not higher education
```

```
Step (5)
Selected for detailed examination: N=44
```

```
Excluded after review of full paper: N=5
  • Not explicit research methodology
  • Not clear connection with teacher education
```

```
Step (6)
Included in the systematic review: N=39
```

Figure 1. The article selection process

(4) Select studies

According to the above-listed criteria, 1,148 records were acquired, whereas only empirical articles focusing unequivocally on TEP were selected. After a detailed analysis of abstracts, 1,104 articles were excluded and 44 remained (see Figure 1). This was mainly due to the fact that a number of studies referred to other fields (i.e. Nursing, Economics, Law, Business) or solely to school education, and others did not involve teaching interventions.

(5) Extract data

In case the abstracts did not explicitly mention the required information (duration, instructional approaches and strategies, assessment methods, results of the intervention, and the associated factors that affected them), during this step we read the 44 full

articles to verify their relevance to our review goals, questions, and target group. Five

articles were further removed in this step (four due to a lack of an explicit description of

the research methodology and one due to its unclear connection to teacher education)

(see Figure 1).

(6) Assess study quality

The quality of the included studies in our review was checked according to the

following criteria: clear research questions or hypothesis, clear description of

methodology, detailed description of intervention, clear answers to the research

questions.

The remaining 39 articles displayed a clear research focus, analytic description

of research methodology, specific information about the intervention and its results, as

well as research-based and justified explanations, interpretations, and proposals. All

ascertained the study quality of the remaining 39 articles that were analysed in our

review (see Figure 1).

(7) Analyse and interpret results

For the sake of clear data processing, a chart containing the thematic axes for the

following analysis was created. In order to ensure homogenous data analysis by

different authors, each of the thematic axes had specific categories that were either

deductively driven, as shown below (i.e. (g) approaches to teaching CT and (h)

interventions and teaching methods) or inductively driven (i.e. (l) enhancing and (m)

inhibiting factors related to intervention or (n) proposals). Thus, detailed descriptive

criteria for coding or a specific description of the categories' content was developed by

the authors for a systematic analysis of the studies. Before the final version of this chart,

a two-level check had been performed, in which four articles had been analysed by all

of the authors and the criteria for coding had been further fine-tuned. The following

thematic axes (see Table 1) were studied and analysed in the 39 articles that were

acquired in order to provide contextual information on the studies, depict their

characteristics and results, as well as examine the fostering and inhibiting factors for the

success of CT instruction.

Table 1. Thematic axes of analysis (for more detailed information, see Appendix 2)

Context of the study	Characteristics of intervention	Results of intervention	Factors and proposals
a) Title and author	f) Duration of the study	k) Results	l) Enhancing factors
b) Aim of the paper	g) Critical thinking instructional approach		m) Inhibiting factors
c) The location of the study	h) Interventions and teaching methods		n) Authors' proposals
d) Type of teacher programme/the subject of teacher education/future specialisation of the teachers	i) Tools of students' assessment		
e) Number of participants	j) Learning environments/facilities		

The papers were analysed by all four authors and intercoder-reliability was 91%

for the first four papers and reached 100% after clarifications were agreed by all four

authors.

Results

The Context of the Studies

The highest representation of the analysed articles by country is as follows: USA,

Turkey, and Taiwan (see Table 2).

Table 2.1 Articles by country

Country	USA	Turkey	Taiwan	Cambodia	Canada	Cyprus	Finland	Greece
No.	12	9	5	1	1	1	1	1

Table 3.2 Articles by country (cont.)

Country	Iran	Ireland	Malaysia	Netherlands	Pakistan	Philippines	Singapore	South Africa
No.	1	1	1	1	1	1	1	1

The average number of the studies' participants was 65.9 (median = 53.3; MIN=2; MAX=247). 35 studies were performed with undergraduate students, 2 with postgraduate, and 2 studies indicated the participation of both undergraduate and postgraduate students.

The Characteristics of Interventions

Duration

Most interventions (22) occurred during one semester of the TEP (MIN=2.5hrs.; MAX=5 semester).

Table 3.1 Duration of intervention

Duration	2,5 hours	8 hours	2 weeks	4 weeks	5 weeks	8 weeks	10 weeks	12 weeks
No.	1	1	1	1	1	3	1	1

Table 3.2 Duration of intervention (cont.)

Duration	18 weeks	14 weeks	1 semester	5 months	2 semesters	2 years	5 semesters
No.	1	1	22	1	2	1	1

CT instructional approach

The frequency of the use of CT instruction approaches are shown in Table 4.

Table 4. Approaches to CT instruction

Approaches	General	Infusion	Immersion	Mixed	Total
No.	4	15	16	4	39

The most frequent methods used in CT instruction were self-learning and dialogue/discussion (see Table 5).

Table 5. Methods of Intervention

Category of methods	Self-learning	Discussion/dialogue	Authentic or anchored situations	Mentoring	Total
No.	30	25	18	15	88

All methods of interventions were employed in seven studies, which brings it just short of less than one fifth of all the analysed research papers. The analysis has shown that some research studies used specific methods that expanded the initial scope of the possible intervention methods, such as the use of art for CT development (TLAE method, i.e. Transformative Learning through Aesthetic Experience, Kokkos 2010). In addition, some studies mentioned complex teaching strategies that worked with a succession of specific stages of the learning process (e.g. using fundamental powerful concepts in the sequence of State-Elaborate-Exemplify-Illustrate method). All in all, the total number of all analysed categories of intervention methods were identified in the examined CT interventions.

Tools of students' assessment

Various types of tests were used in student assessment in one quarter of the studies. The most frequently appearing standardised test was the California Critical Thinking Disposition Inventory (CCTDI). This test examines CT dispositions and not CT skills, thus having limitations as a test of student teachers' CT understanding and competency. However, most researchers developed their own ways of qualitative assessment, namely feedback, self-assessment, and case studies, as well as rubrics, interviews, portfolios, and essays.

Table 6.1 Tools of student assessment

Assessment	Rubrics	CCTDI	CCTST	The Cornell CT test	Watson-Glaser CT Appraisal	California Achievement Test	Feedback
No.	9	6	2	1	1	1	9

Table 6.2 Tools of student assessment (cont.)

Assessment	Self-assessment	Interview	Portfolio	Observation	Case study	Essay
No.	5	2	2	1	1	1

Learning environment

The most prevalent learning environment during CT instruction on TEP was face-to face/in-class interaction. However, it is worth noticing that one quarter of the studies adopted web-based learning environments and used the support of modern technologies in various forms of on-line discussions (e.g. using wiki, Twitter, blogs, web "scenarios" in web-based seminars, video, e-mails, or various forms of self-learning methods). Two studies made use of e-learning environments to create a study community, regardless of whether it was called an e-learning community, SNS (social network system), or electronic Community of Practice. Six studies utilised a blended approach of both traditional and web-based learning environments.

Table 7. Learning environments

Learning Environments	Traditional in-class teaching	Web-based learning	Blended learning	No reference	Total
No.	21	10	6	2	39

Results of the interventions

The main intervention results of the interventions were categorised in relation to the aims of the studies, which were focused on the effects of a given method (i.e. inquiry-based learning, problem-based learning, debate), tools (i.e. detailed rubric, blog posts), and specific ways (meta-cognitive guidance, specific kinds of questioning, on-line discussion forum) of improving student teachers' CT abilities and/or dispositions. Most interventions were directed towards teaching targeted specific CT skills rather than CT dispositions, while a few combined both CT skills and dispositions. Targeted CT skills often referred to analysis and evaluation, while other CT skills were added to these most

frequently as synthesis or explanation. Some studies had more specific aims, such as the ability for argumentation analysis, critical reading skills, and metacognitive monitoring skills. Fewer studies had as aims to test students' CT skills in classrooms, thus to foster student teachers' ability to teach CT to their pupils or their reflective teaching during CT instruction. A few studies also addressed the improvement of student teachers' self-confidence in CT.

The studies were categorised according to the extent to which the intervention aims were accomplished. Those that met all of the the intervention aims were labelled as having "positive results," those that partially met the intervention aims were classified as having "some results," whereas the studies that did not accomplish any intervention aims were identified as having "no results." Various forms of interventions showed results in the field of CT, related skills, and characteristics (39 studies; 27 studies "positive" and 9 "some" results) and in only three cases (Arsal 2017; Clark and Paulsen 2016; Belluigi and Cundill 2017) the outcomes were labelled as no-results. Positive results were reported by showing the statistical differences in students' assessment (improvement) of CT skills between the initial and the final stage of the intervention, or differences among groups that received the specific CT instruction or not. Further positive results were reported based on qualitative methods, such as an analysis of texts (i.e. reflective reports, blog entries, analysis of literary texts) written by students or students' self-reports that reported an improvement of CT skills and/or self-confidence in knowing and practicing them. On the other hand, in some studies it was stated that the results were not homogeneous for all student teachers, since not all intervention aims were accomplished (i.e. progress was identified in specific questions of a Critical Thinking Skill Test) or the intervention aims were not accomplished by all participants. In these cases, the results showed improvement for some of the targeted

CT skills or only for some of the students. Finally, none of the results of the intervention were related to a lack of statistical differences in pre and post testing of CT or the lack of CT improvement based on qualitative methods. These results are particularly contingent on the diversity of the research methods and approaches used and on methods of measuring CT. Similarly to Tiruneh, Verburgh, and Elen (2014), the overall findings showed that a relatively large number of studies employing non-standardised CT measures reported a more significant improvement in the post test or between the experimental and control group than the studies that employed standardised measures.

Factors

Enhancing factors

During the review analysis, we also focused on determining the factors that the authors of the studies themselves indicated – from their point of view - as enhancing factors, factors that contributed to the success of interventions designed to promote participants' CT in TEP. Enhancing factors were indicated in 23 articles (more than one enhancing factor was mentioned in most of them). These factors were grouped into the following categories:

(1) Teacher/instructor:

- From the perspective of the instructors as an enhancing factor, the researchers in 5 studies pointed out the importance of explicit instruction, for instance in the form of explicit statement and relevant guidance of CT skills.
- The authors of 5 individual research papers stressed the role of questioning by instructors, the provision of an adequate knowledge base to avoid uncertainty,

instructors' flexibility, sensitivity, and responsiveness to students' abilities, clear instruction on how to cooperate, argument analysis, and critical reading skills in the teaching process, the need for monitoring and facilitation of cognitive support from the instructors, and the fact that the instructors were good role models for teachers. Instructors' awareness of ways to teach CT and their readiness to put CT into action were also indicated as enhancing factors in 3 studies.

(2) Students:

Researchers in 8 studies pointed out the following as enhancing factors: the participation and motivation of the students to increase their CT performance, their engagement in lively discussions, mutual sharing of emotions and feelings, self-regulated support, as well as feedback and comments from peers, openness to collaboration and interaction among peers, and supportive comments that enhance the students' self-confidence. Among other factors, the increase of students' self-awareness of their teaching, the ability to exchange ideas through reading peers' (other students') reflections and responding to them, and the awareness of other people's perspectives were mentioned.

(3) Approaches, processes and tools:

Enhancing factors mentioned in 9 studies related to this category included complex teaching strategies, procedures, or a well-thought-out mix of various tools or techniques on the one hand, and individual tools, methods, and techniques used in a rather isolated manner on the other. Furthermore, the specific characteristics that affected the success of interventions were the structured collaboration among trainees, the incorporation of self and peer assessment, the control of task difficulty, and the systematicity of the

intervention (including gradual CT instruction from basic to more difficult CT skills in combination with formative assessment of the learning outcomes).

(4) Course and time: clear content of course, duration of intervention

Enhancing factors belonging to this group were identified in 4 studies either as the ones focused on the clarity of the course content that was easy to understand or on the clarity of the goal that fostered the students' active stance. In addition, researchers in 2 studies pointed out the importance of using a mix of approaches (infusion and immersion) or the implementation of a long-term innovative development programme for pre-service teachers. In addition, the duration of the intervention was reported as an important factor that influenced the intervention results.

Inhibiting factors

The inhibiting factors mentioned by researchers could be divided into two groups, with regard to two points of reference: students and interventions. Regarding students, 8 studies mentioned as inhibiting factors the difficulties they faced during their interventions, such as unfamiliarity or the perceived difficulty of the given CT interventions or methods for fostering CT, their unpreparedness to use the technology or specific methods (such as debate), and also the lack of motivation. Specifically, the aspects of the intervention that were regarded as inhibiting factors in 6 studies were the short duration of the intervention (one semester or less) and the context of the course, i.e. inquiry-based learning was implemented in a course whose content was generally theoretical and did not include practical learning activities. No results in three studies were attributed to either a lack of systematicity of the intervention (e.g. the students used blogs in an electronic community of practice, but they were not supported specifically in improving their CT skills) or an emphasis on theory and lack of practical

learning activities related to CT skills. The lack of a holistic perspective in CT instruction, meaning the incorporation of CT instruction in various courses within a TEP, was also addressed as an inhibiting factor to the success of the intervention.

Authors´ proposals

The proposals following the analysed studies can be sorted into two groups. The smaller one (7 studies) referred to proposals with regard to methodology in future research focusing on the need for repeated research with a greater number of participants, a longer duration of the intervention, experiments with variable duration of CT intervention, follow-up on the transfer of acquired skills by student-teachers into their teaching practice, or the use of measurable outcomes or qualitative approaches. They also proposed a focus on culturally appropriate tools for the students' affective accommodation to the CT challenges.

The larger part of the papers (15 studies) contained proposals with regard to CT development during teacher education, either related to TEP or curricula as a whole or to partial interventions to promote CT. Proposals for CT development to become an integral part of teacher education were put forward to enable future teachers to develop CT with their students. In addition, appeals for the choice of an infusion rather than immersion approach were made, because the development of CT should not be perceived just as a "by-product," but should be incorporated into many teacher education courses.

Based on their research results, 8 authors proposed specific teaching methods to be used to enhance the intervention's effect. Some of these were debate, drama as theatrical role-play and weekly follow-up tests, the use of art, and the use of modern technologies in the form of online communities of practice with active learning methods or of online discussion forums. The authors of 3 research papers also stressed the

importance of the encouragement of CT dispositions as a prerequisite for the improvement of CT skills, the need for a positive climate in the classroom, as well as guiding comments from the instructors. Teacher educators were also proposed to possess a willingness for continuous learning and self-reflection. Proposals in 3 studies concerning CT instruction included modelling CT in TEP, explicit scaffolding during CT, and the usage of multiple and diverse teaching methods that foster instructor-participant interactions and peer interactions.

Discussion and Conclusions

Although CT is considered an essential component of the pedagogical grounding of teachers, it is not systematically included in TEP. The geographical distribution of relevant studies reviewed in this paper is rather uneven, since they are found to have been carried out predominantly in the USA, Turkey, and Taiwan, but very sporadically in Europe (except Turkey). Something similar has been observed in the performed CRITHINKEDU O2 analysis (2018), in which 16 studies out of 46 focused on teachers' education were written predominantly in the national languages.

However, our review analysis has shown that there is a growing body of knowledge regarding CT instruction in TEP, encompassing a multiplicity of strategies and methods. Almost all (with two exceptions) of the 27 interventions labelled as having "positive results" (i.e. 93 %) used practices from at least three of the methods that favour active and collaborative strategies in CT teacher education as defined by Abrami et al. (2015), such as self-learning, discussion, authentic situations, and mentoring/feedback. The prevailing methods used in these interventions were related to self-learning and dialogue/discussion categories.

Various forms of interventions showed "positive" or "some" results in the field of CT, related skills, and characteristics (36 out of 39 studies), so it is important to note that

there was no consistent pattern in the methods of CT assessment or methodological design. Regarding the assessment of students' CT and their performance, non-standardised approaches prevailed (i.e. rubrics created by the researcher) and various forms of feedback, reflection, and self-assessment predominated. In standardised tests, CCTDI, CCTST, Watson-Glaser Critical Thinking Appraisal, and The Cornell Critical Thinking Test were used in the context of CT. The first three tests and their benefits are analysed in great detail by Behar-Horenstein and Niu (2011) with the conclusion that statistical significance should not be the only criterion for instructors to consider when choosing new teaching methods. In their recommendations, the authors further state that multiple test measures, including qualitative and quantitative, should be used to assess changes in students' CT skills. However, not all tests measure CT skills but rather the CT disposition or students' views of their efficacy in CT. The variety in measurement methods can be explained by the multiplicity of the aspects of CT under study, and might be seen as an element of the dynamic character of this concept. On the other hand, this variety begs the question of whether it is possible to use certain tools in order to assess the enhancement of CT through educational interventions that have been properly designed according to a common perspective.

Although the face-to face/in-class traditional teaching environment (21 studies) still prevails, 16 studies have utilised a web-based teaching environment or blended learning. As educators begin to understand the potential of web-based learning in education, the role of teachers and teacher educators in integrating new technologies (e.g. mobile devices) becomes essential in addressing students' learning needs across several disciplines (Baran 2014). The authors of the analysed studies in which web-based learning environments (including mobile learning) or blended learning were used

often encountered complications related to students' and/or teachers' competence and willingness to work with these technologies.

This review not only reports on the structural elements of CT instruction, but also delves into the factors that the authors of the research papers regarded as enhancing (or inhibiting). It also examines the researchers' proposals based on their results, either for further research, or for the development of students' CT skills and CT dispositions. Furthermore, it confirms the findings of other reviews regarding the positive results of the explicit instruction of CT in various courses (Abrami et al.2008; Behar-Horenstein and Niu 2011; Pithers and Soden 2000). It highlights several other factors that foster positive results in CT instruction in TEP such as the instructors' awareness of ways to teach CT in TEP or courses (based on their CT knowledge and training on CT instruction), ability to accommodate their instruction to students' varying abilities, and the use of adequate specific techniques of instruction. Thus, an instructor in TEP should be a good role model for his/her students so that their self-efficacy beliefs for modelling CT for their pupils and students can be fostered.

On the part of the students, their motivation and participation, supported by interaction, were also mentioned as enhancing factors. Students' personal characteristics, such as learning style, familiarity with instructional methods, motivation, self-confidence, and anxiety were also mentioned as affecting the results of the intervention. The positive results of interventions presupposed the clarity of the content and goals of CT instruction, preferably within the framework of a long-term programme. The proposals put an emphasis on the thoughtful and purposeful infusion of CT in TEP and/or curricula with clear goals and structured instruction, meaningful questioning, and feedback from instructors to peer learners.

The proposals also referred to the need for complex teaching procedures or creative preparation and the usage of modern technologies. Overall, this review analysis showed that a combination of factors affects the success of interventions aimed to foster student teachers' CT. These can be classified as the personal (i.e. students' learning style), methodological (i.e. tools, duration, feedback), and contextual (i.e. classroom climate, supportive initiatives) features of the intervention that are important for effective CT instruction and the improvement of student teachers' CT skills and dispositions.

Regarding suggestions for future research on CT instruction in TEP and the general need for the methodological improvement of future studies in terms of research design and research samples was most accented, similarly to the suggestions presented in other reviews (e.g. Behar-Horenstein and Niu 2011).

TEP aimed at the empowerment of students to think critically should take into serious consideration a number of issues related to the pedagogy of CT. Assuming that deep thinking accords with deep learning, we propose that TEP should offer opportunities for attaining increasingly deeper levels of CT, consolidate the participants' thoughts about CT, and create a functional bridge between theory and classroom practice in order to fight superficial thinking in Teacher Education Institutions (Moon 2008).

Concerning the teaching methodology used, the research revealed that teaching CT explicitly is more effective (Behar-Horenstein and Niu 2011). This knowledge will have to be taken into account more in designing CT interventions in TEP than it has been so far (immersion, that is implicit strategy, was used in approx. two fifths of the analysed 39 papers). On the other hand, short-term interventions are usually preferred

although research proves that long-term ones are more effective in CT studies (e.g.

Abrami et al. 2015; Behar-Horenstein and Niu 2011).

In conclusion, we believe that the specific characteristics of the reported

interventions aimed to foster CT in TEP can form an added value to the already existing

knowledge base of instruction for those who attempt to organise, practice, and evaluate

their teaching repertoires in order to become effective teachers.

References

Abrami, P. C., R. M. Bernard, E. Borokhovski, D. I. Waddington, and C. A. Wade. 2015. Strategies for Teaching Students to Think Critically: A Meta-Analysis. *Review of Educational Research* 85(2): 275-314. doi:10.3102/0034654314551063.

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

Allen, M., S. Berkowitz, S. Hunt, and A. Louden. 1999. A Meta-Analysis of the Impact of Forensics and Communication Education on Critical Thinking. *Communication Education* 48(1): 18-30. https://doi.org/10.1080/03634529909379149

American Philosophical Association. 1990. Critical Thinking: a statement of expert consensus for purposes of educational assessment & instruction. The Delphi Report: research findings & recommendations prepared for the committee on pre-college philosophy. ERIC Doc. No. ED 315 423.

Anastasiadou, S. and A. Dimitriadou. 2011. What does Critical Thinking mean? A statistical data analysis of pre-service teachers' defining statements. *International Journal of Humanities and Social Science* 1(7): 73-83.

Arsal, Z. 2017. The impact of inquiry-based learning on the critical thinking dispositions of pre-service science teachers. *International Journal of Science Education* 39(10): 1326-1338.

Bandura, A. (Ed.) 1995. *Self-efficacy in Changing Societies*. Cambridge University Press.

Baran, E. 2014. A Review of Research on Mobile Learning in Teacher Education. *Educational Technology & Society* 17(4):17–32.

Behar-Horenstein, L. S., and L. Niu. 2011. Teaching Critical Thinking Skills in Higher Education: Review of The Literature. *Journal of College Teaching and Learning* 8(2): 25-41.

Belluigi, D. Z., and G. Cundill. 2017. Establishing enabling conditions to develop critical thinking skills: a case of innovative curriculum design in Environmental Science. *Environmental Education Research* 23(7): 950–971.

Clark, T. K., and. T. H. Paulsen. 2016. Analyzing Student Teacher Critical Thinking through Blogs in an Electronic Community of Practice. *Journal of Agricultural Education* 57(2): 75-92.

CRITHINKEDU O2. 2018. A European review on Critical Thinking educational practices in Higher Education Institutions. Vila Real: UTAD. ISBN: 978-989-704-258-4

De Bono, E. 1985. *Practical Thinking. 4 ways to be right. 5 ways to be wrong. 5 ways to understand*. Harmondsworth: Penguin Books.

Elder, L. and R. Paul. 1994. Critical Thinking: Why We Must Transform Our Teaching. *Journal of Developmental Education* 18(1): 34-35.

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

Facione, P. A. 1990. Critical Thinking: What It Is and Why It Counts. https://www.nyack.edu/files/CT_What_Why_2013.pdf.

Fawkes, D., O'Meara, B., Weber, D. and D. Flage. 2005. Examining the Exam: A Critical Look at The California Critical Thinking Skills Test *Science & Education* 14(2): 117–135

Gellin, A. 2003. The Effect of Undergraduate Student Involvement on Critical Thinking: A Meta-Analysis of the Literature 1991-2000. *Journal of College Student Development* 44(6): 746-62. 10.1353/csd.2003.0066

Hager, P. and M. Kaye, M. 1992. Critical Thinking in Teacher Education: A Process-
Oriented Research Agenda. Australian Journal of Teacher Education 17(2). doi:
10.14221/ajte.1992v17n2.4

Halpern, D. F. 1996. *Thought and Knowledge. An Introduction to Critical Thinking.*
New Jersey: Lawrence Erlbaum Associates.

Keengwe, J., and J. J. Kang. 2013. A review of empirical research on blended learning
in teacher education programs. *Education and Information Technologies*18(3):
479–493.

Klassen, R. and V. M. Tze. 2014. Teachers' self-efficacy, personality, and teaching
effectiveness: A meta-analysis. *Educational Research Review* 12(6): 59-76.

Kokkos, A. 2010. Transformative Learning through Aesthetic Experience: towards a
comprehensive method. Journal of Transformative Education 8(3): 155-177.

McPeck, J. 1984. Stalking Beasts but Swatting Hies: The Teaching of Critical Thinking.
Canadian Journal of Education 9(1): 28–44.

Moon, J. 2008. *Critical Thinking: An Exploration of Theory and Practice*. London:
Routledge.

Mpofu, N., and M. C. Maphalala. 2017. Fostering critical thinking in initial teacher
education curriculums: a comprehensive literature review. *Gender
&Behaviour*15(2): 9256-9266.

Niu, L., L. S. Behar-Horenstein, and C. Garvan. 2013. Review: Do instructional
interventions influence college students' critical thinking skills? A meta-
analysis. *Educational Research Review*9: 114-128. doi:
10.1016/j.edurev.2012.12.002. ISSN 1747938X.

Pithers, R.T., and R. Soden. 2000. Critical thinking in education: a review. *Educational
Research* 42(3): 237-249.http://dx.doi.org/10.1080/001318800440579.

Song, X. 2016. "Critical Thinking" and Pedagogical Implications for Higher Education.
*East Asia*33(1): 25-40. doi: 10.1007/s12140-015-9250-6

Tiruneh, D. T., A. Verburgh, and J. Elen.2014. Effectiveness of Critical Thinking
Instruction in Higher Education: A Systematic Review of Intervention Studies
Higher Education Studies 4(1): 1-17.https://doi.org/10.5539/hes.v4n1p1.

Tsui, L. 1998. A Review of Research on Critical Thinking. *ASHE Annual Meeting
Paper*. https://files.eric.ed.gov/fulltext/ED427572.pdf.

Uman, L. S. 2011. Systematic reviews and meta-analysis. *Journal of the Canadian Academy of Child and Adolescent Psychiatry* 20 (1):57-59.https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3024725/

Williams, R. L. 2005. Targeting Critical Thinking within Teacher Education: the Potential Impact on Society. *The Teacher Educator* 40(3): 163-187.

Appendix 1. Analysed articles

1. Akyüz, H. I., S. Samsa Yetik, and H. Keser. 2015. Effects of Metacognitive Guidance on Critical Thinking Disposition. *Pegem Eğitim ve Öğretim Dergisi* 5(2): 133-148.

2. Alexander, M. E., N. Commander, D. Greenberg, and T. Ward. 2010. Using the Four-Questions Technique to Enhance Critical Thinking in Online Discussions. MERLOT *Journal of Online Learning and Teaching* 6(2): 409-415.

3. Angeli, Ch., and N. Valanides. 2009. Instructional effects on critical thinking: Performance on ill-defined issues. *Learning and Instruction* 19: 322-334.

4. Arsal, Z. 2017. The impact of inquiry-based learning on the critical thinking dispositions of pre-service science teachers. *International Journal of Science Education* 39(10): 1326-1338.

5. Belluigi, D. Z., and G. Cundill. 2017. Establishing enabling conditions to develop critical thinking skills: a case of innovative curriculum design in Environmental Science. *Environmental Education Research* 23(7): 950–971.

6. Bensley, D. A., and R. A. Spero. 2014: Improving critical thinking skills and metacognitive monitoring through direct infusion. *Thinking Skills and Creativity* 12: 55–68.

7. Cargas, S., S. Williams, and M. Rosenberg. 2017. An approach to teaching critical thinking across disciplines using performance tasks with a common rubric. *Thinking Skills and Creativity* 26: 24-37.

8. Clark, T. K., and T. H. Paulsen. 2016. Analyzing Student Teacher Critical Thinking through Blogs in an Electronic Community of Practice. *Journal of Agricultural Education* 57(2): 75-92.

9. Demirbag, B., A. Unisen, and A. Yesilyurt. 2016. Training of Critical Thinking Skills in Teacher Candidates and Placebo Effect: A Quasi-Experimental Study. *Eurasian Journal of Educational Research* 63: 375-392.

10. Dilek Eren, C., and O. Akinoglu. 2013. Effect of Problem-Based Learning (PBL) on Critical Thinking Disposition in Science Education. *Journal of Environmental Protection and Ecology* 14(3A): 1353-1361.

11. Ekici, D. I. 2017. The Effects of Online Communities of Practice on Pre-Service Teachers' Critical Thinking Dispositions. *EURASIA Journal of Mathematics Science and Technology Education* 13(7): 3801-3827.

12. Engin, G., A. Dikbayir, and S. Z. Genc. 2017. Effectiveness of Learning Strategies Taught to Teacher Candidates. *Educational Policy Analysis and Strategic Research* 12(2): 62-80.

13. Garcia, C. D., and H. H. Hooper. 2011. Exploring Factors of a Web-Based Seminar That Influence Hispanic Preservice Teachers' Critical Thinking and Problem-Solving Skills. *Journal of Hispanic Higher Education* 10(3): 200–211.

14. Ghabanchi, Z., and S. Behroozria. 2014. The Impact of Brainstorming on Reading Comprehension and Critical Thinking Ability of EFL Learners. *Procedia - Social and Behavioral Sciences* 98: 513 – 521.

15. Gul, R. B., S. Khan, A. Ahmed, S. Cassum, T. Saeed, Y. Parpio, D. Schopflocher, and J. Profetto-McGrath. 2014. Enhancing Educators' Skills for Promoting Critical Thinking in Their Classroom Discourses: A Randomized Control Trial. *International Journal of Teaching and Learning in Higher Education* 26(1): 37-54.

16. Han, H. S., and T. Brown. 2013. Effects of Critical Thinking Intervention for Early Childhood Teacher Candidates. *The Teacher Educator* 48(2): 110-127.

17. Cherubini, L. 2009. Exploring prospective teachers' critical thinking: Case-based pedagogy and the standards of professional practice. *Teaching and Teacher Education* 25: 228–234.

18. Chiu, Y. C. 2009. Facilitating Asian students' critical thinking in online discussions. *British Journal of Educational Technology* 40(1): 42–57.

19. Cho, K., and M. H. Cho. 2013. Training of self-regulated learning skills on a social network system. *Social Psychology Education* 16: 617–634.

20. Junsay, M, L. 2016. Reflective Learning and Prospective Teachers' Conceptual Understanding, Critical Thinking, Problem solving, and Mathematical Communication Skills. *Research in Pedagogy* 6(2): 43-58.

21. Lee, H. Y. 2015. Facilitating critical thinking using the C-QRAC collaboration script: Enhancing science reading literacy in a computer-supported collaborative learning environment. *Computers & Education* 88: 182-191.

22. Lynch, R., P. Mannix McNamara, and N. Seery. 2012. Promoting deep learning in a teacher education programme through self- and peer-assessment and feedback, *European Journal of Teacher Education* 35(2): 179-197.

23. Marttunen, M., and L. Laurinen. 2001. Learning of argumentation skills in networked and face-to-face environments. *Instructional Science* 29: 127–153.

24. Mat Daud, N., and Z. Husin. 2004. Developing critical thinking skills in computer-aided extended reading classes. *British Journal of Educational Technology* 35(4): 477-487.

25. Osana, H. P., and J. R. Seymour. 2010. Critical Thinking in Preservice Teachers: A Rubric for Evaluating Argumentation and Statistical Reasoning, *Educational Research and Evaluation* 10(4-6): 473-498.

26. Pena, C., and I. Almaguer. 2012. The Use of Online Discussions to Foster Critical Thinking in a Teacher Thinking in a TeacherEducation Program. *International Journal of Instructional Media* 39(1): 25-32.

27. Raikou, N., T. Karalis, and K. Ravanis. 2017. Implementing an Innovative Method to Develop Critical Thinking Skills in Student Teachers. *Acta Didactica Napocensia* 10(2): 21-30.

28. Sac,liUzunöza, F., and G. Demirhan. 2017. The effect of creative drama on critical thinking in preservice physical education teachers. *Thinking Skills and Creativity* 24: 164–174.

29. Sezer, R. 2008. Integration of Critical Thinking Skills into Elementary Schoolteacher Education Courses in Mathematics. *Education* 128(3): 349-364.

30. Szabo, Z., and J. Schwartz. 2011. Learning methods for teacher education: the use of online discussions to improve critical thinking. *Technology, Pedagogy and Education* 20(1): 79-94.

31. Temel, S. 2014. The effects of problem-based learning on pre-service teachers' critical thinking dispositions and perceptions of problem-solving ability. *South African Journal of Education* 34(1).

32. Toy, B. Y., and A. Ok. 2012. Incorporating critical thinking in the in the pedagogical content of a teacher education programme: does it make a difference? *European Journal of Teacher Education* 35(1): 39-56.

33. Vong, S. A., and W. Kaewurai. 2017. Instructional model development to enhance critical thinking and critical thinking teaching ability of trainee students at regional teaching training center in Takeo province, Cambodia. *Kasetsart Journal of Social Sciences* 38: 88-95.

34. Vrieling, E. M., T. J. Bastiaens, and S. Stijnen. 2012. Effects of increased self-regulated learning opportunities on student teachers' metacognitive and motivational development. *International Journal of Educational Research* 53: 252-263.

35. Wake, D. G., and V. B. Modla. 2012. Using Wikis with Teacher Candidates: Promoting Collaborative Practice and Contextual Analysis. *Journal of Research on Technology in Education.* 44(3): 243–265.

36. Yang, CH.-H., and E. Rusli. 2012. Using Debate As A Pedagogical Tool In Enhancing Pre-Service Teachers Learning And Critical Thinking. *Journal of International Education Research* 8(2): 135-143.

37. Yang, Y.-T. C. 2012. Cultivating critical thinkers: Exploring transfer of learning from pre-service teacher training to classroom practice. *Teaching and Teacher Education* 28: 1116-1130.

38. Yeh, W. Ch. 2004. Nurturing reflective teaching during critical-thinking instruction in a computer simulation program. *Computers & Education* 42: 181–194.

39. Yeh, Y. Ch. 2009. Integrating E-Learning into the Direct-Instruction Model to Enhance the Effectiveness of Critical-Thinking Instruction. Instructional Science: *An International Journal of the Learning Sciences* 37(2): 185-203.

Appendix 2. Criteria for article coding

(1) Author
(2) Title
(3) Citation
(4) Aim of the paper – the main aim of the paper, research questions
(5) Place - state
(6) Type of teacher programme
- Undergraduate
- Graduate
- Postgraduate
- Other (e. g. special education course)
(7) Number of participants of the study
(8) Duration of the intervention
(9) CT instructional approach (Ennis 1989)
- General: CT is taught separately from the presentation of the content of existing subject-matter.
- 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.
(10) Interventions (the major categories for coding strategies and methods for teaching students to think critically are based on Abrami et al. (2015) with enriched subcategories added by the authors of this paper to grasp the variety of CT interventions and methods)
- Self-learning
Assignments contrasting multiple perspectives
Critical analysis of literature
Reflective practice
Make presentations
Performance tasks
Cooperative learning (e. g. Jigsaw, etc.)
- Discussion
Pose open questions
Asking evaluative/higher level questions
Dialogue
Small group discussions
Argumentation debates
Whole class discussions
- Authentic or anchored instructions
Case study
Simulation
Role playing
Small group interactions
Dilemmas (incl. VAKE)
Projects
- Mentoring
Feedback
Mentoring
(11) Tools of student assessment
- Rubrics
- Specific CT tests (CCTDI, CCTST, The Cornell CT Test, Watson-Glaser CT Appraisal, California Achievement Test)
- Feedback

- Self-assessment
- Interview
- Portfolio
- Observation
- Case study
- Essay
- Written test
- Group project
- Oral examination

(1) Learning environments or/and facilities
- Traditional classroom: teacher provides face-to-face instruction to students and communication between students and teacher is face-to-face
- Blended learning: combination of traditional classroom with online digital media
- Web based learning environments: e-learning, online learning, computer-based learning

(2) Method (research methodology)
- Qualitative
- Quantitative
- Mixed (at least 1 qualitative and 1 quantitative method)

(3) Main results
- Positive results: all intervention aims were accomplished
- Some results: some of the intervention's aims were accomplished while others were not accomplished
- No results: no aim of the intervention was accomplished

(4) Enhancing factors (when authors referred explicitly in the discussion of their results to what enhanced or inhibited the outcomes of their intervention, we coded these factors as enhancing or inhibiting)
- Teacher/instructor
- Students
- Approaches, processes, tools
- Course and time: clear content of course and duration of intervention

(5) Inhibiting factors
- Students' difficulties
- Performed interventions

(6) Authors' proposals
- CT development during teacher education
- Future research description (description)