

CriThiSE – Critical Thinking in Sustainability Education

Background

Globalization and development of technologies have brought a variety of societal challenges that require new competencies and skills, among them students' capacity for critical thinking (CT). The CriThiSE project aims to improve the quality of teaching and learning CT skills in primary schools. CT is emphasized as a central twenty-first century skill – central in education, work life and civil society (European Commission, 2016; UD, 2017). In recent years, the way people communicate has radically changed due to globalization and the use of social media (Cornali & Tirocchi, 2012). Knowledge is no longer hierarchically distributed from 'validated' reliable sources in a top-down manner, from traditional institutions via traditional media to the public. Instead, the younger generation communicates through active participation in social networks, where there are no filters to validate the trustworthiness of the shared information. It has become significantly more difficult to distinguish information from disinformation, and 'fake news' has become a reality, as well as accusations of 'fake news' for what objectively could be regarded as facts (Figueira & Oliveira, 2017; Lewandowsky, Ecker, & Cook, 2017). Moreover, standpoints and information are less discussed nowadays because young people mostly communicate in like-minded groups within social media, leading to a reinforced perspective among the participants in those 'echo chambers'. The school of today therefore needs to educate the coming generations in a way that 'vaccinates' them against these trends towards rectification and unification of people's minds.

How can schools promote attitudes and skills among students that encourage them to reflect critically on their own and others' positions in the new media landscape? This is one of the most central issues for elementary school education to contribute to over the next decades to secure a democratic development of society, as also recognized in the new Norwegian curriculum. CT has a newly reinforced importance in the Norwegian governing documents (UD, 2019). In this project, we aim to address this issue to develop CT as a teaching approach in primary school with the long-term aim of developing students' CT skills in order to navigate in the new media landscape.

In contemporary society many questions are amalgams of scientific, ethical and moral issues in which there is no one single solution. Complex issues like these revolving around our common future are summarized in the cross-disciplinary concept of Sustainable Development, where the goal is to meet the needs of the people today without diminishing opportunities for future generations. The teaching approach for reaching this goal is denoted Education for Sustainable Development (ESD) or sustainable education. In ESD, CT is a very important tool for making informed decisions (e.g. Belluigi & Cundill, 2017). Therefore, in this project we use ESD as our educational context in which we develop and investigate the outcomes of CT. In the Norwegian curriculum, ESD is recognized as a central goal of education (KD, 2017), making this project relevant for reaching that goal.

CT is a recognized area of research in the educational sciences, and there is a need for future research to help clarify to students, teachers and researchers what it means to think critically in school (e.g. see Nygren, Haglund, Samuelsson, Af Geijerstam & Prytz, 2019). In this study we will therefore longitudinally explore this issue and develop and evaluate teaching of CT within different contexts of ESD. We propose to undertake an intervention project aimed at strengthening the connection between classroom teaching and everyday life challenges. The ambition of the present project is to undertake a praxis-orientated approach to map out and develop a pedagogical knowledge framework with which educators/teachers can work towards teaching CT in primary school. Together with teachers, we will develop their CT instructions based on programmes within the framework of ESD and investigate if and how these instructions are enacted in the classroom, and further investigate the influence on students' development as critical thinkers.

Project objectives

Focusing on CT in primary school: The primary objective

The two academic disciplines of philosophy and psychology have both developed and explored the idea of CT. The philosophical approach focuses on the ideal critical thinker and standards of thinking, which can be denoted as dispositions. The cognitive psychological approach emphasizes how people actually think under current conditions versus how they should think, and defines CT by the types of actions critical thinkers can take, which can be denoted as skills. In the field of educational research, the three highest levels in Bloom's taxonomy (analysis, synthesis, and evaluation) have been highlighted as representative of CT, but this approach has been criticized for being too vague. Although there are differences between the different approaches of CT in educational research, there is agreement that it should include skills and dispositions (Figure 1), and the need for background knowledge to have something to be critical about (Lai, 2011).

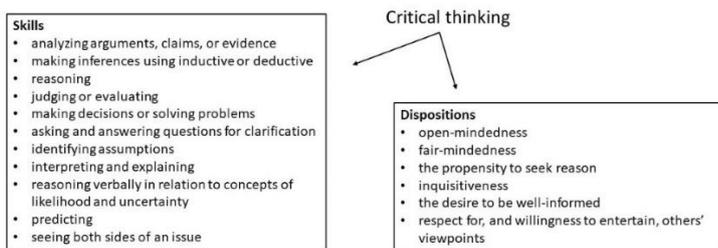


Figure 1 Components of CT (Lai, 2011).

Ennis (1985) defined CT as: "...a form of rational, reflective thinking, focused on deciding on what to believe or do" (Ennis, 1985, p. 46). Based on this definition, we share the arguments of Vieira, Tenreiro-Vieira, and Martins (2011, p. 48) that: "critical thinking involves a set of skills and dispositions to be well mobilized in the context of problem solving, decision making and in the context of interacting with others. This set of intellectual tools includes abilities, namely arguing and analysing arguments, judging the credibility of a source, making inferences (reaching conclusions based on sound evidence and reasons) and deciding on action, as well". In CriThiSE we treat CT as a set of skills and dispositions, as stated in Lai (2011) and Vieira et al. (2011).

CT is important today, and some aspects of the competences will gain in importance in the coming years. Bearing this trend in mind, Ludvigsen et al. (2015) and *Tett på realfag* (KD, 2015) promote CT as a key competence. At the same time, there is a lack of consistency in both the present and the upcoming curriculum with a view to how CT should be developed through the school's education (KD, 2016; UD, 2019). In addition, textbooks do not sufficiently contribute to developing the CT that students need in today's complex and diverse societies (Lorentzen & Røthing, 2017). To meet these challenges and to provide the sector and teacher education with relevant knowledge, **the primary objective of the proposed project is to develop teaching of CT and investigate the outcomes thereof in primary education.**

Construct for CT skills and dispositions: First secondary objective

In examining CT, researchers have used a variety of tests and assessment protocols: self-reports and performance-based assessments. Multiple-choice tests have been the dominant testing regime in research on CT (Hyytinen, 2015). Those tests, however, usually do not encourage higher-order thinking processes and are less sensitive to dispositions (Lai, 2011). Open-ended constructed-response measures (Bennet & Ward, 1993), on the other hand, promote higher-order thinking, encourage extended problem solving, can reveal the level of understanding, support students' self-evaluation skills and are often referred to as authentic assessments. However, these open-ended measures are far more complex; they are difficult to score and might need adjustments to context. We conclude that CT should be measured using multiple criteria (quantitative and qualitative) instead of relying solely on standardized tests. For this project, we need a construct to measure teachers' and students' CT skills and disposition within the educational context of ESD. Thus, **the first secondary objective is to conduct a literature review investigating and conceptualizing the skills and dispositions of CT that could be defined into a construct and to develop**

questionnaire instruments measuring the defined construct (which will be used to meet the second and third secondary objective).

Professional development and instructional practices: Second secondary objective

CT has not been appropriately implemented in classrooms (Santos, 2017). One of the obstacles is the fact that teachers do not have a clear idea about CT because the meaning ascribed to CT in different contexts is rarely explicit (Rui Marques & Matins, 2011). Challenges in implementation are also due to misconceptions of the CT concept, lack of clear guidance for including CT in textbooks and in classroom activities, and insufficient teachers' training in topics regarding CT (Bailin, 2002; Santos, 2017). Thus, the multifaceted conception of being a critical thinker calls for a sophisticated conception of learning and teaching for CT. Based on these facts, there is a need for teacher professional development within CT and we designed the proposed intervention study for teachers in primary school. **The second secondary objective is to describe, explain and evaluate teachers' development of their CT skills and dispositions and CT instruction practices as a consequence of their professional development during the project.**

Evidence-based knowledge about how to promote CT: Third secondary objective

There is agreement that CT can be taught (e.g. Lai, 2011; Abrami et al., 2008) and that teaching should start early (Osakwe, 2009). Students do not develop CT naturally and spontaneously (see Santos, 2017). The question is how CT should be taught. According to Thomas (2009), CT requires a different approach to learning compared with traditional teaching approaches. From studies in higher education, we know that there are effective teaching strategies for teaching CT skills and dispositions, both general and subject content-specific (Abrami, 2015). Exposure of students to 1) authentic or situated problems and examples, 2) opportunities for dialogue, and 3) teachers acting as mentors for the students played an important role in promoting CT. Less is known, however, about classroom activities and techniques to foster students' CT in primary school (Santos, 2017). Thus, based on these conclusions, we designed this project to meet this gap in the literature. **The third secondary objective is to describe, explain and evaluate primary students' development of generic and domain-specific CT skills and dispositions as a response to the new CT instruction practices.**

Evidence-based knowledge about the context's role in developing CT: Fourth secondary objective

CT has been highlighted in the Norwegian curricula for several decades, and in the upcoming school reform (Fagfornyelsen) even more than before: "Critical thinking and ethical awareness are both a prerequisite for and a part of learning" (UD, 2017, p. 7). Furthermore, in the syllabi, CT is interpreted and operationalized in different subject-specific ways (KD, 2018; UD, 2019). At this point, however, research has not managed to establish to what degree CT is a matter of distinct skills in different school subjects and to what degree it is primarily a general ability. Thus, we still do not know how CT can best be integrated into different subjects, and specifically how teachers can incorporate CT into their lessons. Further cross-curricular research is needed to compare CT teaching strategies in different subjects. Based on these conclusions, and the fact that ESD topics are interdisciplinary, we designed this project to gain deeper insight into how CT is enacted in different subjects (science, language and social science). Thus, **a fourth secondary objective is to investigate in which way CT is enacted by teachers in different contexts in order to determine what are generic and domain-specific CT skills and dispositions.**

Research questions

The project objectives will be met by answering the following research questions (RQ), in which 1-4 correspond to the respective secondary objectives:

1. (a) What skills and dispositions constitute CT?
(b) How can teachers and primary school students' CT skills and dispositions be measured?

2. How does professional development influence teachers' CT skills and dispositions and their CT instruction practices?
3. How does the professional development influence students' generic and domain-specific CT skills and dispositions?
4. To what extent and how do different contexts influence teachers and students' generic and domain-specific CT skills and dispositions?

Implementation

Project manager and project group

An overview of the project group is given in Table 1. The project group constitutes of representatives from Department of Teacher Education and The Writing Centre at NTNU, and three partner institutions (Karlstad University, The Science Centre and NIFU). In addition, three municipalities are involved in intervention studies (Melhus, Skedsmo, Karlstad).

Table 1: Project group; partners and participants and their responsibilities

Project partners/participants	Project participants (gender; Male/Female)	Main responsibilities	Co-responsibilities
NTNU, Department of Teacher Education, Science and Social sciences Sections (Project Owner)	Associate Professor Ragnhild Lyngved Staberg (F) Professor Niklas Gericke (M) (Professor II, NTNU) Associate Professor Maria I.M. Febri (F) Associate Professor Festo Kayima (M) Associate Professor Tove Grete Lie (F) Professor Annette Lykknes (F) Associate Professor Eli Munkebye (F) PhD student NN, master students	Project manager, WP2 Co-manager WP2 WP3 WP4 WP1,3, Coord. Melhus	WP1, 3, 4 WP1, 2, 3, 4 WP3, 4 WP2, 4 WP2, 3, 4 WP1 WP2, 3, 4 WP2, 3
NTNU, National Centre for Writing Education and Research (The Writing Centre)	Assistant Professor Marthe Lønnum (F)		WP2, 3, 4
Karlstad University, the SMEER Centre (Centre of Science, Mathematics, Engineering Education Research)	Professor, director Niklas Gericke (M), see NTNU PhD student Teresa Berglund (F) (dissertation December 2019)	Coordinator Karlstad	WP1, 2, 3, 4
Norwegian Centre for Science Education (The Science Centre)	Associate Professor Eldri Scheie (F) Associate Professor, leader Merethe Frøyland (F)	Coordinator Skedsmo AAB (see Table 2)	WP1, 2, 3, 4
The Nordic Institute for Studies in Innovation, Research and Education (NIFU)	Senior Researcher Stephan Daus (M)	WP1, 4	WP2, 3
Melhus municipality	Three schools	Participate in TPD	
Lillestrøm municipality	One school	Participate in TPD	
Karlstad municipality	One school	Participate in TPD	

The CriThiSE project will have an international Academic Advisory Board (AAB) (Table 2), that will provide advice during all stages of the project. The areas of expertise within the board include CT, ESD, TPD and teacher networks, e.g. Erduran is one of the world's most acknowledged researchers within the field of argumentation, which closely relates to CT. CriThiSE will cooperate with school authorities in the three municipalities, to ensure a link between the school district officials, principals and teachers, and the research group. In Melhus we will set up a UAB to ensure user involvement (Table 2).

Table 2: Academic Advisory Board (AAB) and User's Advisory Board (UAB)

Academic Advisory Board (AAB)	Field of expertise
Professor Sibel Erduran, University of Oxford, United Kingdom (Professor II, The Science Centre)	CT, argumentation
Associate Professor Maria Evagorou, University of Nicosia, Cyprus	CT, argumentation
Professor Franz Rauch, Alpen-Adria-Universität Klagenfurt, Austria	ESD, TPD, Teacher networks
Professor Martin Bilek, Charles University, Czech Republic	ESD, TPD
Associate Professor Marta Romero, University of Jaen, Spain	CT, ESD, TPD
Associate Professor Jan Petr, University of South Bohemia in Ceske Budejovice, Czech Republic	ESD, TPD
Associate Professor Merethe Frøyland, Norwegian Centre for Science Education, Norway	ESD, TPD, Teacher networks
User's Advisory Board (UAB)	
Educational advisor Ingrid Sjoner (Melhus), principals, teachers	School contexts

Project organisation and management

To address the CriThiSE project's objectives, four work packages have been devised (Table 3). The work packages relate specifically to the four secondary objectives and their accompanying research questions. *Please see the electronic grant application form for an overview of milestones and deliverables.*

Table 3. Simplified Gantt chart. M=Milestone, D=Deliverable, CM=Coordination meeting, project group (WP leaders, coordinators), AAB=Academic Advisory Board meeting, UAB=User's Advisory Board meeting, T0,1,2,3=Time for survey and interviews.

Year	2020				2021				2022				2023			
Quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Stage	Planning												Evaluation			
	1 st year intervention				2 nd year intervention				3 rd year intervention							
Management	M1:CM M2:AAB M3:UAB	M4	M5:CM M6:UAB	M7	M8:CM M9:AAB	M10:UAB	M11:CM		M12:CM M13:AAB	M14:UAB	M15:CM		M16:CM M17:AAB	M18:CM M19:UAB		M20: Final conf.
WP1 Construct	M1.1															D1.1
WP2 Teachers		M2.1 M2.2				M2.3 D2.1				M2.4				M2.5		D2.2/3/4
WP3 Students			M3.1 M3.2			M3.3 D.3.1				M3.4				M3.5		D3.2
WP4 Context		M4.1												M4.2		D4.1

Work package 1 (WP1) (2020): Developing a construct for CT skills and dispositions: RQ1a, 1b - Lead by Munkebye and Daus

In order to answer to RQ1a – *What skills and dispositions constitute CT?* – WP1 will perform a critical literature review resulting in a construct for CT (see §1.3.2) (spring 2020) followed by writing up for a publication (autumn 2020). Based on the construct of RQ1a, WP1 will answer to RQ1b - *How can teachers and primary school students' CT skills and dispositions be measured?* - by developing questionnaire instruments (teacher and student set), piloting and refining them (see §1.3.2) (spring 2020). The instrument is expected to be ready in August 2020. All three coordinators will be involved in developing the construct. Daus in collaboration with Munkebye will be in charge of developing the questionnaire instrument, piloting, analysis and revision. The results of this work package will feed in to WP2 and WP3.

Work package 2 (WP2) (2020-2023): Investigating teachers' professional development (TPD) and instructional practices: RQ2 - Lead by Febri and Staberg, a PhD-student and master students are involved

In order to answer to RQ2 - *How does the professional development influence teachers' CT skills and dispositions and their CT instruction practices?* - WP2 will use surveys and case studies with five schools (see §1.3.2). We will: (1) Prepare research instruments for case studies (spring 2020), (2) Conduct a large-scale baseline *teacher* survey, construct from WP1 (T0), (3) Establish contact with teachers in recruited schools and pre-interview case teachers (T0), (4) Continuously develop CT materials for TPD, (5) Organize and conduct the intervention several times per semester, (6) Collect data on case teachers for each intervention, (7) Conduct surveys and interviews of case teachers at T1, T2 and T3 (Table 3), (8) Conduct large-scale teacher survey at T3, and (9) Analyse the data and report (autumn 2023). Daus will be in charge of the collection and analysis of the survey data. The coordinators and Lie and Lønnum will develop TPD materials and supervise teachers in TPD. Lie and Lønnum will contribute in carrying out the case studies and analysis respectively from the perspective of social sciences and language. A PhD-student will be responsible in studying the teacher development from a multiple perspective, e.g. by triangulating the datamaterials. The WP2 leaders will oversee the whole activities, and in collaboration with the coordinators finalize the details on organization of intervention and data collection. We will also publish and disseminate the TPD materials in collaboration with The Science Centre and The Writing Centre.

Work package 3 (WP3) (2020-2023): Investigating students' development as critical thinkers: RQ3 - Lead by Cyvin and Kayima, a PhD-student and master students are involved

In order to answer RQ 3 – *How does the professional development influence students generic and domain specific CT skills and dispositions?* – WP3 will use surveys and multi-case study approaches, similar to WP2, but from the student perspective (see §1.3.2). We will: (1) Prepare research instruments for case studies (spring 2020), (2) Conduct a large-scale baseline *student* survey, construct from WP1 (T0), (3) Conduct student pre-interviews (T0), (4) Collect classroom observation and student products during the intervention

period, (5) Conduct student interviews at T1, T2 and T3 (Table 3), and (7) Analyse the data and report (autumn 2023). Daus, Lie and Lønnum will have the same role as in WP2, only this time focused on students. The same PhD-student as in WP2 will study the student development by triangulating the datamaterials. The WP3 leaders will oversee the whole activities, and in collaboration with the coordinators and WP2 finalize the organization of data collection.

Work package 4 (WP4) (2020-2023): Investigating the influence of different contexts: RQ4 - Lead by Lykknes and Daus

In order to answer RQ4 - *To what extent and how do different contexts influence on teachers and students generic and domain specific CT skills and dispositions?* – WP4 will use the data collected from survey and other qualitative data collected by WP2 and WP3, and analyse them from the point of view of contexts dependency and stimulated call interviews (see §1.3.2). WP4 will collaborate with WP1, WP2 and WP3 in designing the research instruments, and with Lie and Lønnum in the analysis of the case studies.

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