New Perspectives in Science Education
International Conference
NEW PERSPECTIVES in SCIENCE EDUCATION


How can students explore critical thinking as an academic practice?

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Abstract

Critical thinking is one of the most important skills imparted by scientific education. It enables students to assess, evaluate and interpret different theories and topics, making up their own minds and coming to their own conclusions.[1, 2] Especially the ability to acknowledge that there might be other ways of understanding the very same information, gains ever more importance as students come face-to-face with new technological developments, such as Artificial Intelligence (AI) or the acquisition of knowledge via Big Data Analysis. However, critical thinking as a practice students need to be introduced to and experiment with, is often neglected by university teachers – in STEM subjects most of all.[3] In this paper, the resulting lack of critical thinking is addressed from a developmental perspective on education. We present the prototype of an interactive video which confronts students with puzzling situations based on philosophical ideas and encourages them to approach these conundrums by means of critical thinking. Using three nicknames of the philosopher Socrates – the gradly,[4] the midwife,[5] and the electric ray[6] – as a starting point, students independently explore the theory and practice of critical thinking. Afterwards, educators will initiate a discussion on why critical thinking is important for higher education. In our project, we explore critical thinking from philosophical and educational perspectives, iteratively refining the interactive video. This paper presents the results of our first iteration.

Keywords: critical thinking, interactive videos, Platonic dialogues, philosophical approaches, Design-Based-Research

1. Introduction

Critical thinking can be described as “the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action.”[7] Critical thinking is considered crucial by both teachers and tutors in higher education – as a skill, it is equally appreciated in all academic disciplines.[1] This, in turn, also impacts the students’ perspective on critical thinking. In a representative survey conducted across German universities by the German Centre for Higher Education Research and Science Studies in 2018, 91.2% of all participating students consider critical thinking very important in regard to their studies. Especially in the Humanities (95.7%), Social Sciences (94.7%) and Legal Sciences (96.6%), students rank the ability to think critically as essential. In contrast, students in the natural and technical sciences consider critical thinking to be far less relevant. 23.1% of the surveyed students of natural sciences and 29% of the students enrolled in technical sciences state that in their studies they are not encouraged to think critically.[8]

This might just be the tip of the proverbial iceberg. On an international level, Richard Arum and Jospia Roksa created a stir as they presented a mixed-methods analysis of more than 2.300 undergraduate students enrolled in 24 different universities.[9] The authors concluded that 45% of undergraduates showed no significant improvement in their critical thinking skills while attending college. The results of this analysis have been confirmed by a replication study in 2011, using data taken from students enrolled in different schools and even including another statistical test in order to measure the participants’ overall intellectual development.[10] Recently, however, the methodology of Arum and Roksa’s original study has been criticized again.[11]

2. The Project

Our project centers around an interactive video meant to encourage students (especially in the STEM subjects) to engage in critical and independent thinking. This paper presents the first results of an ongoing inquiry using design-based research (DBR). The term DBR refers to a research framework characterized by methodological diversity which aims at developing a specific research-based solution

to a real-life problem. Once a solution has been found and applied, it provides data which – in turn – leads to new theoretical insights. As the research for theoretical knowledge and the development of a concrete design object depend on each other, each DBR projects tries to achieve both a development goal and a knowledge goal.[12] Our development goal is to create a prototype for an interactive video helping students explore the theory and practice of critical thinking, while our knowledge goal is to collect data on the improvement of critical thinking in this specific educational setting.
According to McKenney and Reeves, DBR projects can be divided into three interconnected phases: *Analysis and Exploration, Design and Construction, Evaluation and Reflection.*[13] To complete a project, several iterations of these three phases are necessary. Each repetition forms a so-called "DBR cycle" in which a prototype (e.g., the video script or a software mock-up) and theoretical educational hypotheses are developed, adapted and revised. In the following paragraphs, we outline the methods and results of our first DBR-cycle.

2.1. Phase: Analysis and Exploration

In the first phase, we created the theoretical groundwork for our prototype. In order to encourage students to engage in critical thinking, it is necessary to first introduce them to the characteristics of *thinking*. In his writings, the Greek philosopher Plato uses three nicknames of his fellow philosopher Socrates – the gadfly,[4] the midwife,[5] and the electric ray[6] – to explain what thinking might entail. We decided to base our interactive video on these metaphors. In Plato's writings, these nicknames indicate that critical thinking is an exhausting activity which destroys supposed knowledge, dissolves conventions and often turns out to be at least partially inconclusive. A perfect approach to making students in STEM subjects reconsider their thinking habits: In their studies, these students often differentiate correct answers from incorrect ones – which is why it is so important for them to start questioning theories and concepts and to accept the fact that sometimes there is no clear-cut solution.

Following Plato's idea of presenting philosophical concept as metaphors, we investigated the use of metaphors in education. Metaphors can be understood as cognitive patterns.[14] In our DBR project, the nicknames of Socrates form a connection between the Platonic hypotheses of thinking and students' conception of their own thought process. Those metaphors, in fact, have a theory-constitutive effect because they help students visualize the activity of thinking, highlighting specific aspects of critical thinking and allowing students to explore them in a theoretical context.[14, 15]

2.2. Phase: Design and Construction

Based on Plato's descriptions of thought and our research into metaphors in education, three pictures are created to represent the gadfly,[4] the midwife,[5] and the electric ray.[6] In the interactive video itself, which is created with the software H5P, these images will be animated and presented one after another. Following each animation, the video will provide tasks and a user interface with a text box for students to type their results. In accordance with the educational postulate of thinking from the known to the unknown,[15] the students will start interacting with the video by associating the profession of the midwife, the hunting method of the electric ray or experiences with gadflies.

Fig.1: Images by Andrea Wandinger used for the interactive video.

To demonstrate how the interactive video shapes this thought process, here is an excerpt taken from the questions about the gadfly:
1) Imagine being the horse in the picture. Gadflies are buzzing around your head. What spontaneous thoughts come to your mind when you imagine this and what adjectives would you use to describe the gadflies? Write down your thoughts.
2) Could you put your spontaneous ideas into context with the activity of thinking? To what extent can the gadfly be a metaphor for thinking?
Write down your thoughts and try to always start your explanations with the following sentence: "Thinking is / means / leads to ... "
As their next task, the students will be asked to link their ruminations to the activity of thinking. Once the students have answered the first questions by associating what they know, a short excerpt from Plato's writings will appear to provide further information about one of the nicknames of Socrates. Based on this new information, the students will once again be asked to contribute their own ideas about the activity of thinking:
1) Read the passage from Plato's "Apology" in which he compares Socrates to a gadfly.
2) Afterwards, consider and discuss whether you have reached similar reflections in connection with the metaphor of the gadfly and the activity of thinking. How do you interpret Plato's use of the gadfly in the text?

At the end of the video, the students will be asked to apply these thoughts to their academic subjects: In which contexts might critical and independent thinking impact their studies and, later in life, their work?

2.3 Phase: Evaluation and Reflection

To prepare for video production, we tested the concept (including pictures and tasks) in a 4-hour online seminar with 60 students from the course Mediendidaktik (m*edia education)* in the subject Media Production at OWL Technical University of Applied Sciences and Arts. The students used a video conferencing tool to work in groups, jointly solving the tasks and discussing the material as well as reflecting individually on what the video asked of them.
Applying the method of *conjecture mapping*, we used the data obtained in this seminar to test both the design of the interactive video and our theoretical hypotheses. Based on this analysis, modifications were also made to the specific learning material. As a result, the students will be provided with a short introduction to Socrates in the interactive video and will be invited to brainstorm about the activity of thinking. To increase access to Plato's texts, we will also change the excerpts of the platonic dialogues and will use a simple and modern language.

2.4. The Next Steps

As a next step, we will design and develop the actual interactive video. This prototype will be tested by students enrolled in technical and scientific subjects at OWL Technical University of Applied Sciences and Arts. The answers of these participants will be evaluated. Based on this analysis, we will improve the prototype of the interactive video while using the data collected in this DBR cycle to further explore students' stance on and theoretical knowledge of critical thinking in engineering and scientific subjects.

3. Conclusion

We hope that our interactive video will help students in STEM subjects to engage in critical thinking and discover its importance for their field of studies. Furthermore, we would like to make the video available to other target groups and create an interdisciplinary workshop during which students from different subjects would be able to express and exchange their ideas on critical thinking. A workshop such as this would allow us to gather more data on the application of critical thinking in different fields of academia. At this point, however, we should also point out the limitations of our project. Naturally, our video only creates an impulse: It gets students to casually think about critical thinking, but it does not and cannot lead to an in-depth examination of the activity of thinking. The aim is rather to find an entry point to the topic – and to take it from there in later projects.

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