Critical Thinking Learning Experiences in the Digital Era (Short Paper)

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Abstract

Educating scientists and engineers to be critical thinkers is viewed as a core competency essential for university graduates to successfully compete in the 21st century global economy. However, much obscurity remains regarding its practical role or how to integrate it in science and engineering education, especially in an era of digital teaching and learning. The goal of the current study was to analyze, from a sociocultural perspective, the way CT is experienced by instructors, Israeli students, and Chinese students in a research university in Israel which offers degrees in science and engineering and its international branch campus in China; and accordingly, design a culturally inclusive framework for CT cultivation in the digital era. In order to address the research goal, the study applied an integrated dual-analytic approach, where data was collected via semi-structured interviews. The findings show that many instructors and students have experienced activities which promote CT to some extent. The findings also show that academic courses tend to involve students in CT mainly through analysis processes, and less by means of self-regulation activities. Overall, it is apparent that the Chinese students claim to have had more experience with all of the CT skills than the Israeli students and equivalent or more encounters than the instructors. Most of the participants acknowledged that technology has primarily been incorporated into lessons to present and drill information rather than promote CT. Two core skills have been predominantly apparent in technology-enhanced learning: Analysis and Evaluation.

Keywords: critical thinking, higher education, technology-enhanced learning.

Introduction

Critical thinking (CT) is viewed as a national priority and a core competency essential for university graduates to successfully compete in the 21st century global economy (Barak et al., 2007; Kuhn, 2019; Pellegrino & Hilton, 2012). In the context of science and engineering education, CT is essential for such practices as processing new information, establishing relationships, identifying and solving complex problems as well as designing and conducting scientific experiments (Ahern et al., 2019; Avsec & Savec, 2019; Forawi, 2016). Accordingly, a number of frameworks have recommended the promotion of CT skills in higher education (e.g., OECD, 2018; Pellegrino & Hilton, 2012; Vincent-Lancrin et al., 2019).

Yet, none of the numerous policy documents have resulted in a sustainable pedagogical change or even an accepted educational plan with guidelines that university instructors can lean on for integrating CT into subject instruction (Lombardi, et al., 2021; Manalo, 2020). In fact, a review of the literature indicates that much obscurity still remains regarding the topic and its practical role in science and engineering education, especially in an era of digital teaching and learning (Ahern, 2019; Usher & Barak, 2020). This problem is gaining more significance as current globalization trends in higher education include international student mobility and partnerships between universities.

In light of the aforesaid, the current study was conducted to answer the following questions:

1. What have been the experiences of instructors, Chinese students, and Israeli students regarding the fostering of critical thinking?
2. How has technology-enhanced learning been incorporated in science and engineering education to promote critical thinking skills?

Methodology

The study was conducted at a research university in Israel which offer degrees in science and engineering and its international branch campus in China, and involved ten higher education instructors from Israel, 17 Israeli students, and 17 Chinese students. In order to address the research goal, the study applied a dual-analytic approach (Bazeley, 2012), in which the data set was analyzed form both qualitative and quantitative perspectives, each making a supplementary contribution. The study applied the case-study approach with designated participants, which is applied in social science research for generating in-depth understanding of real-life events (Yin, 2014). Data were collected via semi-structured interviews with open and structured questions through a series of personal meetings that were carried out face-to-face in a private setting and varied in length up to 50 minutes.

Findings and discussion

The way critical thinking is experienced in academic courses

Data analysis of participants' responses indicate that most of the instructors (88%), many of the Chinese students (71%) and roughly two-thirds of the Israeli students (65%) allege to have incorporated or experienced activities which promote CT. A quantitative analysis of participants' responses focused on five CT skills: *interpretation*, *analysis*, *evaluation*, *inference* and *self-regulation* (Facione, 1990; 2015). Figure 1 portrays the percentage of instructors, Chinese students, and Israeli students who have incorporated or experienced each CT skill in classroom or homework assignments.

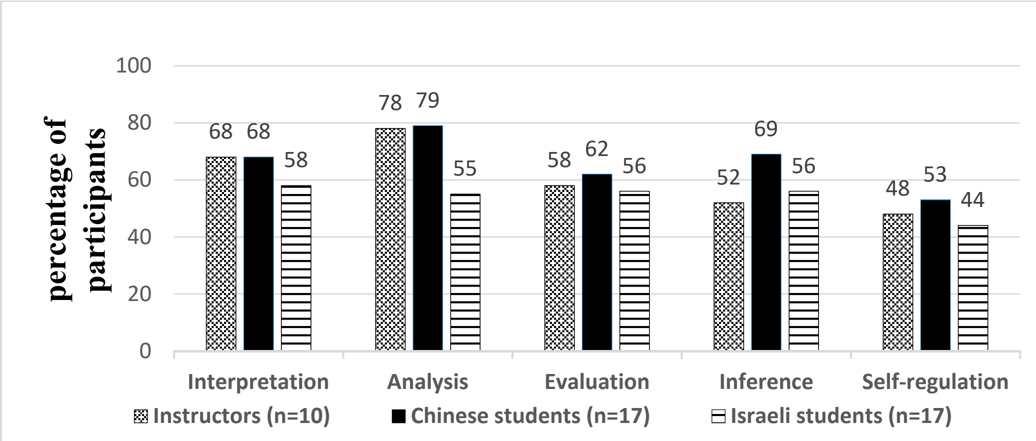

Figure 1. Percentage of participants who have incorporated or experienced each CT skill.

Figure 1 indicates that both the instructors (78%) and Chinese students (79%) found *analysis* to be the most prominent CT skill in their courses, while roughly only half of the Israeli students (55%) indicated this. The data also shows that *self-regulation* is the CT skill least apparent among the instructors (48%), Chinese students (53%) and Israeli students (44%). While *analysis* assignments engage students in identifying main claims and providing reasons to support or criticize them; *self-regulation* assignments engage students in monitoring and evaluating their inferential judgments and self-correction. According to the participants, academic courses tend to involve students in CT mainly through analysis processes, and less by means of self-regulation activities. Overall, it is apparent that the Chinese students claim to have had more experience with all of the CT skills than the Israeli students and equivalent or more encounters than the instructors.

Promoting Critical thinking through technology-enhanced learning

Most of the participants acknowledged that technology has been primarily incorporated into lessons to present and drill information rather than promote CT. Both the Chinese and Israeli students contended that knowledge is commonly transferred with the aid of PowerPoint presentations and YouTube videos. For example, Jing, a Chinese student, stated that *"PowerPoints and videos are often utilized when presenting something new; however, this is less typical when teaching math."* According to Amir, an Israeli student, *"Online quizzes like those on Moodle or Kahoot are common for reviewing the course material. My chemistry teacher also likes to conduct experiments and hold competitions related to the experiment by means of a PowerPoint with questions. The questions are mostly basic, but sometimes there are more complex questions that require thinking."*

Two core skills have been predominantly apparent in technology-enhanced learning: Analysis and Evaluation. The skill 'Analysis' includes *exploring multiple perspectives* and *examining pros and cons*; whereas, the skill 'Evaluation' embraces *judging arguments* and *determining truth*. Due to space limitation, an example has only been provided for the first subskill, '*exploring multiple perspectives'* [analysis], which involves using technology to engage students in exploring multiple ideas and perspectives; i.e., analyzing views or scientific methods from different angles. For example, Dr. Abigail, asserted: *"In my course, I have an online forum where I show interesting scientific cases and ask questions that require CT, beyond what is written in the text. It is not about remembering the material, but involves case analysis and looking at things from different perspectives."*

Contribution

The study provides insights into how CT is experienced, while addressing contemporary changes in higher education such as the internationalization of universities and the incorporation of digital technology. Based on the study's results and previous work on CT (Facione, 1990; 2015), the study's practical contribution is in proposing a pedagogical approach with suggestions for fostering CT competencies with digital activities in science and engineering courses. These activities include digital technology that promotes social interactions while focusing on the five CT skills. They can be integrated in science and engineering education, for policy makers and instructional designers.

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