Applying Macro- and Micro-scripts to Facilitate Undergraduates' Interdisciplinary Competence

Guo SU[a]
[a]*National Institute of Education, Nanyang Technological University, Singapore*
*nie22.sg4560@e.ntu.edu.sg

Abstract: This study aims to develop principles for designing CSCL scripts that can guide interdisciplinary collaboration and knowledge-creation practices to facilitate undergraduates' interdisciplinary competence. Design-based research (DBR) will be conducted in an undergraduate course to investigate if the macro- and micro-scripts have the potential to improve students' performance, and why and how these designs make a difference.

Keywords: Interdisciplinary collaboration, CSCL scripts, interdisciplinary competence

1. Introduction

1.1 Interdisciplinary Competence in Interdisciplinary Collaboration

Fostering collaborative learning is a major educational goal related to the development of lifelong learners in the twenty-first century (Lee et al., 2014). Interdisciplinarity is a particular form of collaboration (Claus, & Wiese, 2019). In interdisciplinary collaboration, group members who come from various backgrounds are frequently formed around a certain subject or question. Interdisciplinary collaboration in our context is expected to elicit collaborative knowledge-creating learning where individuals with expertise in several fields are expected to create new knowledge to solve complex real-world problems (Paavola & Hakkarainen, 2005; Vartiainen et al., 2022). However, there is still a lack of research investigating how interdisciplinary collaboration and knowledge creation could be promoted and practically acted in higher education (Vartiainen et al., 2022). Edmondson and Harvey (2018) have argued that interdisciplinary collaboration has become a key success factor for today's organizations. Researchers and practitioners design meaningful interdisciplinary collaboration to investigate interactive patterns as well as students' experiences, promote students' acquiring new knowledge and higher-order thinking skills, etc. For example, Cowden and Santiago (2016) sought to promote students' critical thinking skills via problem-based learning in an interdisciplinary collaboration context. Tan and Vicente (2019) also proposed interdisciplinary collaboration combining Computer Science and Product Design in an undergraduate program to support students' development of 21st-century skills such as problem-solving, creativity, collaboration, etc.

To successfully engage in interdisciplinary collaboration - more precisely, to be able to understand and act in interdisciplinary learning or work situations - students need adequate interdisciplinary competence which is defined as "the capacity to integrate knowledge and modes of thinking in two or more disciplines or established areas of expertise to produce a cognitive advancement - such as explaining a phenomenon, solving a problem, or creating a product - in ways that would have been impossible or unlikely through single disciplinary means" (Boix Mansilla et al., 2000, p. 17)." Interdisciplinary competence includes taking a critical stand on disciplinary limitations, solving complex problems across disciplines, communicating across disciplines, handling interdisciplinary collaboration and teamwork, as well as using integrative potentials to create innovations (Brassler, & Dettmers, 2017). Though interdisciplinary competence highly relates to each of the twenty-first-century skills (Brassler, & Dettmers, 2017), there seems to be a lack of design principles and

pedagogical support to facilitate students' interdisciplinary competence in complex problem-solving when students engage in interdisciplinary collaboration (Vartiainen et al., 2022).

The empirical research on interdisciplinary learning design in higher education in the exploratory stages (Brassler & Dettmers, 2017). Many researchers have called for pedagogies in which students can co-create new knowledge and develop more generic key competencies, such as interdisciplinary competence, for the future (Binkley et al., 2010). Further investigation on effective interdisciplinary teaching and learning design and implementation is needed. Hence, this study aims to develop design principles for effective interdisciplinary collaborative learning and knowledge creation to better support students' development of interdisciplinary competence.

1.2 Scripting Interdisciplinary Collaboration

Research shows that learners often have difficulties spontaneously engaging in beneficial collaborative learning activities (Vogel et al., 2017). Also, learners typically do not engage in these "high-level" collaboration processes without guidance (Fischer et al., 2013). To overcome these problems, scaffolding for collaboration can be provided through CSCL scripts. According to the granularity of the prescribed actions, there are two different scripts named macro- and micro-scripts. Macro-scripts are pedagogical models, i.e., they model a sequence of tasks to be performed by groups, whereas micro-scripts are interaction models that are embedded in the environment and that students are expected to use and progressively internalize (Dillenbourg & Hong, 2008). According to the way learners collaborate with each other, two scripts are commonly used: epistemic scripts specify how learners work on a given task, while social scripts structure how learners interact with each other (Mahardale & Lee, 2013).

The goal of scripting interdisciplinary collaboration can be twofold: first, increasing interaction through knowledge interdependence; second, engaging in interdisciplinary problem-solving (Vogel et al., 2017), which shares the same purpose as interdisciplinary competence development. Jigsaw script, a pedagogical model, will be used as the macro-script in this study. According to studies, jigsaw can create a learning environment that is crucial for the development of problem-solving skills (Sevim, 2015) which is part of interdisciplinary competence and is critical to engaging in interdisciplinary collaboration. In the jigsaw script, each group member is given a certain subtopic. Then, the "expert group" is made up of group members from several groups who were given the same subtopic. Finally, the experts go back to their home groups to teach other group members the specialized subtopics and solve problems together. Under the macro-script, micro-scripts are applied to structure the interaction process that students are expected to follow (Villasclaras-Fernández et al., 2009). An epistemic script and a social script will be designed as micro-scripts in our context. To support the "expert group" co-creating knowledge and understanding the subtopics that they focus on, problem-oriented prompts will be used as epistemic scripts. In addition, when learners share their knowledge and ideas in their home groups, sentence openers for responding to each other will be provided as the social scripts that aim to facilitate interactions within groups.

1.3 Significance of the Study

There seems to be a lack of cases that identify effective pedagogical practices for supporting students in developing competencies needed to address complex challenges across disciplinary boundaries. Therefore, the theoretical contribution is that this research has the potential to fill in the gap by developing pedagogical design principles for effective interdisciplinary collaborative learning activities in higher education settings. Furthermore, effective interdisciplinary collaboration results in more creative solutions by bringing new and diverse views to the problem-solving process, which is the practical contribution of this study.

The guiding research question is how to script effective interdisciplinary collaboration and knowledge creation to improve undergraduates' interdisciplinary competence. The specific sub-research questions are: (1) To what extent do the macro- and micro-scripts

enhance students' interdisciplinary competence? (2) How to further improve the script design to better support teaching and learning in interdisciplinary higher education?

2. Methodology

2.1 CSCL Context and Participants

Second-year undergraduate students who come from different backgrounds will be randomly grouped together to form interdisciplinary teams of 5 or 6. In the course, students will systematically analyze major current sustainability challenges from various perspectives. Several different topics will be involved in one semester. During the tutorials, first, each group member chooses a role for themselves, such as an economist. Then, each "expert" goes to his or her own expert group to read materials, discuss the relevant topics and record the results on the online platform with the support of epistemic scripts (about 25 minutes). Finally, each expert goes back to his or her original group to discuss these topics with the social scripts and writes a report on the platform about the final decision of the whole group (about 25 minutes).

2.2 Research Design

Design-based research (DBR), which is a useful method for developing new theories and practices (Barab, 2014), has the potential to be conducted in this context. Dedicated to dealing with problems in the real-world learning context via close collaboration between researchers and practitioners, factors of DBR (design, problem, theory, and the naturalistic context) interact with each other, and each iteration in DBR offers a progressive refinement (Collins, 1992). DBR provides evidence of not only what functions, but of why and how functions. There will be about three cycles of DBR throughout the study. The overall procedure of the research design is as follows (see Figure 1). Our goal is to develop design principles that can guide interdisciplinary collaboration and knowledge-creation practices to facilitate undergraduates' interdisciplinary competence. First, with the guidance of theoretical ideas and principles of scripts from the literature, practitioners and researchers will co-design and implement macro- and micro-scripts embedded in tutorial activities for interdisciplinary collaboration and knowledge co-creation. Then, through analyzing data about students' interdisciplinary competence and perceptions of practices by the lecturer and students, we further improve our pedagogical practices which will be implemented in the next cycle. Finally, implications for refining the design principles will come from all the cycles.

To answer the first research question, content analysis will be conducted to evaluate the quality of groups' written artefacts in terms of interdisciplinary competence. Additionally, a self-reported survey on interdisciplinary competence will be analysed. For the second research question, discussion dialogue, behavioural data recorded by videos and screen recordings will be analyzed to investigate how students use the scripts and identify what scripts can be improved. Also, theme-based coding will be implemented to analyse the facilitator's and students' perceptions of scripts which are gathered through interviews.

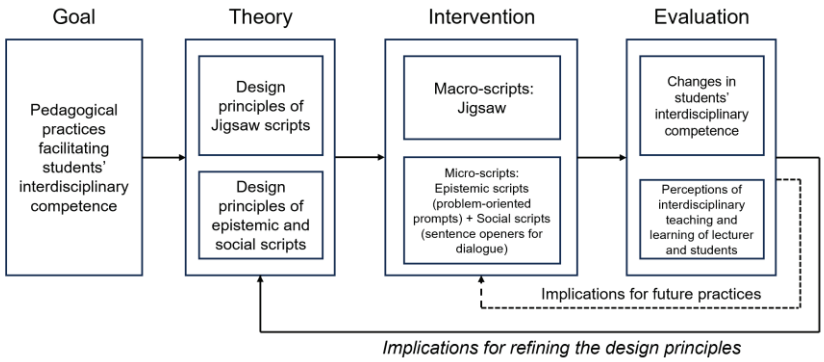

Figure 1. The Overall Procedure of Design-based Research (Lakkala et al., 2015).

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