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To cite this article: Mei-Shiu Chiu (2021): Making open educational resource videos on sustainable development: students' attitudes, rationales, and approaches, Research in Science & Technological Education, DOI: [10.1080/02635143.2021.1966406](https://doi.org/10.1080/02635143.2021.1966406)

To link to this article: <https://doi.org/10.1080/02635143.2021.1966406>



Published online: 18 Aug 2021.



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Making open educational resource videos on sustainable development: students' attitudes, rationales, and approaches

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ABSTRACT

Aim and background: The aim of this study was to investigate students' attitudes, rationales, and approaches to making open educational resource (OER) videos (a form of OERs) on sustainable development (SD) in order to identify students' competencies and effective pedagogical designs.

Method: Students registering for a teacher training course were invited to design and create pedagogies, make OER videos, and share the videos on YouTube on five SD topics: sustainable lifestyle, campus, community, enterprise, and earth development. The students provided their weekly journals and a final reflection on the whole process of making the OER videos on SD. This study used qualitative data analysis and text mining methodologies to analyse students' process data of making OER videos on SD.

Results and discussion: The analysis results revealed that making OER videos on SD needed students' ideational, inquiry, societal, and disciplinary competencies. Inferred pedagogical suggestions for practitioners to support students in making digital products on SD are to follow a linear pathway from ideational creation, inquiry process, societal transformation, to transdisciplinary reflection.

KEYWORDS

Digital content; science education; open educational resources; sustainable development

Introduction

Sustainable development (SD) is a topic and global endeavour prioritized by the United Nations (UN) for the 21st century. SD and education for sustainable development (ESD), however, were relatively new issues during the decade of 2005–2014 advocated by the United Nations Educational, Scientific and Cultural Organization (UNESCO). During the decade, research on SD or ESD started with environmental issues and focused on concept, curriculum, and teaching in descending order (Wu and Shen 2016). While SD was relatively rarely placed into national curricula and teacher-education programs (Gottlieb et al. 2012), teacher education involving ESD could generate positive effects on student teachers attitudes and perception to contribution to SD (Andersson et al. 2013). Recently, SD has been gradually formally integrated into the national curriculum but still implemented by education systems as innovations (Fredriksson et al. 2020).

One of the measures for achieving the aspiration of SD or ESD may be open educational resources (OERs), or specifically making OERs on SD for teachers to use in

educational settings and for the public to gain knowledge about SD. Incorporating making OERs on SD into a teaching methodology or pedagogy course can cultivate student teachers' trans-literacy. Broadcasting OERs can also reduce inequality in education because they can be used by the public with minimal cost, time, and space limitations (Hilton et al. 2013). Some salient examples of OERs include Khan Academy, YouTube videos for educational purposes, massive open online courses (Liyanagunawardena, Adams, and Williams 2013), and the sub-Saharan Africa teacher education program (Murphy and Wolfenden 2013). These fundamental features of OERs shared with SD or ESD suggest a potential to connect SD (as the content) and OERs (as a tool) for achieving the aspiration of SD or ESD.

Despite the merit of making OERs on SD for the makers and the public, there are embedded challenges for both OER makers (i.e. student teachers) and their teachers (i.e. the instructors) in a teacher-training program. SD is largely a response to the energy crisis, global warming, and other environmental issues, and the push for SD has raised tensions in many societies. For example, implementing an 'energy conservation and carbon reduction' policy has created tensions in boundaries between technology and nature, in lifestyles between having and being, in social systems between authority and conformity, and in knowledge bases between energy conservation and carbon reduction in Taiwan (Author 2013). When instructors' course designs require student teachers to make OERs on SD, instructors are likely to face tensions similar to the implementation of a new energy policy. By understanding students' attitudes, rationales, and approaches to making OERs on SD, teachers are likely to develop more suitable pedagogical designs for supporting students to make OER on new knowledge such as SD.

This study aims to investigate students' attitudes, rationales, and approaches to making OER videos on SD by implementing a course with diverse pedagogies and assessment measures for supporting and understanding the process involved in their production. OER videos are a particular form of OERs (in general) benefiting learners' competencies (Gil et al. 2012; Lin and Wang 2018). From this, this study will infer likely effective and proper pedagogical designs for making OERs (particularly OER videos) on SD from understanding student competencies in the process. Figure 1 presents the conceptual framework of this study.

Theoretical basis: OERs' potential to support ESD

To integrate making OERs to SD as part of a course or curriculum, the first step is to identify the overlap between making OERs and SD (Fredriksson and Persson 2011) at the conceptual level. This forms the theoretical basis of this study.

Content knowledge and competencies: from SD to making OERs

Combining SD and making OERs can provide a coherent design. The coherence comes from the links between the knowledge structure of SD and the learner competencies that ESD seeks to cultivate through making OERs.

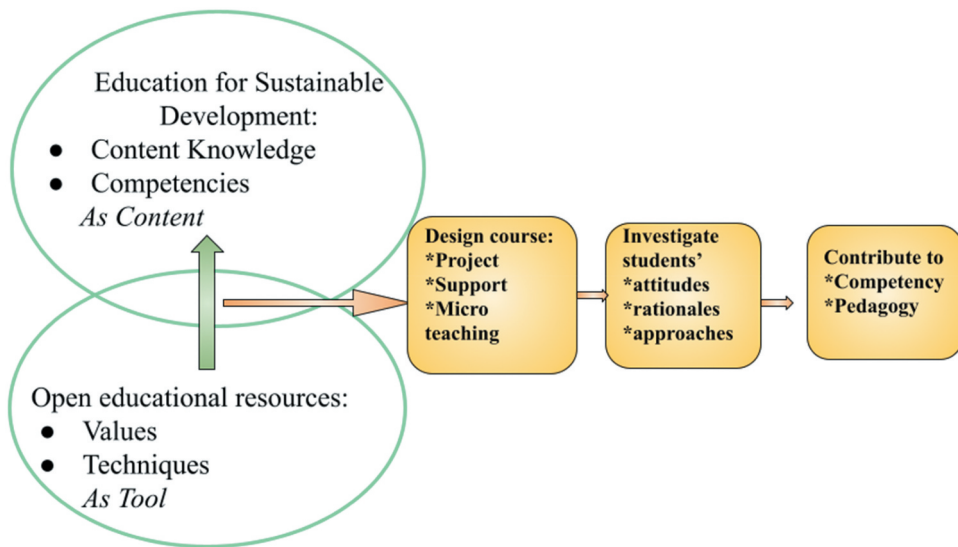


Figure 1. This conceptual framework of this study.

Knowledge

SD has a transdisciplinary essence. A complete SD curricular design for higher education institutions may need to cover three domains of knowledge: economics (e.g. GDP, resource use, and consumption patterns), the environment (e.g. pollution, climate change, and eco-efficiency), and society (e.g. population, education, and cultural diversity; Lozano 2010).

It may also need to include cross-disciplinary competencies to promote participatory learning and higher-order thinking. Examples of the competencies include systems thinking, communication, emotions, ethics, action, interdisciplinary work, and interactive use of diverse tools (e.g. language and technology) and pedagogies (Mochizuki and Fadeeva 2010; Rieckmann 2012).

Competencies

From a top-down view, learners (including student teachers) are expected to gain SD (or environmental) competencies in three major aspects: knowledge, attitudes/concerns, and behaviours/uses (Tuncer et al. 2009; Yavetz, Goldman, and Pe'er 2009). From a bottom-up view, empirical studies are consistent with the top-down view. Student teachers view SD competencies as involving knowledge, ethical values, attitudes, and emotions. ESD competencies include clarifying values, living with complexity, acting for change, contextualizing, thinking critically, managing emotions, and envisioning futures (Cebrián and Junyent 2015).

Making OERs on SD can increase students' self-reflection on their own unsustainable behaviours, which promotes reflection on opportunities for changing to a more sustainable lifestyle for themselves and others in their societies (Savageau 2013).

In summary, ESD can be a responsibility of most courses on economics, the environment, and society (Lozano 2010). A variety of pedagogies, tools, and thinking and emotional skills can be involved to promote students' higher-order thinking and

participatory learning (Clark and Button 2011; Laurie et al. 2016). Making OERs on SD in a teaching methodology, pedagogy, or education course fits all the above curriculum criteria for ESD. In addition, SD as a new domain of knowledge potentially lacks educational resources, so OERs can serve as efficient teaching materials.

Tool values and techniques: from making OERs to SD

Combining making OERs and SD in a curriculum can also be justified by the values and techniques of making OERs.

Values

OERs are a means of educating the public at a low cost and with theoretically unlimited distribution (Hilton et al. 2013). Low cost implies low natural resource use with high distribution, which fits the essence of SD in its objective of benefitting all human beings.

For higher education instructors, influencing factors in the use and creation of OERs are similar. There are 60% common factors between using and creating OERs (McKerlich, Ives, and McGreal 2013). These common factors include reducing student costs, environmental concerns, academic quality, ICT knowledge and skills, as well as time, administration, and group support. Instructors feel easier to use OER textbooks (Delimont et al. 2016) but need more time for preparing related materials or making OER textbooks than traditional textbooks (Bliss et al. 2013). Flexibility to change pedagogical content is also acknowledged by instructors (Belikov and Bodily 2016; Hilton et al. 2013).

OER use benefits students' academic achievements and reduces failures from schooling, especially for low socioeconomic students (Colvard, Edward Watson, and Park 2018). OER use and creation are driven by learner attitudes and related rationales, such as intrinsic motivation, knowledge, or skills, as well as supportive or collaborative environments and resources. For individual OER makers, OER making and products need altruistic motives, comment provisions, and positive reputations; when making OERs, the OER makers are normally also OER users in need of content knowledge and related skills (De Langen 2013).

Techniques

Making OERs on SD requires combining the knowledge and techniques of science, art, and community in local, state, national, and international areas and utilizes higher-order thinking skills such as metacognition, aesthetics, and creativity (Clark and Button 2011). This fits the essence of SD as a multidisciplinary field with interactive activities that benefit the development of higher-order thinking skills.

In the process of making OER videos, learners encounter multiple challenges or affordances (e.g. affect, content, collaboration, technical skills, and equipment) and acknowledge advantages (e.g. content, usage, and enjoyment in creativity and processes) (Olivier 2019). The process of making OERs from design and publishing to re-design, re-use, and re-publishing satisfies both the human needs of social affiliative life and personal emotional ownership (McKerlich, Ives, and McGreal 2013).

Pedagogies for making OERs on SD in a curriculum

The aforementioned theoretical arguments suggest that SD or ESD as the content and OERs as the tool can forge a pedagogy to fulfil the potentials of both. Student SD knowledge and ESD competencies as learning outcomes can be supported through developing OERs and the pedagogical approaches to such development. The next step is to address the concerns of suitable pedagogies, especially for a teacher training course. Instructors need to develop suitable pedagogies for supporting students to make OERs on SD in higher education. A teacher-training course involving making OERs on SD is likely to include diverse pedagogical designs as follows.

High-quality, inquiry-based, and multi-disciplinary projects

SD serves as a fertile ground for innovation and high-quality education. At the policy level, the claim is supportive given the emerging interest in and knowledge about tensions related to global warming and the implementation of energy policy (Author 2013). At the pedagogical level, the assurance of high-quality ESD manifests in building student knowledge, skills, and values to resolve diverse SD issues and allow for innovative, intensive ICT use into curricula (Laurie et al. 2016).

Informal, inquiry-based, and self-directed learning are likely pedagogies that instructors can use for learners' to engage in using or making OERs (Schmidt-Jones 2012). In the process of making OERs as group work, students undergo both processes of self and social regulation, including activities such as monitoring, strategy use, reflection, and planning (Shea et al. 2013). Inquiry-based learning in higher education can involve earning a degree or course credits while working with local communities as a form of experiential learning (Ellis and Weekes 2008).

Pedagogically effective designs to support student teachers doing projects (making OERs) include negotiating learning objectives, using OERs to make teaching materials, and meaningful instruction. These technological and pedagogical designs can successfully engage student teachers with confidence in the process from OER users to OER authors (Makrakis 2010). This study focuses on inviting student teachers to do projects, particularly making OER videos on SD, which appears to be not researched to date.

Supportive environment

Among the diverse likely pedagogies, a supportive environment is transformative, flexible enough for student teachers to make OERs on SD. A supportive environment allows student teachers to face the innovative, challenging, and multi-disciplinary project of making OERs on SD. Teacher training courses need to increase teacher expertise in creating digital learning and teaching materials through a supportive and collaborative environment (Hsu and Ching 2013) including extending to communities (Green and Somerville 2015). Student teachers' sustainability is likely to be cultivated through the process of knowledge creation, design, and collaboration (Tsai et al. 2013).

A line of research similar to this study to date is inviting student (pre-service) teachers to use an online wiki platform on SD to make related OERs (Makrakis 2010). Technically,

the wiki platform provides diverse teaching resources such as materials, pedagogies, and technological support. These facilitate scaffolding, authentic content, multimodal representations, meaningful collaboration, and reusability.

Microteaching as project-based learning for student teachers

Transformative pedagogies and action orientation are suitable pedagogies for SD (Chen and Liu 2020). Micro-teaching is an action-taken practice for student teachers that invite making, implementing, and sharing educational designs of pedagogies. Micro-teaching also provides opportunities for reflection on teachers' (technological) pedagogical content knowledge, content knowledge, and their relationships (Chai, Ling Koh, and Tsai 2013). Making OERs on SD through micro-teaching needs students' real engagement to build, design, and share knowledge about SD and reflect on the whole process.

Making OERs based on micro-teaching about SD can further promote the creation of a knowledge-building society. Given OERs' broadcasting via open social media (e.g. YouTube), the learning community would potentially extend from inside the learning community (i.e. the course) to broader societal and global levels. Research has indicated that a pedagogical design for extending a professional teaching community can pass through several phases from socialization, externalization, combination, to internalization (Tammets, Pata, and Laanpere 2013). This will further deepen student teachers' reflection on their micro-teaching.

In summary, related research has suggested high-quality, inquiry-based, and multi-disciplinary projects with a supportive environment are likely pedagogies for a course on making OERs for SD. Microteaching is particularly suitable for a teacher-training course in terms of project-based learning with a supportive environment, which will be the major pedagogical design of this study. The pedagogical design may be properly examined by collecting and analysing students' learning outcomes such as students' attitudes, rationales, and approaches to making OERs on SD. The learning outcomes that emerge from implementing the pedagogy may serve as valuable experiences or exploratory evidence for the future development of a related pedagogy.

The present study

SD curricula in the world

UNESCO (2021) initiates education for sustainable development (ESD) for our sustainable futures. The initiative aims to support all countries to develop high-quality education to increase people's SD knowledge, values, and skills. While educational systems in different countries face their own challenges, they develop culturally adaptive visions, models, and practices. Detailed descriptions of ESD implemented by diverse countries are beyond the scope of this study. Therefore, three example countries from three different continents are provided for illustrative purposes, which allows a comparison to the study context, Taiwan.

Sweden has a solid background for ESD because of its long emphasis on infusing nature into all its educational system (Cars and West 2015). As a reasonable development, Sweden's national curriculum set SD as an overarching, societal goal for all school

subjects. SD is fundamental values and tasks, aiming at all agents in educational systems and society, including all teachers, students, and citizens. Schools have a general interest in SD. Teachers and students exercise their autonomy to fulfil SD under higher-order values such as human rights, democracy, environmental responsibility, and global development. Perhaps due to the overarching goals for all schools in Sweden, there appear to be few differences between schools emphasizing SD and those that do not, except in the economic aspect (Berglund, Gericke, and Chang Rundgren 2014).

Japan sets SD as an approach to internationalization (Fredriksson et al. 2020). SD is integrated into other teaching programs or school subjects, aiming to nurture global leaders. Diverse competencies are emphasized to help students become life-long learners. Key SD competencies include technologies, intelligence, virtue, and understanding people from different cultures.

The United States (US) implements SD as part of environmental education (EE). EE in the US, however, is evolving, striving to be a formal part of the national curriculum, and subject to political debate (Simmons 2014). Environmental literacy is the key for EE and comprises four sets of competencies: (1) questioning, analysing, and interpreting, (2) knowing environmental processes and systems, (3) understanding and addressing environmental issues, and (4) taking personal and civic responsibilities. Teachers' professional capacity to implement EE plays a central role, aiming to emphasize both SD-related knowledge and action.

Taiwan's SD curriculum: the study context

At the policy level, Taiwan's ESD is guided by the Taiwan Environmental Education Act enacted in 2011 (Laws and Regulations Database of the Republic of China, websites <http://law.moj.gov.tw/eng/> (in English) and <http://law.moj.gov.tw/> (in Chinese)). According to the Act, government-related employees (including teachers) are required to attend four hours of environmental and sustainability education each year. ESD in Taiwan was criticized as a measure for international recognition and being implemented through a top-down approach. For example, the government used incentives to attract SD behaviours, including school participation in SD projects (Huang, Asghar, and Nichols 2021). On the other hand, these incentives effectively build SD-related campuses, teaching materials, and societal transformation (Su and Chang 2010).

At the curriculum level, there is no school subject called 'SD' in the national curriculum for grades 1–12 students in Taiwan (Ministry of Education in Taiwan 2014). Nevertheless, the national curriculum sets SD as part of the 'environmental education (EE)' agendas or issues among the total 17 agendas, optional for being infused into any school subjects or being part of additional, special or multidisciplinary courses in school (Ministry of Education in Taiwan 2019). SD, therefore, appears to play a peripheral role in Taiwan's national curricula.

At the implementation level, cultivating teachers' environmental literacy is the key to implementing SD or environmental education. Environmental literacy is normally defined as including three aspects: knowledge, attitude, and action/behaviour. Research finds that in-service teachers have better environmental knowledge and attitudes than environmental action (Liu et al. 2015). A cultural comparison study, however, shows that Taiwanese grade-12 students have higher sustainability behaviour but lower knowledge

and attitudes than their Swedish counterparts. Culture-specificity may be part of the reasons for this difference (Berglund et al. 2020).

In summary, the commonality of ESD among the countries includes internationalization, flexibility, and inclusion into their own original educational systems. The differences between countries lie in original cultures and educational systems. Comparing Taiwan with the three illustrative countries, both Taiwan and Japan are more centralized and Sweden is more decentralized in implementing ESD (Fredriksson et al. 2020). While Sweden places SD in the centre of its national curriculum (Cars and West 2015), Japan defines SD as a strategy for internationalization. The US focuses on EE, striving to play a substantial role in its national curriculum (Simmons 2014). Taiwan only places SD as part of EE, with EE playing a peripheral role in the national curriculum. The weak role of SD in the national curriculum suggests a need to promote SD in Taiwan.

Research questions (RQs)

The above review of the literature suggests that relatively few studies have focused on investigating learners' attitudes, rationales, and approaches to making OERs in general, much less on OERs on SD specifically. Understanding learners' processes of making OERs can suggest effective pedagogies for supporting future students in making OERs on SD.

Concretely speaking, this study uses a teacher-training course in Taiwan as a platform to invite student teachers to make OER videos (a particular form of OERs) on SD. This small study in the specific location can serve as a step towards understanding the opportunities and challenges provided by making OERs on SD through answering the following RQs.

1. What are students' attitudes and rationales for making OERs on SD?
2. What are students' approaches to making OERs on SD?

RQs 1 and 2 will be answered by qualitative data analysis (QDA) in education and text mining methods in data science, respectively. Answers to RQs 1–2 are synthesized and used to provide suggestions for practitioners in implementing related courses.

Method

Participants

The research participants were 33 students, who registered for a course as part of a pre-service teacher-training program. This course was a selective one among several required ones on pedagogies for becoming a secondary school teacher at a university in northern Taiwan. The students were selected by written and/or tests to become student teachers. After completing all the required credits for becoming teachers and those for a bachelor's degree, the student teachers become in-service teacher candidates. The candidates had to experience a half-year practicum and pass a national examination in order to obtain a teacher's licence.

All the participants were in their first year of undergraduate. Therefore, the student teachers had very little knowledge, skills and practical experiences in designing or

implementing pedagogies. Among the students, 25 were female, and eight were male. As for the fields of study, 31 students studied education, and two students studied foreign languages. Sixteen students were from Taiwan and five students were from other Asian countries (e.g. Japan, Malaysia, and South Korea). Most students aimed to become a teacher, and some were still exploring their career development.

Teaching design

Course design

The aim of the course was to cultivate student-teacher sustainability in using and making OER videos on SD through group work. The course content focused on pedagogical knowledge and implementation. The content knowledge about SD and technological knowledge about OER use and production for online media (e.g. YouTube) were partially taught in class. The instructor briefly introduced basic SD and ESD in the first four weeks of the course before the student teachers focused on the five specific topics of SD in groups, as stated in the next section, 'Group work'. The instructor intensively used diverse OERs (e.g. instructor compiled teaching materials in text, YouTube videos, and social media news) as part of the teaching content and demonstrated related pedagogies. OERs were used to show methods to edit OER videos. Related software packages provided by the university were also suggested.

Group work

The students were divided into five groups. Each group designed and implemented two 35-minute teaching activities in class. The five groups worked on the topics of the sustainable lifestyle, campus, community, enterprise, and earth, respectively. The first round of teaching focused on knowledge and emotion, and the second focused on intention and action. Each group video-recorded their teaching activities, edited their videos, and shared the edited videos in class. After the sharing, the groups were encouraged to share their videos on YouTube. At the end of the course, ten videos were made and shared, eight of which were available on YouTube at the time of writing this paper. In total, there were 35-minutes * 2 periods of teaching and 10 minutes for sharing a group OER video for each group in class. Outside class time was not recorded.

Measures

The students kept weekly journals on what they learned from the course. In the midterm and final essays, detailed guiding questions were used to elicit student concerns, thoughts, and ideas during the process of making the OER video. The guiding questions included three sections: (1) design and implementation in terms of teaching materials and methods used before and while teaching, (2) production of the OER video based on the design and implementation in terms of teaching materials and methods, and (3) uploading the OER video to YouTube, including teaching materials, teaching methods, and the usefulness and likely impact of their OER videos. The full content of the guiding questions is provided in the appendix.

Data analysis

This study was situated in a real teacher-training course in a particular context. For both educational and research purposes, naturally generated data from the course were used without additional data collection such as surveys. The RQs can be answered by diverse data analysis methods, aiming to find meanings from the diverse data naturally generated from the whole process of the course.

The students' text data on the weekly journals and essays were analysed using both traditional QDA methods in education and text mining methods in data science. The data analysis followed the procedure from QDA for answering RQ 1, text mining for RQ 2, to synthesizing the results from both QDA and text mining (Figure 2). The QDA methods in education have advantages of meaning finding and high validity, but potential disadvantages include researchers' intuition, cherry-picking, fragmentary analysis, low reliability, and context-dependence (Creswell et al. 2003). Text mining methods in data science may partially remedy these disadvantages by quantifying qualitative data into word counts and statistically examining semantic patterns. Theoretical or conceptual backgrounds of the three methods are presented as follows. (Detailed processes of using the three methods are presented in the results section.)

For RQ 1, QDA as explicit theme finding

The major methods are general QDA, with a procedure of open coding, theme finding, and interpretation (Miles and Huberman, 1994). In the process of analysing data and writing papers, the other QDA methods such as grounded theory (Strauss and Corbin 1998) and phenomenology (Marton, 1981) are also used as supporting conceptions of research methodologies. The software packages used to support the QDA include the

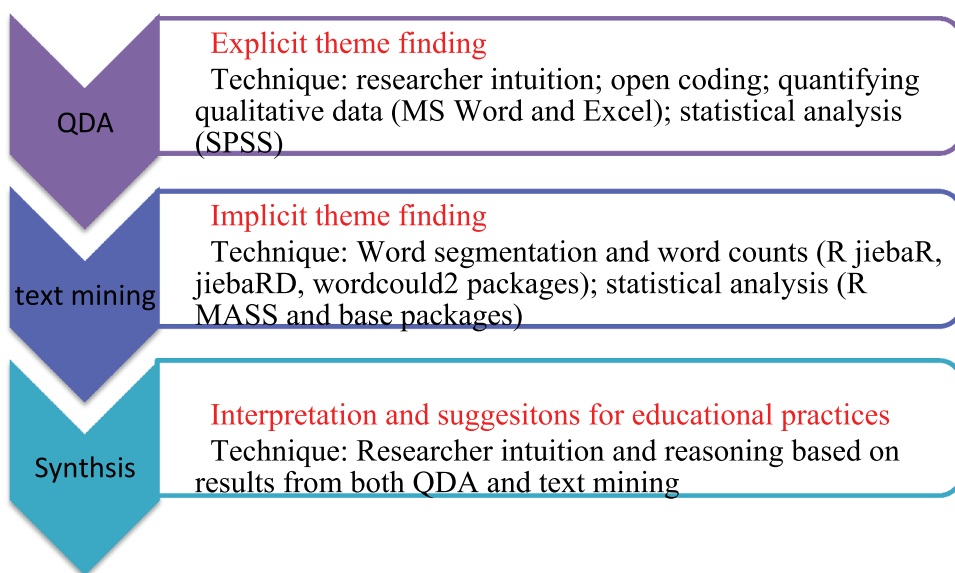


Figure 2. Data analysis procedure. QDA = Qualitative data analysis.

Atlas.ti Version 6.0.15 software (Atlas.ti GmbH, Berlin, Germany). Chi-square analyses were used to analyse the quantified theme frequencies obtained from QDA.

For RQ 2, text mining as implicit theme finding

Typical student cases (text files) for each of the themes identified by QDA was analysed using text mining. This analysis method mimicked the QDA but used an automatic algorithm. The students wrote in Chinese and thus R and its jiebaR and jiebaRD packages were used to segment (tokenize) and clean words, find keywords, and calculate similarities between students' text files (cases). Keywords were found using three methods: term frequency, term frequency-inverse document frequency (TF-IDF), and simhash. Term frequency tended to generate more interpretable keywords than TF-IDF and simhash did. Term frequency results, therefore, were reported in this paper. Student text similarities were indicated by the Hamming distance of words by comparing the simhash values between different text files, with smaller Hamming distance values representing higher similarities between two text files (Dhumal et al. 2017). Chi-square analyses were used to analyse the quantified term or keyword frequencies obtained from QDA.

The discussion section presents the last stage of data analysis by synthesizing the results from QDA and text mining. Synthesis could be a general method of academic analysis that goes beyond the results and can inform implications and suggestions for educational practices and future research.

Ethical concern

This study met the criteria for teaching research without requiring the approval of the ethical committee. The two criteria addressed in Official Document 1,040,003,540 issued by the Ministry of Science and Technology, Taiwan, were (1) the research participants are all adults (above 20 years old) and (2) all the data used in this study were naturally generated in the process of instruction, assessment, and evaluations for understanding or improving learning outcomes, pedagogies, and the related educational environment.

To minimize tensions and risks arising from the positions of the participants and the researcher, the researcher put the participants as students first before as research subjects (Aluwihare-Samaranayake 2012). That is, the course design solely depended on course objectives and instructional principles/rules. The data was naturally generated from the course design and process. Next, university students are mature, autonomous enough to have relatively equal status or relationship with the instructor. For example, this is an elective course; the participants as students could assess the instructor anonymously through the university's system. Further, to reduce participants' vulnerability, all the participants' responses, reports, and creations were presented in papers in a way that the participants' identification is protected.

Results

Students' attitudes and rationales for making OERs on SD

QDA methods were used to analyse the data in three phases. Firstly, reading through the students' weekly journals and essays suggested that the students' attitudes and rationales

for making the OER videos might be properly understood by the students' responses to the guiding question '(about) uploading the video to YouTube' (Appendix Question III.1–4). The guiding question elicited students' attitudes and rationales for sharing the OER videos on YouTube. Secondly, open coding and interpretations were made for identifying themes related to students' attitudes and rationales.

Four attitudes

Students' attitudes were mostly elicited by the guiding question 'How do you think you can promote your videos?' (Appendix Question III.3) although some were by the other guiding question and weekly journals. Open coding found that students possessed four types of attitudes toward making OER videos on SD: positive, certain, uncertain, and negative. Table 1 shows the counts of the four attitudes, with most students having a positive attitude ($n = 16$ students) and then certain (6), uncertain (6), and negative (3) attitudes. The characteristics of each attitude and students' typical responses are presented as follows.

Positive attitudes

Students with positive attitudes towards making OER videos on SD normally use diverse methods aiming to promote their video's visibility. They also have confidence in the contribution of their videos to numerous people now and in the future, such as future teachers (Makrakis 2010). A typical journal is:

- 'In addition to the video link we placed on Moodle (the e-learning system for our course), we posted links in the Facebook group for our course. We even shared the video content on the Facebook group of the university so that the video would be used by more people.' (Student ID = 11, male, response to the guiding question Appendix Question III.3)

Positive students appeared to combine diverse SD competencies of knowledge, attitudes, and behaviours (Tuncer et al. 2009; Yavetz, Goldman, and Pe'er 2009). They have an open mind and take action to go beyond their personal knowledge, skills, and society.

Table 1. Chi-square test results for the frequencies of attitudes by rationales.

Rationales Attitudes	others-driven			self-driven			Total	Total %*
	no	1	2	no	1	2		
positive	0	13	3	13	1	2	16	48
certain	6	0	0	0	6	0	6	18
uncertain	6	0	0	5	0	1	6	18
negative	3	0	0	3	0	0	3	9
Total	15	13	3	21	8	2	31*	100
chi-square	31.00			26.33				
p value	< 0.0005			< 0.0005				

Note. *2 cases are missing because no clear responses in their writing.

Certain attitudes

Students with certain attitudes do not take additional effort or diverse measures to promote their OER videos. However, they expect an impact of their OER videos on a broad scope such as SD, ESD, and related domains, as a student stated:

- '[We] hope that those who see the video can understand the concept mapping teaching method and become interested. [We] also hope that the viewers can learn some methods to teach SD, which will have some impact on the future of natural science education.' (ID = 52, female, response to Appendix Question III.1)

Certain students appeared to only focus on interested people. They also set a boundary of their OER videos' contribution to SD, related, and relatively broad fields.

Uncertain attitudes

Students with uncertain attitudes doubt whether people would view their videos. Students who did not indicate their attitudes to OERs on SD clearly were also coded as having an uncertain attitude.

- 'Will anyone see [the video]?' (ID = 22, female, response to Appendix Question III.1)
- 'One of our group members edited the video smartly. This was the best instructional video I've ever viewed. ... ' (ID = 26, male, Week-17 journal)

The second quote indicates the enjoyment of group members' creativity (Olivier 2019) and meaningful collaboration (Makrakis 2010). They, however, only focused on their group (or a small inner society) and did not link to SD or a broader world.

Negative attitudes

Students with a negative attitude doubt people would learn from their OER videos. Some students limited the use of their OER videos to a very narrow scope, like only future students of the course would view their videos.

- 'How the video is interpreted depends on the viewer's own ideas. Those who have no idea about the course may not understand. In particular, it all depends on how individuals use videos that are uploaded to open places like YouTube. I think this is beyond our control.' (ID = 14, female, response to Appendix Question III.3)
- 'Only the group member who edited the video uploaded it. ... Only future students of this or similar courses or people who are particularly interested in this specific topic will view it ... ' (ID = 44, female, response to Appendix Question III.3)

Negative students appeared to focus on the challenges of making OERs (Olivier 2019) and limit their use.

In summary, these four attitudes potentially have their focuses, rationales, and boundaries. Linking to SD represents a larger world and a more positive attitude. Without linking to SD indicates a smaller world and a more negative attitude. The attitudes also link to action taken in promoting their OER videos by broadening avenues, activating motivation, and creating measures.

Others- or self-driven rationales

Further, open coding was conducted to identify the students' rationales. The rationales could be categorized into two major categories: others- and self-driven, each with several sub-categories. The interpretation of the major rationales and students' typical responses in the sub-categories are presented as follows.

Others-driven rationales

This rationale focused on concern about, helping, or entertaining people about the environment. Sharing appeared to be an enjoyable activity in and of itself.

- **Help others learn.** 'In fact, I worry about the number of views [that the video receives], so I go up to see if the views are increasing from time to time. After all, I hope that it will attract attention and hope that it will help others.' (Student ID = 11, male, positive attitudes)
- **Help the environment/earth.** 'Putting our teaching videos on YouTube was of course based on the hope that more people could understand the importance and examples of sustainable enterprises. All ethnic groups of people can view without any limit. I think this topic [SD] is something everyone needs to understand.' (Student ID = 41, female, positive attitudes)
- **Share.** 'Putting [the video] on YouTube means it is watched by the public, not just in Taiwan, but around the world.' (Student ID = 33, male, positive attitudes)
- **Entertaining others.** 'If you put [the video] on YouTube, there will be a lot of people viewing it. So we also hope that our video can be liked by everyone. I hope that our video will not only entertain people but also teach them something!' (ID = 47, female, positive attitude)

Self-driven rationales

Self-driven students' rationales focused on three aspects of the students' concerns about themselves.

- **Self-achievement or creativity.** 'Putting the teaching videos on YouTube, I think, is a modern way to present our lesson plans. . . . With the video, we can understand the meaning of creation with first-hand information and understand the intention to design teaching activities.' (ID = 54, female, positive attitude)
- **Self-reflection or learning.** 'I feel that learning SD is very meaningful because I can reflect on my own behaviour.' (ID = 16, female, positive attitude)
- **People's recognition.** 'It was a short video clip. We used the time-lapse technique. I think it is fun. . . . It can attract more people's attention. I feel great!' (ID = 46, female, uncertain attitude)

The interaction between attitudes and rationales

Thirdly, the themes of the attitudes and rationales were quantified by counting their frequencies. Among the 16 students with positive attitudes, 13 students had one kind of others-driven rationales and 3 students had two (Table 1). The students with the other three attitudes had no other-driven rationales. The result of chi-square analysis revealed

a significant difference in the frequencies between different attitudes and rationales (chi-square = 31.00, $p < 0.0005$). The results revealed that positive attitude students focused on others-driven rationales.

In self-driven rationales, for all the six certain attitude students, each had one self-driven rationale (Table 1). Among the 16 positive attitude students, one student had one self-driven rationale, and two students each had two self-driven rationales. One out of six uncertain students had one self-driven rationale, while the three negative attitude students had no self-driven rationales. The chi-square test result reveals a significant interaction effect in frequencies between attitudes and self-driven rationales (chi-square = 26.33, $p < 0.0005$). The results suggested that the certain attitude students focused on self-driven rationales.

The QDA results successfully identified the themes in students' attitudes and rationales. This proved that the QDA was valid in describing the students' underlying psychological process of making the OER videos on SD. By quantifying the qualitative themes, interactions in frequencies between attitudes and rationales were found. The interaction effect suggested that others-driven rationales were related to positive attitudes towards making OER videos and self-driven rationales were related to certain attitudes toward making OER videos. However, the students with uncertain and negative attitudes could not be interpreted by the dichotomy of others- and self-driven rationales and the likely factors underlying these two attitudes remained unresolved in this study.

Students' approaches to making OERs on SD

The weekly journals written by the most typical cases (students), each for one of the four attitudes, were selected and analysed in order to understand the learners' implicit themes or approaches while making OER videos on SD. Three text mining methods were used to provide insights about the students' approach to making OER videos in relation to four different levels of attitudes.

Firstly, fifty keywords for each case were extracted using the term frequency method of text mining. As shown in Table 2, for each case, the top five keywords were translated and are presented in English.

Secondly, the keywords that were likely to distinguish the four attitudes were selected and adjusted based on their total word counts (Table 3). Chi-square tests were used to examine differences in the keyword counts between the four attitudes. As revealed by the chi-square test results, positive attitudes tended to relatively use the keywords 'teach', 'demo', and 'sustain' with greater frequency; certain attitudes used 'every' and 'self'; uncertain attitudes used 'we', 'can', 'class', and 'cooperate'; negative attitudes used 'video', 'sustain', 'how', and 'feel'.

Thirdly, text similarity was identified using the Hamming distance of words by comparing the simhash values between the four cases' text files. Lower Hamming distances represented higher degrees of text content similarity (Table 3). The results revealed that the language used by the uncertain attitude students was more similar to the students with positive attitudes (Hamming distance of words [HDW] = 14) and certain attitudes (HDW = 15). The other pairs of text files were not so similar to each other (HDW = 21–30). This suggested that

the four attitude-related approaches might not be linear because uncertain attitudes were more similar to positive and certain attitudes than to negative attitudes.

Based on the three text mining results above, the attitude-related approaches to making OERs on SD were identified. The student with a positive attitude tended to take an ideational approach. The student with a certain attitude took an inquiry approach. The student with an uncertain attitude took a social approach. The student with a negative attitude took a disciplinary approach. Descriptions of the four approaches are presented in Table 2.

Discussion

Theoretical synthesis: four competencies in making OERs on SD

This study identifies learners' four attitudes, two rationales, and four approaches to making OERs on SD. A synthesis of the results suggests four competencies of students in the making by the following two steps. Firstly, Table 2 serves as the basis of the four competencies (in relation to the four attitudes). Secondly, the descriptions are supplemented with the quotations from the students' four attitudes and the quantitative results of interactions between attitudes and rationales (Table 1) and between attitudes and keywords (Table 3). The characteristics of the four competencies are described with reference to related literature as follows.

Ideational competency (positive attitudes; others-driven rationales)

Students with ideational competency have a tendency to link the environment with technology in order to promote SD and have a positive attitude towards making OERs on SD. Ideational students, therefore, are consistent with some notions of ESD that advocate ethical values, managing emotions, acting for change, envisioning futures

Table 2. Four typical learning approaches in terms of attitudes of top word counts.

Attitudes to making OER	Approaches	5 most frequent words	Word count	Word count % (within approach)
Positive	Ideational approach: We can benefit and impact by teaching, demonstrating, and sharing videos for people, earth, and environment.	we	59	10.63%
		can	32	5.77%
		teach	27	4.86%
		demo	26	4.68%
		video	21	3.78%
Certain	Inquiry learning: We each can experience the process of working on a project by enjoying activities, creativity, and data use for ourselves.	we	36	4.49%
		everyone	33	4.12%
		one	29	3.62%
		can	23	2.87%
		myself	22	2.75%
Uncertain	Social learning: We can learn and benefit by cooperating with the people inside the community.	we	128	13.17%
		can	71	7.30%
		learn	46	4.73%
		classmate	37	3.81%
		cooperation	36	3.70%
Negative	Disciplinary learning: We need to focus on how to teach and make videos and how we feel, which have little connections with outsiders.	how	24	4.85%
		teach	20	4.04%
		we	19	3.84%
		video	19	3.84%
		feel	16	3.23%

Table 3. Chi-Square Test Results for the Adjusted Standardized Word Counts of Selected Keywords and Hamming Distance of Words Between the Four Attitudes.

Attitudes	Words														Hamming distance of words		
	we	can	teach	demo	video	sustain	every	self	class	cooperate	how	feel	Positive	Certain	Uncertain		
Positive	106.31	57.66	48.65	46.85	37.84	14.41	32.43	10.81	7.21	10.81	36.04	12.61					
Certain	44.94	28.71	11.24	3.75	4.99	9.26	41.20	27.47	6.24	17.48	2.50	1.25	23				
Uncertain	131.69	73.05	29.84	12.35	16.46	2.02	26.75	23.66	38.07	37.04	26.75	29.84	14	15			
Negative	38.38	20.20	40.40	14.14	38.38	14.41	20.20	10.10	14.14	26.26	48.48	32.32	25	30	21		
Chi-square	78.72	40.68	24.05	55.83	33.41	9.05	7.89	13.09	40.34	16.89	39.92	34.25					
p value	<0.005	<0.005	<0.005	<0.005	<0.005	0.01	0.05	<0.005	<0.005	<0.005	<0.005	<0.005					

Note. Adjusted standardized word counts = Original word count (within approach)/N (within approach)*100

(Cebrián and Junyent 2015). Environmental awareness can resolve the tension between nature and technology (Author 2013).

Ideational competent students have a salient others-driven rationale. They aim to benefit the generalized others that synthesize both the environment (physical world) and people (human beings). This competency shares some characteristics of making OERs in altruistic motivation, related knowledge with skills (De Langen 2013; Olivier 2019), and environmental concerns (McKerlich, Ives, and McGreal 2013).

Inquiry competency (certain attitudes; self-driven rationales)

Inquiry competent students have a certain attitude toward making OERs on SD by engaging in the process of making OERs with a sense of self-satisfaction and a slight expectation of others' recognition. They take an inquiry approach to making OERs for themselves, as advocated by OER curricula's emphasis on inquiry-based learning (Schmidt-Jones 2012). Self-driven rationale or recognition is a characteristic of OER makers (McKerlich, Ives, and McGreal 2013).

Although inquiry competent students do not particularly emphasize SD, their inquiry approach is a higher-order thinking emphasized by ESD (Laurie et al. 2016; Shea et al. 2013). In other words, they engage in the process of making for self-achievement, not for a broader world as perceived by ideational students.

Social competency (uncertain attitudes)

Students with social competence pay attention to people (or others) in their local society only, not generalizing to the environment or people outside their local community. Their behaviours focus on establishing liaisons or affiliations between people in their local community. Perhaps given that they are unable to generalize beyond their own local environment or to people outside their communities, they take an uncertain attitude towards making OERs on SD. In other words, they focus on local society and break the tension between conformity and authority in their own society (Author 2013) to form an affiliative local community.

Social competent students cannot be explained by the others- vs. self-driven rationales identified in this study (Table 1). However, contextualizing experiential learning is advocated by ESD (social approaches; Ellis and Weekes 2008). Social support is required in OER making (Belikov and Bodily 2016; Hilton et al. 2013; Hsu and Ching 2013; Makrakis 2010). Social competent students appear to perceive that social endeavour for the local community is so necessary that making OER on SD for a broader world becomes peripheral. Future research needs to identify another rationale for socially competent students.

Disciplinary competency (negative attitudes)

Students with a negative attitude toward making OERs on SD do not go beyond their own disciplines, but focus on using techniques for high-quality OER products that are only for interested people. They do not generalize to the other domains of knowledge or a broader audience. In other words, they focus on making OER products for people in their own disciplines and do not aim to resolve the tensions between different knowledge bases (Author 2013).

Disciplinary competent students appear to violate the notion of SD competencies, which emphasize cross-disciplinary knowledge, attitudes/concerns, and behaviours

(Lozano 2010; Tuncer et al. 2009; Yavetz, Goldman, and Pe'er 2009). Their task-focused thinking with negative attitudes, however, is worth noticing when practitioners design a similar curriculum requiring diverse domains of knowledge and skills.

In summary, the above synthesis is based on multiple data analyses. Although the results appear to echo related literature and empirical research, cautions still need to be made given the small sample size of this study. The small sample size has led this study to a more qualitative study than a quantitative one, though quantifying qualitative data is used. Future research needs to validate the finding using larger sample sizes.

Pedagogical suggestions for practitioners

The four competencies identified above suggest there exist four patterns of students in making OERs on SD in a class. Although the four competencies relate to different levels of attitudes towards making OERs on SD, for educational practitioners, the collaboration between students with diverse competencies may increase the possibility of making a high-quality OER on SD.

Pedagogical designs are better depicted linearly because courses are implemented along with time development. The four competencies, therefore, are re-formatted based on the linear desirability of attitudes from positive, certain, uncertain, to negative attitudes. This design appears to advocate a pedagogical procedure starting with ideals and ending with techniques. Instructors may manage a course on making OERs on SD or related topics through the following four phases.

Phase 1, ideational creation

Students are introduced to the mindset and possibility that technology can be used to promote SD for the overall betterment of the human and physical world (Laurie et al. 2016). Students can be invited to use creativity to link the environment (nature) and technology and create initial OERs on SD.

Phase 2, inquiry process

Students engage in the process of inquiry individually and cooperatively in order to expand upon their initial creations (Tsai et al. 2013). Independent inquiry based on expertise is needed for specific parts of making OERs. Group inquiry is also needed to structure or elaborate OERs produced on the basis of independent inquiry.

Phase 3, societal transformation

Students need to test their refined creations by working in the community (Chen and Liu 2020; Ellis and Weekes 2008) aiming to transform society. Students build an affiliative relationship with people in their community by broadcasting and inviting people in their society to use or view their creations, receiving others' feedback, and making necessary changes in response to the feedback.

Phase 4, transdisciplinary reflection

After the above testing with students' local society, students are invited to reflect on their competence development in the whole process of Phases 1–3 (Ellis and Weekes 2008; Shea et al. 2013). The reflection aims to transcend their previous disciplines or

competencies (e.g. education, environmental science, and economics) to add the other disciplines, techniques, or knowledge into their competence profiles, such as information communication technology, SD, and OER making as an activity that integrate science, art, and science (Clark and Button 2011). Lifestyle changes for SD may also be a possible reflection topic (Savageau 2013). A note to make is that instructors' endeavours to invest time and teaching in this phase are especially important for students focusing on disciplinary competencies because they have a tendency to focus on their own disciplines and have a negative attitude towards making OERs.

The above pedagogical design is likely to involve students of four competencies for making OERs on SD. This pedagogical design appears to be a revision to Tsai et al.'s (2013) and Chai, Ling Koh, and Tsai (2013) technological pedagogical content knowledge models by adding broad and individual emotional ownership (McKerlich, Ives, and McGreal 2013) (Phases 1–2 in this study). This design also overlaps Tammets, Pata, and Laanpere (2013) pedagogical design for extending professional teaching in the aspect of socialization (Phase 3) and internalization (Phase 4), but the phase sequence and detailed content are different.

Conclusion

Contribution

This study uses QDA and text mining to analyse students' processes of making OER videos on SD and identifies four attitudes, two rationales, and four approaches in the making process, which forms four competencies. The four competencies are ideational, inquiry, societal, and disciplinary competencies. A pedagogical design derived from the four competencies follows a linear manner from ideational creation, inquiry process, societal transformation, to transdisciplinary reflection. This pedagogical design may provide insights for future practitioners to implement related courses, particularly making OERs on SD.

Limitations

There are, however, some limitations in this study, which need future research to resolve or elaborate.

Firstly, although some findings are consistent with past research findings, the findings are based on data from a specific course with a small sample in a specific culture. The generalization of the findings should be done with caution. Future researchers and educators need to evaluate the degrees to which this particular context (including only focusing on OER videos, rather than all forms of OERs) resonates with their own contexts in order to gain suitable insights for their courses and contexts.

Further, combining QDA and text mining methodologies may be an innovative approach. Text mining, however, is still in the development stage for use in education. The validity of research findings emerging from text mining results remains a question and merits further attention by future researchers on the methodology for proposing arguments, speculations, and theories.

Thirdly, this study relies more on QDA methodology or quantifying qualitative data (including using text mining techniques). Quantitative methodologies, such as

experiments or surveys, can validate the identified student attitudes, rationales, and approaches.

Finally, this study is exploratory in nature, though with potential value. Involving many variables makes this study hard to ascribe attitudes, rationales, and approaches (as contained in the RQs) to specifically defined aspects required to develop and publish the OERs on SD. Future research, therefore, needs to examine the suggested specific pedagogies in more detail and examine how these pedagogies impact students' attitudes and related learning outcomes.

Acknowledgments

This work was supported by the Ministry of Science and Technology, Taiwan (NSC101-3113-S-004-001; MOST 106-2410-H-004-131). The funder only provides financial support and does not substantially influence the entire research process, from study design to submission. The author is fully responsible for the content of the paper.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by the Ministry of Science and Technology, Taiwan [MOST 106-2410-H-004-131].

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References

- Aluwihare-Samaranayake, Dilmi. 2012. "Ethics in Qualitative Research: A View of the Participants' and Researchers' World from A Critical Standpoint." *International Journal of Qualitative Methods* 11 (2): 64–81. doi:10.1177/160940691201100208.
- Andersson, Klas, Sverker C. Jagers, Annika Lindskog, and Johan Martinsson. 2013. "Learning for the Future? Effects of Education for Sustainable Development (ESD) on Teacher Education Students." *Sustainability* 5 (12): 5135–5152. doi:10.3390/su5125135.
- Author. (2013).
- Belikov, Olga, and Robert Bodily. 2016. "Incentives and Barriers to OER Adoption: A Qualitative Analysis of Faculty Perceptions." *Open Praxis* 8 (3): 235–246. doi:10.5944/openpraxis.8.3.308.
- Berglund, Teresa, Niklas Gericke, Jelle Boeve-de Pauw, Daniel Olsson, and Tzu-Chau Chang. 2020. "A Cross-cultural Comparative Study of Sustainability Consciousness between Students in Taiwan and Sweden." *Environment, Development and Sustainability* 22 (7): 6287–6313. doi:10.1007/s10668-019-00478-2.
- Berglund, Teresa, Niklas Gericke, and Shu-Nu Chang Rundgren. 2014. "The Implementation of Education for Sustainable Development in Sweden: Investigating the Sustainability Consciousness among Upper Secondary Students." *Research in Science & Technological Education* 32 (3): 318–339. doi:10.1080/02635143.2014.944493.

- Bliss, T. J., T. Jared Robinson, John Hilton, and David A. Wiley. 2013. "An OER COUP: College Teacher and Student Perceptions of Open Educational Resources." *Journal of Interactive Media in Education* 1 (Art): 4. doi:10.5334/2013-04.
- Cars, Mikiko, and Emma E. West. 2015. "Education for Sustainable Society: Attainments and Good Practices in Sweden during the United Nations Decade for Education for Sustainable Development (UNDES)." *Environment, Development and Sustainability* 17 (1): 1–21. doi:10.1007/s10668-014-9537-6.
- Cebrián, Gisela, and Mercè Junyent. 2015. "Competencies in Education for Sustainable Development: Exploring the Student Teachers' Views." *Sustainability* 7 (3): 2768–2786. doi:10.3390/su7032768.
- Chai, Ching Sing, Joyce Hwee Ling Koh, and Chin-Chung Tsai. 2013. "A Review of Technological Pedagogical Content Knowledge." *Journal of Educational Technology & Society* 16 (2): 31–51.
- Chen, Shih-Yeh, and Shiang-Yao Liu. 2020. "Developing Students' Action Competence for A Sustainable Future: A Review of Educational Research." *Sustainability* 12 (4): 1374. doi:10.3390/su12041374.
- Clark, Barbara, and Charles Button. 2011. "Sustainability Transdisciplinary Education Model: Interface of Arts, Science, and Community (STEM)." *International Journal of Sustainability in Higher Education* 12 (1): 41–54. doi:10.1108/14676371111098294.
- Colvard, Nicholas B., C. Edward Watson, and Hyojin Park. 2018. "The Impact of Open Educational Resources on Various Student Success Metrics." *International Journal of Teaching and Learning in Higher Education* 30 (2): 262–276.
- Creswell, J. W., V. L. Plano Clark, M. L. Guttman, and E. E. Hanson. 2003. "Advanced Mixed Methods Research Design." In *Handbook of Mixed Methods in Social and Behavioural Research*, edited by A. Tashakkori and C. Teddlie, 209–240. Thousand Oaks: Sage.
- De Langen, Frank H. T. 2013. "Strategies for Sustainable Business Models for Open Educational Resources." *International Review of Research in Open and Distributed Learning* 14 (2): 53–66. doi:10.19173/irrodl.v14i2.1533.
- Delimont, Nicole, Elizabeth C. Turtle, Andrew Bennett, Koushik Adhikari, and Brian L. Lindshield. 2016. "University Students and Faculty Have Positive Perceptions of Open/alternative Resources and Their Utilization in a Textbook Replacement Initiative." *Research in Learning Technology* 24 (Art): 29920. doi:10.3402/rlt.v24.29920.
- Dhumal, A. S., S. V. Dhadse, M. N. V. Gavhane, S. S. Kokate, and R. Patil. 2017. "Real Time Shop Recommendation via Text Messaging." *Imperial Journal of Interdisciplinary Research* 3: 1311–1314.
- Ellis, Geraint, and Tony Weekes. 2008. "Making Sustainability 'Real': Using Group-enquiry to Promote Education for Sustainable Development." *Environmental Education Research* 14 (4): 482–500. doi:10.1080/13504620802308287.
- Fredriksson, Peter, and Magnus Persson. 2011. "Integrating Sustainable Development into Operations Management Courses." *International Journal of Sustainability in Higher Education* 12 (3): 236–249. doi:10.1108/14676371111148027.
- Fredriksson, Ulf, Kanako N. Kusanagi, Petros Gougoulakis, Yaka Matsuda, and Yuto Kitamura. 2020. "A Comparative Study of Curriculums for Education for Sustainable Development (ESD) in Sweden and Japan." *Sustainability* 12 (3): 1123. doi:10.3390/su12031123.
- Gil, Pablo, Francisco Candelas, Gabriel Garcia, and Carlos Jara. 2012. "Open Educational Resources: The Role of OCW, Blogs and Videos in Computer Networks Classroom." *International Journal of Emerging Technologies in Learning* 7 (3): 4–10. doi:10.3991/ijet.v7i3.2116.
- Gottlieb, Dan, Eran Vigoda-Gadot, Abraham Haim, and Meidad Kissinger. 2012. "The Ecological Footprint as an Educational Tool for Sustainability: A Case Study Analysis in an Israeli Public High School." *International Journal of Educational Development* 32 (1): 193–200. doi:10.1016/j.ijedudev.2011.03.007.
- Green, Monica, and Margaret Somerville. 2015. "Sustainability Education: Researching Practice in Primary Schools." *Environmental Education Research* 21 (6): 832–845. doi:10.1080/13504622.2014.923382.
- Hilton, Ill, John Levi, Donna Gaudet, Phil Clark, Jared Robinson, and David Wiley. 2013. "The Adoption of Open Educational Resources by One Community College Math Department."

- International Review of Research in Open and Distributed Learning* 14 (4): 37–50. doi:[10.19173/irrodl.v14i4.1523](https://doi.org/10.19173/irrodl.v14i4.1523).
- Hsu, Yu-Chang, and Yu-Hui Ching. 2013. "Mobile App Design for Teaching and Learning: Educators' Experiences in an Online Graduate Course." *International Review of Research in Open and Distributed Learning* 14 (4): 117–139. doi:[10.19173/irrodl.v14i4.1542](https://doi.org/10.19173/irrodl.v14i4.1542).
- Huang, Ying-Syuan, Anila Asghar, and Naomi E. Nichols. 2021. "Implementing a National Policy Initiative to Support Education for Sustainable Development: Lessons from Taiwan's Environmental Education Act." *Educational Research for Policy and Practice* 20 (2): 187–205. doi:[10.1007/s10671-020-09274-6](https://doi.org/10.1007/s10671-020-09274-6).
- Laurie, Robert, Yuko Nonoyama-Tarumi, Rosalyn Mckeown, and Charles Hopkins. 2016. "Contributions of Education for Sustainable Development (ESD) to Quality Education: A Synthesis of Research." *Journal of Education for Sustainable Development* 10 (2): 226–242. doi:[10.1177/0973408216661442](https://doi.org/10.1177/0973408216661442).
- Lin, Yu-Ju, and Hung-Chun Wang. 2018. "Using Enhanced OER Videos to Facilitate English L2 Learners' Multicultural Competence." *Computers & Education* 125: 74–85. doi:[10.1016/j.compedu.2018.06.005](https://doi.org/10.1016/j.compedu.2018.06.005).
- Liu, Shiang-Yao, Shin-Cheng Yeh, Shi-Wu Liang, Wei-Ta Fang, and Huei-Min Tsai. 2015. "A National Investigation of Teachers' Environmental Literacy as A Reference for Promoting Environmental Education in Taiwan." *The Journal of Environmental Education* 46 (2): 114–132. doi:[10.1080/00958964.2014.999742](https://doi.org/10.1080/00958964.2014.999742).
- Liyanagunawardena, Tharindu Rekha, Andrew Alexandar Adams, and Shirley Ann Williams. 2013. "MOOCs: A Systematic Study of the Published Literature 2008-2012." *International Review of Research in Open and Distributed Learning* 14 (3): 202–227. doi:[10.19173/irrodl.v14i3.1455](https://doi.org/10.19173/irrodl.v14i3.1455).
- Lozano, Rodrigo. 2010. "Diffusion of Sustainable Development in Universities' Curricula: An Empirical Example from Cardiff University." *Journal of Cleaner Production* 18 (7): 637–644. doi:[10.1016/j.jclepro.2009.07.005](https://doi.org/10.1016/j.jclepro.2009.07.005).
- M, Marton, Ference. 1981. „Phenomenography—describing conceptions of the world around us,„ *Instructional Science* 10 (2): 177–200.
- Makrakis, Vassilios. 2010. "The Challenge of WikiQuESD as an Environment for Constructing Knowledge in Teaching and Learning for Sustainable Development." *Discourse and Communication for Sustainable Education* 1 (1): 50–57.
- McKerlich, Ross, Cindy Ives, and Rory McGreal. 2013. "Measuring Use and Creation of Open Educational Resources in Higher Education." *International Review of Research in Open and Distributed Learning* 14 (4): 90–103. doi:[10.19173/irrodl.v14i4.1573](https://doi.org/10.19173/irrodl.v14i4.1573).
- Miles, Matthew B., and A. Michael Huberman. 1994. *Qualitative data analysis: An expanded source-book*. Thousand Oaks: Sage.
- Ministry of Education in Taiwan. 2014. "Curriculum Guidelines of 12-year Basic Education." Accessed 17 June 2021. <https://cirn.moe.edu.tw/Upload/file/32077/83646.pdf>
- Ministry of Education in Taiwan. 2019. "Curriculum Guidelines of 12-year Basic Education: Manuel for Infusing Issues." Accessed 17 June 2021. <https://cirn.moe.edu.tw/Upload/file/29143/83847.pdf> (in Chinese)
- Mochizuki, Yoko, and Zinaida Fadeeva. 2010. "Competences for Sustainable Development and Sustainability: Significance and Challenges for ESD." *International Journal of Sustainability in Higher Education* 11 (4): 391–403. doi:[10.1108/14676371011077603](https://doi.org/10.1108/14676371011077603).
- Murphy, Patricia, and Freda Wolfenden. 2013. "Developing a Pedagogy of Mutuality in a Capability Approach: Teachers' Experiences of Using the Open Educational Resources (OER) of the Teacher Education in sub-Saharan Africa (TESSA) Programme." *International Journal of Educational Development* 33 (3): 263–271. doi:[10.1016/j.ijedudev.2012.09.010](https://doi.org/10.1016/j.ijedudev.2012.09.010).
- Olivier, Jako. 2019. "Short Instructional Videos as Multimodal Open Educational Resources in a Language Classroom." *Journal of Educational Multimedia and Hypermedia* 28 (4): 381–409.
- Rieckmann, Marco. 2012. "Future-oriented Higher Education: Which Key Competencies Should Be Fostered through University Teaching and Learning?" *Futures* 44 (2): 127–135. doi:[10.1016/j.futures.2011.09.005](https://doi.org/10.1016/j.futures.2011.09.005).

- Savageau, Ann E. 2013. "Let's Get Personal: Making Sustainability Tangible to Students." *International Journal of Sustainability in Higher Education* 14 (1): 15–24. doi:10.1108/14676371311288921.
- Schmidt-Jones, Catherine Anne. 2012. "An Open Educational Resource Supports a Diversity of Inquiry-based Learning." *International Review of Research in Open and Distributed Learning* 13 (1): 1–16. doi:10.19173/irrodl.v13i1.1141.
- Shea, Peter, Suzanne Hayes, Sedef Uzuner Smith, Jason Vickers, Temi Bidjerano, Mary Gozza-Cohen, Shou-Bang Jian, Alexandra M. Pickett, Jane Wilde, and Chi-Hua Tseng. 2013. "Online Learner Self-regulation: Learning Presence Viewed through Quantitative Content and Social Network Analysis." *International Review of Research in Open and Distributed Learning* 14 (3): 427–461. doi:10.19173/irrodl.v14i3.1466.
- Simmons, Bora. 2014. "Excellence in Environmental Education for Elementary and Secondary Schools in the United States." In *Schooling for Sustainable Development across the Pacific*, edited by J.C.-K. Lee and R. Efrid, 79–98. Dordrecht: Springer. doi:10.1007/978-94-017-8866-3_4.
- Strauss, Anselm and, Juliet Corbin. 1998. *Basics of qualitative research techniques*. Thousand Oaks: Sage.
- Su, H. Jenny, and Tzu-chau Chang. 2010. "Sustainability of Higher Education Institutions in Taiwan." *International Journal of Sustainability in Higher Education* 11 (2): 163–172. doi:10.1108/14676371011031883.
- Tammets, Kairit, Kai Pata, and Mart Laanpere. 2013. "Promoting Teachers' Learning and Knowledge Building in a Socio-technical System." *International Review of Research in Open and Distributed Learning* 14 (3): 251–272. doi:10.19173/irrodl.v14i3.1478.
- Tsai, Chin-Chung, Ching Sing Chai, Benjamin Koon Siak Wong, Huang-Yao Hong, and Seng Chee Tan. 2013. "Positioning Design Epistemology and Its Applications in Education Technology." *Journal of Educational Technology & Society* 16 (2): 81–90.
- Tuncer, Gaye, Ceren Tekkaya, Semra Sungur, Jale Cakiroglu, Hamide Ertepinar, and Michael Kaplowitz. 2009. "Assessing Pre-service Teachers' Environmental Literacy in Turkey as a Mean to Develop Teacher Education Programs." *International Journal of Educational Development* 29 (4): 426–436. doi:10.1016/j.ijedudev.2008.10.003.
- UNESCO. 2021. "Education for Sustainable Development." Accessed 18 January 2021. <https://en.unesco.org/themes/education-sustainable-development>
- Wu, Yen-Chun Jim, and Ju-Peng Shen. 2016. "Higher Education for Sustainable Development: A Systematic Review." *International Journal of Sustainability in Higher Education* 17: 633–651. doi:10.1108/IJSHE-01-2015-0004.
- Yavetz, Bela, Daphne Goldman, and Sara Pe'er. 2009. "Environmental Literacy of Pre-service Teachers in Israel: A Comparison between Students at the Onset and End of Their Studies." *Environmental Education Research* 15 (4): 393–415. doi:10.1080/13504620902928422.

Appendix. Guiding questions for eliciting students' ideas during making OERs on SD

I. The entire process of designing and implementing the teaching

(I) Before teaching

- (1) What thoughts did you have? What were you most concerned about?
- (2) Teaching materials: Regarding the selection of teaching materials, what were your considerations? How did you find relevant information (For example: from other teachers, family and friends, the Internet, etc.)? How did you make sure the information was accurate? (e.g.what standards were used to evaluate the accuracy of the teaching materials?) Please provide a concrete example (such as from a portion of the process that left the deepest impression on you).
- (3) Teaching methods: How did you carry out the educational activity design process? (For example: How could you make the implementation process better? How did you divide the work? Was there anything that happened during the process that left a deep impression on you?)
- (4) Do you have any other thoughts, suggestions, expectations, etc.?

(II) While teaching

- (1) What thoughts did you have? What were you most concerned about?
- (2) Teaching materials: How do you feel about the materials you used? For example, where they appropriate for your students? How accurate do you feel the materials were? How did you make sure the educational content was accurately conveyed? Please provide a concrete example (such as from a portion of the process that left the deepest impression on you).
- (3) Teaching methods: How do you feel about how the whole educational process was put into effect? (e.g.how could you make the implementation process better? How did you divide the work? Was there anything that happened during the process that left a deep impression on you?)
- (4) Do you have any other thoughts, suggestions, expectations, etc.?

II. Producing the video (based on I. the entire process of designing and implementing the teaching)

- (1) What thoughts did you have? What were you most concerned about?
- (2) Teaching materials: What kind of information did you want to communicate to your audience? How did you make sure the information you are communicating was accurate? Please provide a concrete example (such as from a portion of the process that left the deepest impression on you).
- (3) Teaching methods: How did you carry out the work for the 'educational activity design video production'? (e.g.how could you make the implementation process better? How did you divide the work? Was there anything that happened during the process that left a deep impression on you?)
- (4) Do you have any other thoughts, suggestions, expectations, future plans, etc.?

III. Uploading the video to YouTube

- (1) What thoughts did you have? What were you most concerned about?
- (2) Teaching materials: How do you think your audience will feel about it? How do you think they will use the information you have shared? What will they think about the accuracy and usefulness of the information conveyed in the video? Please provide a concrete example (such as from a portion of the process that left the deepest impression on you).
- (3) Teaching methods: How did you put the video on YouTube? (e.g.how could you make the implementation process better? How did you divide the work? Was there anything that happened during the process that left a deep impression on you?) How do you think you can promote your videos?
- (4) Do you have any other thoughts, suggestions, expectations, future plans, etc.?