様　式　Ｃ－１９、Ｆ－１９－１、Ｚ－１９　（共通）

科学研究費助成事業　　研究成果報告書

令和　６ 年　 ６ 月 １０ 日現在

機関番号：３２５１０
研究種目：基盤研究(C)（一般）
研究期間：2021～2023
課題番号：２１Ｋ００６８３

研究課題名（和文）Advancing Language Learning for the 21st Century Using Maker Education

研究課題名（英文）Advancing Language Learning for the 21st Century Using Maker Education

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交付決定額（研究期間全体）：（直接経費）　　2,400,000円

研究成果の概要（和文）：本研究は、既存の高等教育カリキュラムにメーカー教育を導入した成果について調査したものである。既存の論文に基づき、調査のための枠組みと、中核となる構成要素のリストを作成した。メーカー教育アクティビティ終了後、参加者（N＝350）がリフレクションを行った。NLPソフトウェアを使用して定量的に、また、コーディングを通じて定性的に分析された。分析結果は、ソフトスキルの向上と、メーカープリンシプルとの一致を示すものであった。メーカー教育の導入は、内容と言語を教えるための状況学習シナリオとして成果があったことが証明された。この結果は、四本の論文として査読され、四つの国際会議で発表された

研究成果の学術的意義や社会的意義
The research demonstrated that Maker Education can be integrated into higher education content-language integrated learning contexts. Data proved that Maker Education created a situated learning environment where learners can simultaneously develop skills, content, and language knowledge.

研究成果の概要（英文）：The study investigated Maker Education's implementation into established higher education curricula at two international studies-oriented universities in Japan. The researchers developed a framework and list of core constructs for the approach and then vetted these for adherence to existing literature and suitability for the new context. Participants (N = 350) from 17 existing class groups completed reflections. These reflections were analyzed quantitatively using NLP software and through a qualitative coding process. Participant reflections showed evidence of soft skill development and alignment with Maker Principles. The interventions proved successful as situated learning scenarios for teaching content and language in a meaningful context. The results were disseminated in four peer-reviewed papers (with an additional paper under review) and four presentations at international conferences.

研究分野：Computer Assisted Language Learning

キーワード：Maker Education　Situated Learning　STEM　Skills development　Higher education　CLIL

様　式　Ｃ－１９、Ｆ－１９－１（共通）

１．研究開始当初の背景

Before obtaining the JSPS grant, the study's principal investigator received two institutional grants to explore Maker Education as a vehicle for content and language education in higher education curricula. These grants allowed the researchers to purchase initial materials and supplies for the project. By this time, Maker Education was becoming more well-known internationally, yet little research was published about the method's efficacy, especially in higher education language learning contexts. As a pilot for a more extensive study, the researchers explored Maker Education as a dedicated elective course and in daily 70-minute informal conversation sessions (Kushida et al., 2023). The researchers also piloted Maker Education activities within established courses. Following these initial pilots, the researchers began the development of a preliminary list of core constructs of a Maker Education approach for higher-education language and content that could form the basis of our study.

２．研究の目的

The purpose of this study was to determine whether Maker Education is a suitable model for enriching the educational outcomes of higher education language learning while promoting skill development and encouraging synergy between the humanities, specifically language education, and the STEAM (Science, Technology, Engineering, Art, and Mathematics). As few studies currently provide data for this context, the study sought to gather extensive data on implementing Maker Education in existing higher education content language-integrated learning (CLIL) contexts.

The research explored Maker Education in this context through the following research questions:

1. In a CLIL higher learning context, does Maker Education provide skill development benefits similar to those found in Maker Education literature? If so, what skills are utilized most often as a result of Maker Education activities?
2. Is there evidence to suggest that Maker Education supports (a) content and (b) language learning in CLIL higher education courses?
3. Is Maker Education a good fit for existing CLIL higher education curricula? If so, how can it best be integrated?

The study aimed to identify the affordances and limitations of Maker Education, intending to offer guidance for educators interested in exploring alternate methods to address some of the shortcomings of the current educational paradigm. The researchers envisioned Maker Education as a potential way of furthering students' knowledge of STEAM subjects, building their soft skills such as problem solving and critical thinking, and furthering depth of content and language knowledge through situated meaningful learning.

３．研究の方法

The study involved 350 participants from 17 CLIL classes across various subjects at two Japanese international studies universities. Participants were predominantly female (70%), ranged from 18 to 21 years old, and had an average CEFR B1 English proficiency.

The researchers worked with volunteer higher-education lecturers to integrate Maker Education activities into existing CLIL curricula. The lecturers proposed activities that fit their courses and met learning outcomes. These activities were then vetted to ensure they were hands-on, student-driven, integrated language learning, and aligned with the nine core constructs. Following this, materials were procured or sourced to prepare for carrying out the activities.

Each Maker Education intervention was preceded by content and language instruction. For example, in the "environmental science and sustainability" unit, students learned about e-waste and consumer rights through targeted vocabulary and articles before engaging in electronics repair activities. Based on the amount of and type of instruction prior to the

intervention, implementations were categorized into two general groups, extensive CLIL and limited CLIL. The extensive CLIL classification was applied if there were at least 90 minutes of explicit content and language instruction before the intervention. Conversely, if there were less than 90 minutes of explicit instruction, the activities were classified as limited CLIL. After each activity, students completed a survey with Likert-scale and open-ended questions to assess engagement and reflect on the project.

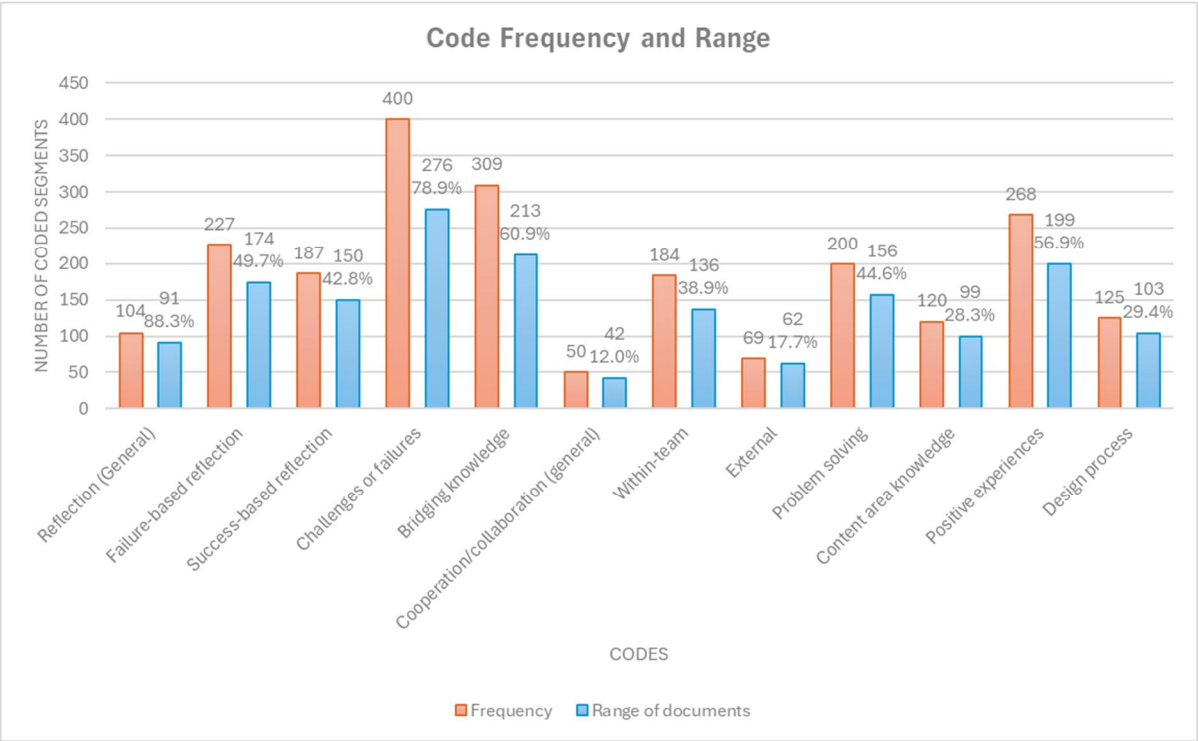
The researchers first analyzed participant reflections (N = 350) through a qualitative coding system. The researchers employed a deductive a priori coding system based on established frameworks for Maker Education as a basis for the coding process. The researchers further refined the initial coding system as new themes emerged from the data (e.g., *positive experiences*, *design process*). A new theme was only added if it occurred in at least a range of 15% of the total number of reflections. Two independent experts coded the data to ensure reliability; their agreement was substantial (80%). In addition to the coding process, the researchers analyzed participant reflections using natural language processing and vocabulary concordancing to examine the reflections' syntactical features and the profile of lexical items used. The researchers also conducted statistical analysis to compare the output of the limited and extensive CLIL implementations.

4．研究成果

RQ1. In a CLIL higher learning context, does Maker Education provide skill development benefits similar to those found in Maker Education literature? If so, what skills are utilized most often as a result of Maker Education activities?

Once the reflections were coding completed, the researchers were able to look for evidence and trends to indicate skill development in the participants (Figure 1).

Figure 1. Code frequency and range



Reflective statements were the most frequent (518) and covered the greatest range of documents (88.9%). This category of coded segments was further broken down into *general reflective statements* (104, 88.3%), *failure-based reflection* (227, 49.7%), and *success-based reflection* (187, 42.8%). *Cooperation and collaboration* (303, 86.7%) was next most frequent and was broken down further into *within-team collaboration* (184, 38.9%) and *external collaboration* (69, 17.7%). *General statements about collaboration* rounded out this board theme with statements referring to collaboration but specifying the other party (50, 12.0%).

This was followed by challenges or failures (400, 78.9%). Another significant theme was *bridging knowledge* (309, 60.9%), wherein participants referred to other subjects, disciplines, or past experiences. Next, *problem-solving* (200, 44.57%) and *content-area knowledge* (120, 28.29%) were found frequently in the reflections. Two emergent themes, *positive experiences* (268, 56.86%) and *design process* (125, 29.43%), were also prevalent.

The themes found in the reflections, such as *reflection*, *cooperation and collaboration*, and *problem solving*, align with previous literature about the capacity of Maker Education to promote skill development. The addition of language to the making process did not seem to affect the development of these skills. The study underscored the importance of problems and challenges as catalysts for problem-solving, reflection, and bridging knowledge across disciplines. Additionally, emphasis on the importance of process over product coupled with the possibility of failure created real situations that encouraged creative problem solving and highlighted the importance of collaboration and communication.

RQ2. Is there evidence to suggest that Maker Education supports (a) content and (b) language learning in CLIL higher education courses?

The study investigated whether Maker Education supports content and language learning in CLIL higher education courses. Evidence of content learning was found in reflections, with 28.29% of segments indicating direct reference to class content and 60.86% suggesting deeper connections with lesson content.

To investigate the Maker Education intervention's impact on participant language use, the researchers chose a controlled subset of 172 reflections. All participants received the same vocabulary and language instruction then completed the same Maker Education intervention. This subset focused on environmental science and sustainability content through the lens of the right-to-repair movement. Participants received three hours of instruction, including authentic reading texts and vocabulary lists, before engaging in a Maker Education activity—disassembling and repairing electronic devices. This set of reflections was first analyzed using SiNLP software (Crossley et al., 2014) for a simple profile of the linguistic characteristics of the reflections (Table 3). Reflections contained an average of 195.38 tokens, and 114.81 types (TTR = 1.59), with an average of 4.28 letters per word and 15 words per sentence. Next, the researchers used AntWordProfiler (Anthony, 2022) to generate a vocabulary profile of the reflections, look for specialized language connected with the task, and see the degree to which participants used the target vocabulary. This analysis revealed that target vocabulary comprised 4.9% of the total lexical items in participant reflections (*Mdn* = 9 target vocabulary per reflection). Still, range data indicated that lexical choice was contextual to the activity, with words related to the activity appearing in a high range of documents.

Though Maker Education can create situated language learning environments, learners may need to be primed with the necessary language. In our study, participants within the intermediate CEFR B band could use the target language (English) for basic communication, allowing language instruction to focus on specialized vocabulary and phrases. Explicit scaffolding and practice may be needed at lower levels for successful interaction during maker activities.

The Maker Education approach integrated well within the CLIL context, situating language in a context linked to the content—learners connect personally with the content, augmenting the learning process. The approach encouraged decompartmentalization of subject matter, integrating science, design, technology, and language. Maker Education facilitated strong connections between content and learners' schemata, promoting communication and collaboration skill development. Participants used the target language to negotiate problems, navigate the making process, and reflect on their experiences.

RQ3. Is Maker Education a good fit for existing CLIL higher education curricula? If so, how can it best be integrated?

Maker Education activities were seamlessly incorporated into CLIL courses, enabling students to engage in hands-on, motivating learning experiences. *Positive experiences* were reported in 56.86% of reflections, and engagement survey results were overwhelmingly

positive. Positive reception and ease of integration into existing courses, when coupled with evidence showing skill development, content learning, and situated language practice, suggest that Maker Education is suitable for the higher education CLIL context. However, we wanted to know how to implement it effectively, so we examined the differences between the limited CLIL and extensive CLIL implementations.

Due to the non-normal distribution of the data, we used the non-parametric Mann-Whitney U test to analyze the variation between the extensive CLIL and limited CLIL interventions. We analyzed 13 dependent variables, including core constructs and their subcategories. The Mann-Whitney U test allowed us to reject the null hypothesis for five variables: (1) *bridging knowledge*, U = 12444.50, p = .002, r = -.16; (2) *content-area knowledge*, U = 12503.00, p < .001, r = -.19; (3) *design process*, U = 11918.50, p < .001, r = -.23; (4) *cooperation and collaboration*, U = 13344.50, p = .001, r = -.18; and (5) the subcategory of *external cooperation and collaboration*, U = 13265.00, p = .003, r = -.16.

In the extensive group, there was a significantly higher incidence of *bridging knowledge*, *content-area knowledge*, and *external cooperation and collaboration* compared to the limited group. Conversely, the limited group showed higher ranked means in *cooperation and collaboration* and *design process*. These findings suggest that frontloading instruction and content before a Maker Education activity enables students to utilize a rich repertoire of content knowledge and encourages interdisciplinary connections. Conversely, with less content and language knowledge, participants relied more on peer or external support during activities. For CLIL contexts, frontloading content and language instruction appears beneficial, enabling students to apply these resources during maker activities effectively.

However, there are caveats to the approach. When learner autonomy is a focus, there is no guarantee that learners will use the target language. The language used often skews towards the concrete, physical domain, which may make it challenging to encourage the use of abstract concepts or ideas. There is also the issue of cognitive load, which may make it difficult for learners to use the target language as their mental faculties are occupied with the making process. Segmenting the making process into chunks interspersed with dedicated times to discuss the making process and negotiate difficulties may be ideal.

Conclusion

This study shows that Maker Education can benefit higher education, supporting skills development even in contexts different from those typically explored by the literature. Participants engaged in problem-solving, communication, collaboration, and knowledge bridging. The hands-on nature of Maker Education aligns with the ethos of CLIL, creating a context where language and content intertwine. Despite challenges such as material provision and ensuring outcomes, the benefits may justify the preparation needed. Participants navigated science, design, and technology realms using the target language, facing real-world problems and crafting solutions collaboratively. The study suggests that CLIL tertiary contexts may benefit from Maker Education, but more studies are needed to confirm these findings and explore their applicability to different learner groups. Despite challenges, Maker Education could help meet the demands of the 21st century.

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５．主な発表論文等

〔雑誌論文〕　計2件（うち査読付論文　1件／うち国際共著　0件／うちオープンアクセス　2件）

１．著者名 Ryan Lege	４．巻 5
２．論文標題 Making and Language: Maker Education and Situated Vocabulary Acquisition	５．発行年 2023年
３．雑誌名 教育イノベーション研究センター年報	６．最初と最後の頁 98-105
掲載論文のDOI（デジタルオブジェクト識別子） なし	査読の有無 有
オープンアクセス オープンアクセスとしている（また、その予定である）	国際共著 －

１．著者名 Ryan Lege, Phillip Standlee, Jonathan McNair, Euan Bonner, Erin Frazier, Sam Godin	４．巻 33
２．論文標題 Reconceptualizing the English Lounge with Maker Duty	５．発行年 2021年
３．雑誌名 神田外語大学紀要	６．最初と最後の頁 309-326
掲載論文のDOI（デジタルオブジェクト識別子） なし	査読の有無 無
オープンアクセス オープンアクセスとしている（また、その予定である）	国際共著 －

〔学会発表〕　計3件（うち招待講演　0件／うち国際学会　1件）

１．発表者名 Ryan Lege, Erin Frazier
２．発表標題 Advancing Language Learning for the 21st Century using Maker Education
３．学会等名 CALICO 2022（国際学会）
４．発表年 2022年

１．発表者名 Ryan Lege, Euan Bonner, Erin Frazier
２．発表標題 Hands-On Design Tasks for Integrating Content, Language, and Skills Development
３．学会等名 JALT 2022
４．発表年 2022年

１．発表者名 Ryan Lege, Andria Lorentzen
２．発表標題 Maker Conversation: Hands-on activities for social language practice
３．学会等名 JASAL 2022
４．発表年 2022年

〔図書〕　計0件

〔産業財産権〕

〔その他〕

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６．研究組織

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７．科研費を使用して開催した国際研究集会

〔国際研究集会〕　計0件

８．本研究に関連して実施した国際共同研究の実施状況

共同研究相手国	相手方研究機関