

Integrating Active Learning and Analysis with Near-Infrared Spectroscopy into Virtual English for Specific Purposes Classes

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Abstract— This study introduces an effective online course design adopting active learning and analysis with Near-Infrared Spectroscopy from a brain science and educational technology perspective to meet English for Specific Purposes Curriculum goals for Japanese engineering students and develop global engineers. Before introducing active learning into English for Specific Purposes classes, an experimental study using Near-Infrared Spectroscopy was conducted to clarify preferable combinations of learners’ characteristics and the pedagogical methods. Based on its results, project-based learning was successfully integrated into face-to-face English for Specific Purposes classes as active learning. This new attempt obtained favorable outcomes, enhancing learners’ collaborative skills, and critical and creative thinking. The results show the effects of adapting active learning strategy into the online English for specific purposes classes.

Keywords- *Near-Infrared Spectroscopy (NIRS); English for Specific Purposes (ESP); Active Learning (AL); project-based learning (PBL); online*

I. INTRODUCTION

English for Specific Purposes (ESP) is often defined as English language teaching which is designed to meet specified needs and related in content to particular disciplines, occupations, and activities of learners. ESP also requires careful research and design of pedagogical materials and activities for an identifiable group of adult learners within a specific learning context [1]. According to a theoretical framework of ESP, Needs Analysis-based researches and experiments had been conducted to develop global engineers. In previous studies, the outcomes revealed that many Japanese engineering students tend to be anxious about expressing themselves in English and less motivated to improve their communication skills [2][3]. To solve these concerns, several studies have been implemented integrating data from brain activities and the pedagogical concept to verify an effective ESP course design [4][5]. Before the COVID-19 pandemic, Active Learning (AL) had been introduced as in-person ESP classes and obtained favorable outcomes, such as, raising students’ motivation and attitudes to engage tasks and activities [6]. In this study, to develop an effective online ESP course design, AL was embedded into ESP classes using a virtual meeting platform.

Section II briefly introduces pedagogical methods related to brain science and educational technology. In Sections III and IV, implementing AL strategies in ESP classes is described, and Section V presents the conclusions and future remarks.

II. APPLYING BRAIN DATA TO COURSE DESIGN

In the field of educational technology, Aptitude Treatment Interaction suggests that pedagogical strategies work effectively when the instructions match to the learners’ aptitudes [7]. Recently, brain activity has become subject to monitoring by technologically innovative instruments, such as Near-Infrared Spectroscopy (NIRS) [8]. NIRS is recognized as a practical non-invasive optical technique to detect hemoglobin density dynamics response during functional activation of the cerebral cortex [9]. Accordingly, to develop an effective ESP course design, Aptitude Treatment Interaction based experiments using NIRS data have been conducted to examine the interaction of learners’ aptitudes and instructions in previous studies. In these experiments, participants’ listening proficiencies were adopted as learners’ aptitudes, and silent and oral reading were adopted as instructions to investigate the difference of brain activity during practice to verify effective AL strategy [6].

III. ACTIVE LEARNING METHODOLOGY

Recently, The Ministry of Education, Science and Technology attempted to integrate AL methodology to Japanese education. Thus, AL frequently appears in university syllabi and textbooks used by instructors. Methodologically, there are various terms used to describe AL, including: student-centered learning, collaborative learning (team, peer or group learning), and participatory learning in which students are actively engaged in building their understanding of facts, ideas, and skills through the completion of instructor- directed tasks and activities [10]. Moreover, AL has a number of benefits for students, for instance, raising motivation, engaging in tasks and activities and, in higher order thinking skills such as synthesis, and evaluation, and avoiding passive listening.

IV. APPLYING PROJECT- BASED LEARNING

Acquiring English communication skills is a critical need so as to develop global engineers who can work in the real-world environment and exchange ideas globally. Thus, in this study, Project-Based Learning (PBL) is implemented to develop global engineers. PBL is a pedagogical approach encouraging learners to gain knowledge and skills through engaging tasks; therefore, in this study, adapted material was task-based themed, in addition to applying a communicative approach to improve communication skills. The material is ideal for building English communicative fluency and confidence while developing practical workplace knowledge and skills. Especially through this material, learners imagined that they were new interns at a fictional company where they worked together in small teams to perform a series of linked tasks and projects to develop new products such as SWOT analysis and focus group. Therefore, integrating PBL material enabled the learners to develop fluency and confidence in speaking, listening, reading, and writing via highly-contextualized tasks (as shown in Table 1), including discussions, presentations, self and team evaluations, report writing, and viewing video instructions using online meeting platform. In addition to PBL, assignments for improving reading and vocabulary-building skills were given to the learners. Due to the COVID-19 pandemic, PBL had to be integrated into virtual ESP classes. This online ESP classes conducted for about 150 engineering students at Japanese technical colleges in 2020 and 2021.

TABLE I. PBL: PROJECT SEQUENCE.

Stage 1	Inters join the company orientation
Stage 2	Teams prepare new product proposals
Stage 3	Teams discuss and evaluate product proposal
Stage 4	Teams perform market research on the product
Stage 5	Teams plan a multimedia advertising campaign
Stage 6	Interns prepare a resume and interview for a job

Table 2 shows the implementation of PBL strategies in ESP classes with Zoom. Having learners in shared small groups could foster a deeper level of connection and communication through breakout rooms.

TABLE II. PBL: INSTRUCTIONSL SEQUENCE USING ZOOM.

Intro- duction and review (10min.)	Viewing video instruction (10min.)	Giving instructions for small group activities (15 min.)	Breakout rooms' activities (30 min.)	Feedback and review (15 min.)
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However, breakout rooms' activities enabled learners to engage with small group discussion, presentation, and evaluation, offering opportunities for deeper learning in context and for the development of valuable skills tied to learners' career readiness, instructors' involvement, and support visiting each breakout room is essential. To clarify the effect of integrating AL into virtual ESP classes, the learners were required to submit weekly reflection papers and a final reflection report, to conduct a Can-Do statement

and take The Test of English for International Communication (TOEIC) at the end of the semester.

V. CONCLUSION

Learners' feedback gathered from the reflection papers was mainly positive. Significant improvements were also noted in students' competence to communicate using engineering terms and capability of team-work skills to attain the tasks such as SWOT analysis and focus group. Accordingly, it can be said that continuously implementing an AL pedagogical framework into virtual ESP classes could result in effective outcomes and enhance and promote learners' qualities as global engineers. This study and its findings could be relevant to online AL classes. There are still some limitations that need to be addressed. In further study, the latest data of NIRS should be integrated to clarify the effectiveness of AL.

ACKNOWLEDGMENT

This study is supported by a Grant-in-Aid for Scientific Research (C) (No. 18K00788), from 2018 to 2022.

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