

Science Classes in English at a Super Science High School: Biology Classes on Cells and Chemistry Classes on Chemical Bonding

Sithabile NDELU*, Jordao Laurindo MANUEL*, Benedita Paula BILA*,
Mohammad Salim HAKIMZAI*, Ragahi BAZIE*, Junyi ZHANG*,
Letian ZHU*, Xinchao LI*, Ting LI*,
Yuan ZUO*, Yukio TERASHIMA**, Kiyoshi TAKEDA***

(Keywords: Science class in English, Biology, Chemistry, Cells, Chemical bonding, High school)

1 Outline of the science classes

The improvement of science education is one of the important issues for international cooperation in education over the world. Science should be shared and exchanged among different countries and cultures since they deal with universal natural phenomena and logics as well as mathematics. In the Field of Mathematics and Science Education of Global Education Course of Graduate School of Naruto University of Education, staffs and students have engaged in developing effective teaching materials and methods for improving worldwide science and mathematics education.

As a part of the educational activities, we performed Biology and Chemistry classes taught in English by international students of Naruto University of Education for Japanese 10th and 11th grade students on November 11th in 2022 at Tokushima Prefectural Tomioka-nishi Senior High School selected as a Super Science High School (SSH). This school has been committed to “International Science Study” so far to develop human resources who can contribute for both regional and global fields with an international sense. In collaboration with the high school, we have designed and conducted educational activities that allow Japanese high school students to learn science in English with a different approach from the usual one for foreign students to improve their teaching skills effectively. Through these classes, most of the high school students understood not only the learning contents properly but also the usefulness of learning science in English, and the international students developed effective teaching materials and methods overcoming the language barrier. As a result, effective educational outcomes were achieved by both sides. In this paper, we report the details of these classes.

2 Biology classes

2.1 Background

Science and mathematics are major branches in the economic and cultural development of nations as they improve the quality of life in populations (Burthorn, 1995). This world of scientific civilization leads to the most effective educational systems to provide opportunities for knowledge sharing in science and mathematics. There is also a growing shift from learning English as a foreign language to using English as a Medium of Instruction (EMI) for school subjects (Chapple, 2015).

In this context, the international students at Naruto University of Education prepared and taught Biology classes for Japanese 10th and 11th graders during the combined courses of “Science Education Cooperation Lesson Study” and “Teaching Materials Development Research”.

2.2 Learning topic and objectives

Science classes in Japan associates theory and practice, and the contents of cells are taught at the 8th grade with the spiral approach. The contents cover the study of cellular organelles using a microscope and explaining their functions. This allows the student to better understand the functioning of the organisms.

One of today’s trends for countries is to exchange experiences. Through this activity, learners can gain experience, such as in methodologies, contents, language and culture among other aspects. There are many benefits of using EMI in Japan such as cross-cultural understanding and increasing global awareness (Chapple, 2015).

The main objective of this class was to exchange experience using EMI to give Japanese students a biology class. Although Japanese students study English for 6 years as one of mandatory

* Global Education, Human Education, Graduate School of Naruto University of Education

** Advanced Practice of School Education, Naruto University of Education

*** Human Education, Naruto University of Education

subjects in secondary school, they often demonstrate little success with it when they enter higher education” (Sakae, 2017).

2.3 Teaching plan and practice

We conducted two Biology classes of one single period (50min) for 1) 28 students of the 11th grade of the general course and 2) 40 students of 10th grade of the math and science course with the same learning topic. The lesson’s topic was “Cell”, and students identified the cellular organelles using a microscope and mentioned their functions. Table 1 indicates the lesson plan for the Biology class. The class started by connecting the learner’s prior knowledge to the class. This was achieved through using the question-answer method, as they already knew the topic from their previous classes.

According to Chapple (2015), there are so many factors that should be taken into account, when conducting an EMI lesson, such as how English will be used, the amount of content and the representation that will be utilized. During the class preparation, we had to consider how to reduce the content and how to simplify the language use. After the class, a post-questionnaire survey was conducted for students using an online response form to evaluate the educational effects of this class.

2.4 Results and discussion

The teacher guided the practical activity by demonstrating the practical to the students, and then they followed the activity by observing the plant cell, drawing a microscopic picture of plant cells on a A3 paper and presentation took place. Figure 1 shows several scenes of the group works. This class provided a moment of anxiety and vision for the future of education for the international students, but one special experience was how monolingual Japanese-speaking students interacted in a class

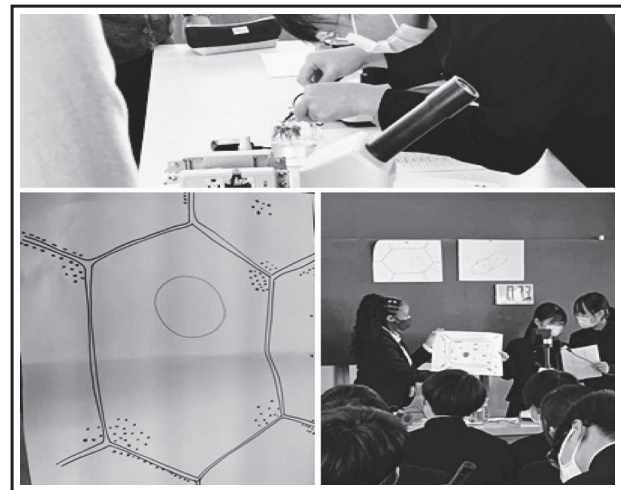


Fig.1 Scenes of students’ activities in the biology classes

taught in a foreign language.

Figure 2 shows the results of the post-questionnaire survey of the students. A total of 28 students out of 68 (28/68 = 41%) responded to the survey. The accumulated data showed that 92.8% of the students enjoyed using English during their classes. There were 85.7% students who agreed with a view that they would like to learn science in English. The research findings demonstrated that the students had an interest in learning science in English. According to the data presented, about 71.4% of the students would like to have more Biology classes in English, revealing that there is an intrinsic (individual) motivation to learn the language, that is, they see themselves speaking English in their adult life.

There were 89.3% students who agreed with a view that they were able to observe the cells, and more than half of students disagreed with the following two items: the teacher talked fast, and I could not understand the teacher. The results said that

Table 1 Teaching plan for the Biology classes

Duration/ Part of the class	Activity of teacher	Activity of students	Teaching strategy
5 min Pre-requisites	- What are the characteristics of living things? - Give examples of living things? - What is the smallest unit of living things?	-Answer to the questions.	Classroom discussion
5 min Development Introduce to the class	-Ask questions about the microscope as an introduction to the observation activity: -What do we use the microscope for? -Can someone demonstrate how to use a microscope?	-Answer the question. -Observe and listen attentively.	Question and answer
18 min Activity	-Give instructions. -Demonstrate the practical activity to the students.	-Read the activity in law voice. -Observe the plant cells, and draw.	Group work Observation
17 min Evaluation	-Give orientation for the presentation of the group work. -Explain the function of a few organelles (Nucleus, Cytoplasm, Chloroplast, Cell wall and Cell membrane).	-Two groups will share their work and the other groups will comment on the presentations.	Presentations Peer review
5 min Conclusion Summary	-What organelles did you identify in the plant cell? -Why are plant cells green?	-Students will state what they learnt during the class.	

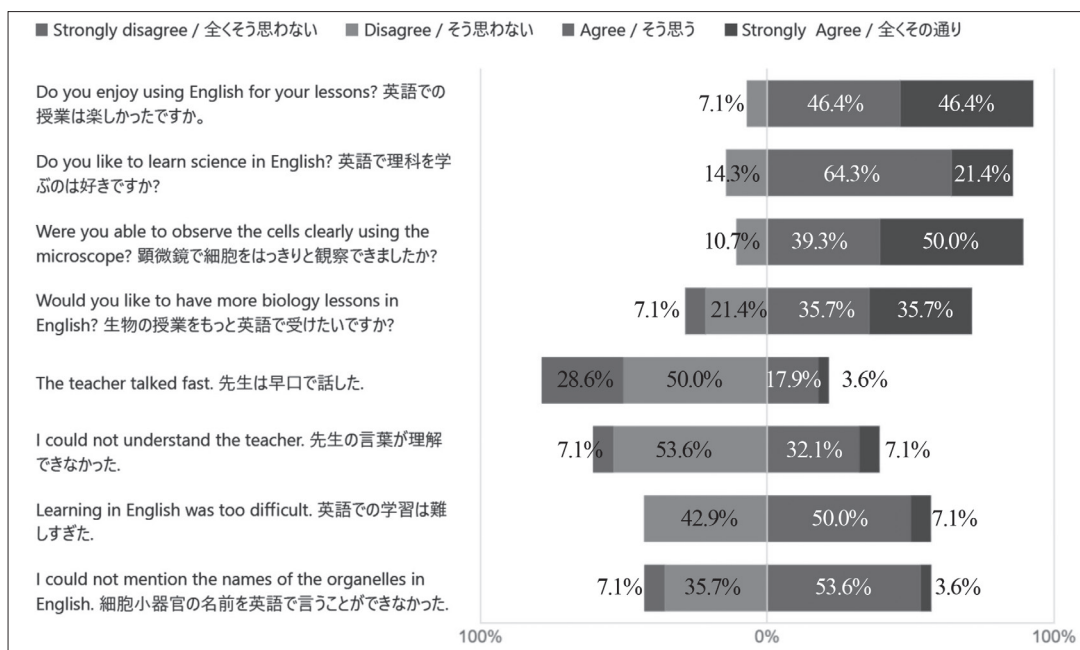


Fig. 2 Results of the post-questionnaire survey on the Biology classes (n = 28)

most of students were able to understand the teacher’s instructions even in English. However, there were 57.1% students who agreed with an impression that learning in English was too difficult for them. There were also 57.2% students who agreed with a view that they could not name the organelles in English. There can be other factors of this difficulty such as the presence of a new person in front of them and the non-regular use of English that can explain the fact that learning in English is too difficult. According to a study conducted by Chapple (2015), students that lack the ability to keep up with a class tend to have trouble comprehending the class, hence classroom participation decreases. The classroom is composed of diversity, the students process information differently, and their learning pace differs. Learning has distinct stages of perception and execution, in particular, when it comes to learning a language.

2.5 Summary

Learning in English prepares the students for their adult life. The place of teaching allows the students to communicate in English at any circumstance. The students could participate in the class, but they were a little shy, possibly because it was their first contact with the international student who play the role of the teacher. Hence, we suggest that this activity could be done more often. International students could familiarize themselves with the Japanese teaching style and experiment teaching tools used in such an excellent high school.

There is a dearth of research on the appropriate pedagogical and theoretical frameworks to implement EMI in Japan. There is also a lack of researched methods for EMI lesson delivery

(Chapple, 2015).

A teacher-centered classroom approach does not provide a chance for students to gain confidence and improve their communication skills. This approach limits the opportunity for students to broaden their understanding during the learning process. Therefore, there is a need to introduce innovative teaching methods that will promote students’ engagement. Teachers should not only depend on talking but also they introduce a variety of teaching methods that will promote students’ participation (Chapple, 2015).

3 Chemistry classes

3.1 Background

Chemistry is a part of science subjects and has the curriculum of various educational levels, and the understanding of it goes through handling various theories and practical applications. The great diversity of molecules that atoms form by bonding together constitutes a large field of study, so that it gives students a great complexity. Chemical bonding plays an extremely important role in the process of molecules junction and understanding them helps students view other chemical concepts better.

3.2 Learning topic and objectives

At the beginning of our class about chemical bonding and its related topics, we had the student have two introductory questions: “How are substances constituted?” and “What will you call the last layer (shell) of an atom?” For an active learning and engaging all students in classroom activities, the class

management strategy was based on group work with individual activities (6 groups of 6 or 7 students). For this particular class, our main objective was to identify the different types of chemical bonding. We conducted two Chemistry classes of one single period (50 min) for 1) 40 students of the 11th grade of the general course and 2) 40 students of 11th grade of the math and science course with the same learning topic.

3.3 Teaching plan and practice

Introduction: The class comprised briefly introduction which included outlining the structure of an atom, prerequisite knowledge, a motivation and encouragement, and the presentation of the objectives together with the key questions distributed to each student in each group. The lesson plan of the Chemistry classes and the worksheet for students are shown in Table 2 and Figure 3, respectively.

Table 2 Teaching plan for the Chemistry classes

Time	Students' activity	Teachers' activity	Assessment
5 min	Introduction (Review) concept of atom, valence layer: <i>-How are substances constituted?</i> <i>- What will you call the last layer (shell) of an atom?</i>	-Review with the students about the concept of atoms in a general way. -Divide the class into groups for further discussion.	Questions and answers
40 min	Development -After revising the atom concept, teacher will introduce the <i>purpose of the class.</i> <div style="border: 1px solid black; padding: 5px; text-align: center; margin: 10px auto; width: 80%;">Identify the different types of chemical bonding</div> <i>-What do we call the set of atoms?</i> <i>-How do atoms come together to form molecules?</i> <i>-Using the molecular structures, identify the different types of chemical bonding and explain it.</i>	-Teacher will guide all the activity, checking the groups work and organizing all answers and content.	Group work Presentations Peer review
5 min	Conclusion or summary -Make a summary of what they solved in the classroom.		

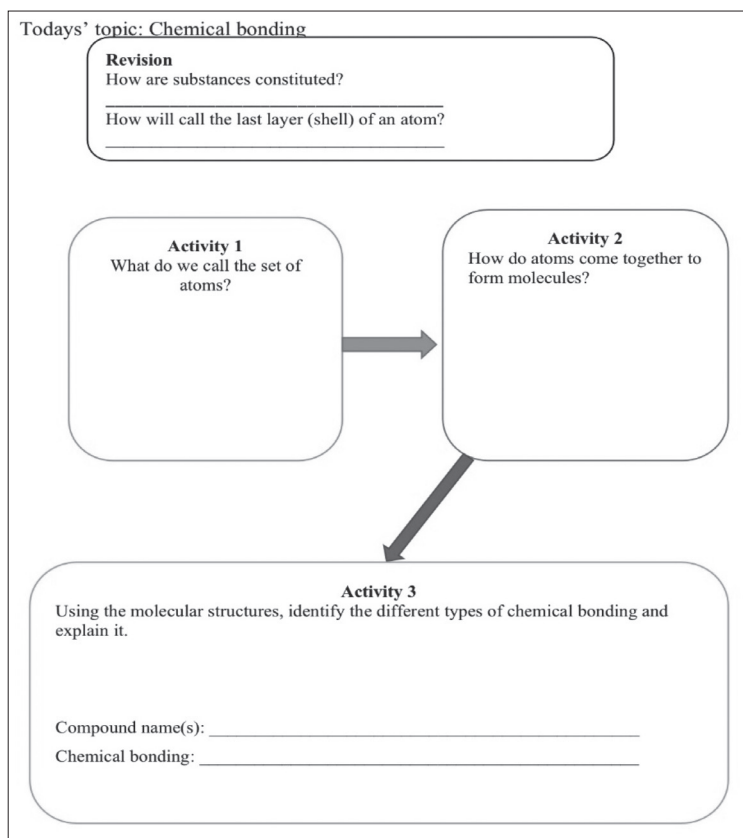


Fig. 3 The worksheet of the Chemistry classes

Activity 1: Our first activity started with a short and meaningful discussion about the atoms, material structures and layer of an atom in each group of students, then the properties of elements and compounds are determined by their structures. The simplest structural unit of an element is an atom. Atoms are very small. Obviously, the smallest particle of a substance that has all of the physical and chemical properties of that substance. Molecules are made up of one or more atoms. Therefore, students discussed the set of atoms and its chemical name that is called molecule using all of their previous knowledge and understanding of atoms and their combinations.

Activity 2: Our second activity was about “how do atoms come together to form molecules?”. A molecule is the smallest thing that a substance can be divided up into. It is made up of two or more atoms held together by chemical bonding. These atoms can be of the same kind, or of the different kinds. Clearly, approximately everything is made up from molecules, including the air we breathe in, the food we eat, and even the water we drink. These different elements’ atoms come together to form molecules by sharing their electrons. In order to answer the question in second activity, the students discussed it among each other, then each group shared their understanding about the above question. Different students from every group had

their individual answer.

Activity 3: The third activity aimed to make the molecular structure visual, help students identify different types of chemical bonding, understand and explain them. Based on this, we divided students into three parts groups to build a molecular model that involves covalent, ionic and metallic bonding. From the first group to the fourth group, the covalent and ionic bonding molecular models will be assembled. Figure 4 shows several scenes of students’ group works. Taking account of the short time and the difficulty, the fifth group and the sixth group had a plan to only established the two molecular models, one of which consists of element Fe and the other of element Au. We used molecular model props to build non-metallic bonding molecules. For metallic bonding, we used foam boards, colored foam balls and toothpicks to let students form and display the description of electron movement. Such activities could help students understand the combinations for the bond among and functions of atoms more intuitively. After completing the establishment of the molecular model in activity 3, students needed to write the names of the elements of the completed model and the type of chemical combination. Each group then publishes and shares their model. Figure 5 shows typical examples for ionic bonding models which were made by



Fig. 4 Scenes of students’ group works

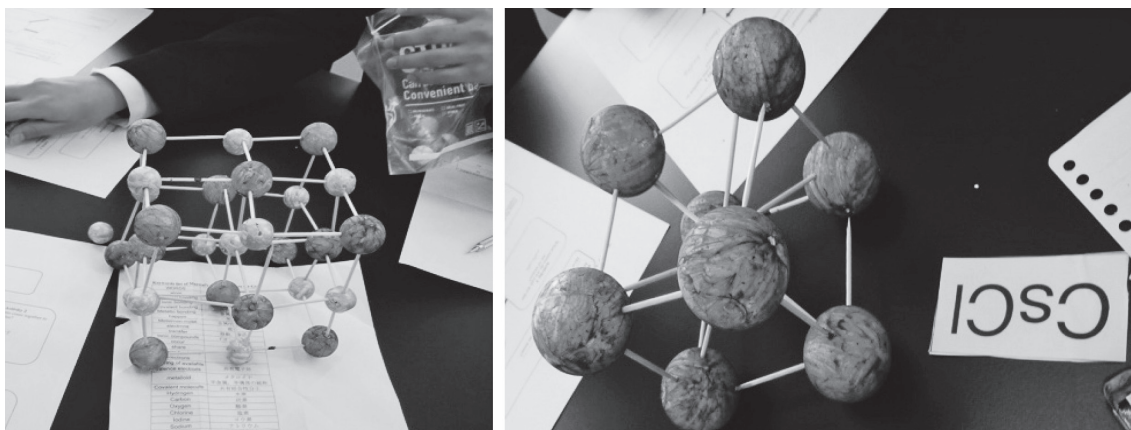


Fig. 5 Chemical bonding models completed by students

students. We hope that students could understand and participate in the teaching through interesting forms, improve their interest in exploring the wonderful chemical world, and realize the close relationship between chemistry and life.

3.4 Evaluation and limitation

We translated the English keywords into Japanese one and distributed them to students before the class and we tried to make it easier for students to understand the teaching content. However, in the actual class, we found that the language is still the biggest barrier between teachers and students. This was the first time that students exposed themselves to pure English teaching. Although students had already mastered the knowledge of the class, most students could not interact with the teacher because they were not familiar with the English teaching mode. However, while the group work progressed, and the students were allowed to use their computers for

translation. Most students interacted with their teachers as much as possible and positively carry out the group activities. Other teachers played a great role in class. They also helped the students to understand the class content as much as possible. Since the students needed time to understand what the teacher said, they failed to finish the first class behind schedule. In the second class, we summarized the experience of the first class and asked the other teachers to help the students understand the question and complete the class activities. The last was completed on time. Despite the presence of the language barrier, most students understood and enjoyed the class in English and then they integrated into the class in English.

After the class, a post-questionnaire survey was conducted of students using an online response form to evaluate the educational effects of this class. A total of 20 students out of 80 (20/80 = 25%) responded to the survey. The results of the survey are shown in Fig. 6. The students faced some problems

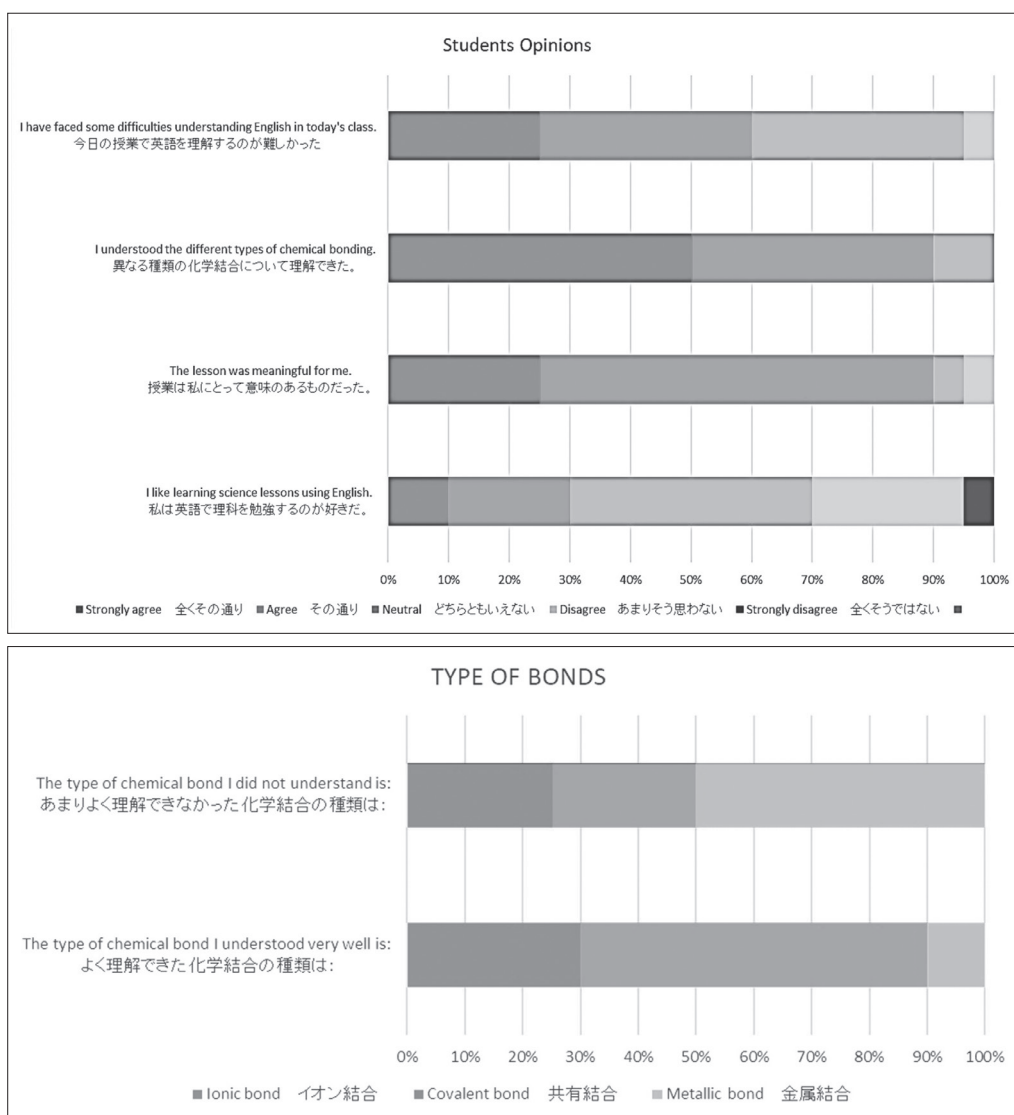


Fig.6 Results of the post-questionnaire survey on the Chemistry classes (n = 20)

to understand science in English because they used only Japanese in their usual classes. However, they understood clearly the different type of chemical bonding with the help of the activities in progress. The class was important for students who are introverted to answer in English to learn science in English.

Metallic bond was a little bit difficult for students to understand because of some complexity as it appears only between metallic elements. And covalent bonding was understood by the students because of the easy and well-known compound that the students can form molecular models or bonding models.

3.5 Conclusions

In the preparation process of this course, we tried to combine the Angolan teaching model with the Japanese one to achieve a helpfully comprehensive effect, and our main goal was to identify different types of chemical bonding. Although there was a language barrier in the class, and the students were not used to the class in English, the students positively participated in the classes through the group activities, and the class content went smoothly with the help of the teachers. This course was a challenge for both teachers and students, but we were very glad to complete this challenge together with high school students, which is undoubtedly a good teaching experience.

Acknowledgements

Thanks to the support of the staffs of Tomioka-nishi Senior High School, the conditions of the classes were perfect and the results were as expected. After the teachers' instructions, the students were able to conduct some experiments and activities independently, and they diligently participated in the course in English throughout. We would also like to thank Prof. Yoshihiko YONEZAWA of Naruto University of Education for his useful advice on microscopic observation of cells.

References

- Burthorn, R., *The role of sciences in our society*, Stanford Linear Accelerator Center, Washington, DC, 15p., 1995.
- Chapple, J., Teaching in English Is Not Necessarily the Teaching of English, *International Education Studies*, 8(3), pp. 1-13, 2015.
- Sakae, S., Emerged challenges for English education in Japan: The emotional baggage of language learners, *Journal of Applied Language Studies*, 11(1), pp. 5-11, 2017.