Development and Practice of the Rotating Duty System in Robot Contest Study

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Abstract- In this study, the authors employ the topic of "Rotating Duty System" with the goal of developing collaborative learning in robot contest study, and examine how the system enhances language activities in technology education in Japan. This system is a learning system where a project is jointly carried out by a group, the group representative changes depending on the meeting content and each member of the group is given responsibility. In addition, this system intentionally and systematically incorporates "language activities" such as discussion or summarizing in text, etc. Reviewing students' reports and scrutinizing outcomes of the practical education, we concluded that this system is noticeable effect from the perspective of discussion as well as the effect of allowing students to understand their role and take responsibility. Furthermore, comparing it with basic theory of pedagogy, we inferred that this system can be applied to all technology education in activities where a project is carried out collaboratively as well as robot contest study.

Keywords – Rotating Duty System, collaborative learning, Language activities, Technology education

I. INTRODUCTION

In Japan, each teaching department has been seeking "language activity enhancement" under the new Japanese Course of Study (2008) [1]. Accordingly, it has become necessary to intentionally and systematically incorporate effective language activities into the learning activities of each subject. The language activities required in each subject by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) refer to intellectual activities (thinking and logic), communication and sensitivity and emotion-based activities based on the role of language (2011, Teaching case studies on language activity enhancement) [2]. Depending on the above perspective, it is suggested that development of effective collaborative learning is necessary for "language activity enhancement" in technology education as well as each subject.

In this paper, the authors propose the Rotating Duty System (hereafter "RD system") for developing collaborative learning in robot contest study, and as a method of enhancing "language activities in a technical field (2008, Course of Study Commentary, Technology and Home Economics) [3]". The RD system is system where a project is jointly carried out by a group, the group representative changes depending on the meeting content and each member of the group is given responsibility. In this study, the authors develop the RD system and practice the System in junior high school in Japan. In addition, the authors examine the educational effectiveness of this system by reviewing outcomes of the practical education and students' reports. Furthermore the authors consider how the system enhances language activities in all technology education, as well as robot contest study, by comparing it with basic theory of pedagogy.

II. PREVIOUS STUDIES ON COLLABORATIVE LEARNING

Here the previous studies on collaborative learning in basic theory of pedagogy. According to Vygotsky's (1926) [4], in his theory named "zone of proximal development", collaborated learning is important for enhancing students' ability. In his theory, the zone in between the "stage that can be reached on one's own" and the "stage that be reached with the aid of others" is called the "zone of proximal development" and he advocates the importance of learning

within the zone. Bruner (1885) [5] suggests that cooperative learning methods improve problem-solving strategies because the students are confronted with different interpretations of the given situations. Slavin (1989) [6] contends, for effective collaborative learning, there must be "group goals" and "individual accountability". According to Totten et al. (1991) [7], shared learning gives students an opportunity to engage in discussion, take responsibility for their own learning, and thus become critical thinkers. Other researchers [8-10] also indicate affirmative points of view in collaborative learning as a learning strategy.

Here the previous studies on collaborative learning and language activities in technology education are summarized. Kawamata et al. (2007) [11] clarified the effect of collaborative learning through an "information sharing system" in a robot contest. An "information sharing system" was confirmed as a highly effective system where group members could share information such as ideas and learn from and respect the ideas of other group members. However, although language activities are effectively utilized, this system focuses on group interaction and not on the individual activities carried out within the group. Yamamoto et al. (2007) [12] confirmed an increase in student learning motivation with the incorporation of collaborative learning in a class for the creation of a program to control the robot. However, Yamamoto et al also identified the challenges in collaborative learning and stated "further examination is required regarding the roles within groups and means of supporting group activities". While there is a great deal of additional research that has demonstrated the effectiveness of collaborative learning, we have not come across any research concerning a group system that actively seeks to increase the language activities of each individual student. Furthermore, the majority of language activity-related studies are focused on lesson improvement; this includes research related to teaching methods, ideas and materials such as the research of Furuya (2010) [13] and Mochizuki et al .(2010) [14]. These studies are assumed to pursue curriculum improvement and corresponding lesson development. As a result of having summarized previous studies, we have not come across any study which has points of view like the RD system. From the above, we were able to confirm the meaning of this study.

III.RD SYSTEM OVERVIEW AND EDUCATIONAL EFFECTIVENESS

A. RD system overview –

Here the RD system in the author's practical example of a robot contest is summarized. Discussion between group members is essential in a learning situation such as a robot contest where a group is required to produce one piece of work. However, in reality "students who leave the work to others", "students who don't participate in discussion" and "students who try to do all the work themselves" always emerge. The RD system has been developed as a method of solving these problems. The definition of the RD system is shown in table 1.

Table -1 RD system definition

1) Three members per group
2) Members hold meetings during learning activities comprising three different perspectives
3) Members take turns acting as chief and presiding over the meeting

The RD system is a system where each group member is a chief with a differing perspective and they take turns (rotate) presiding over the meeting depending on the purpose of the meeting. The reason groups are limited to three members is because in the author's experience if a group contains more than three members, members often split into two groups within the group. In the author's practical example, each member of the group was given a different perspective – design, production or maneuvering. For example, a system design as seen in figure 1 was created with student A as the "design chief", student B as the "production chief" and student C as the "maneuvering chief".

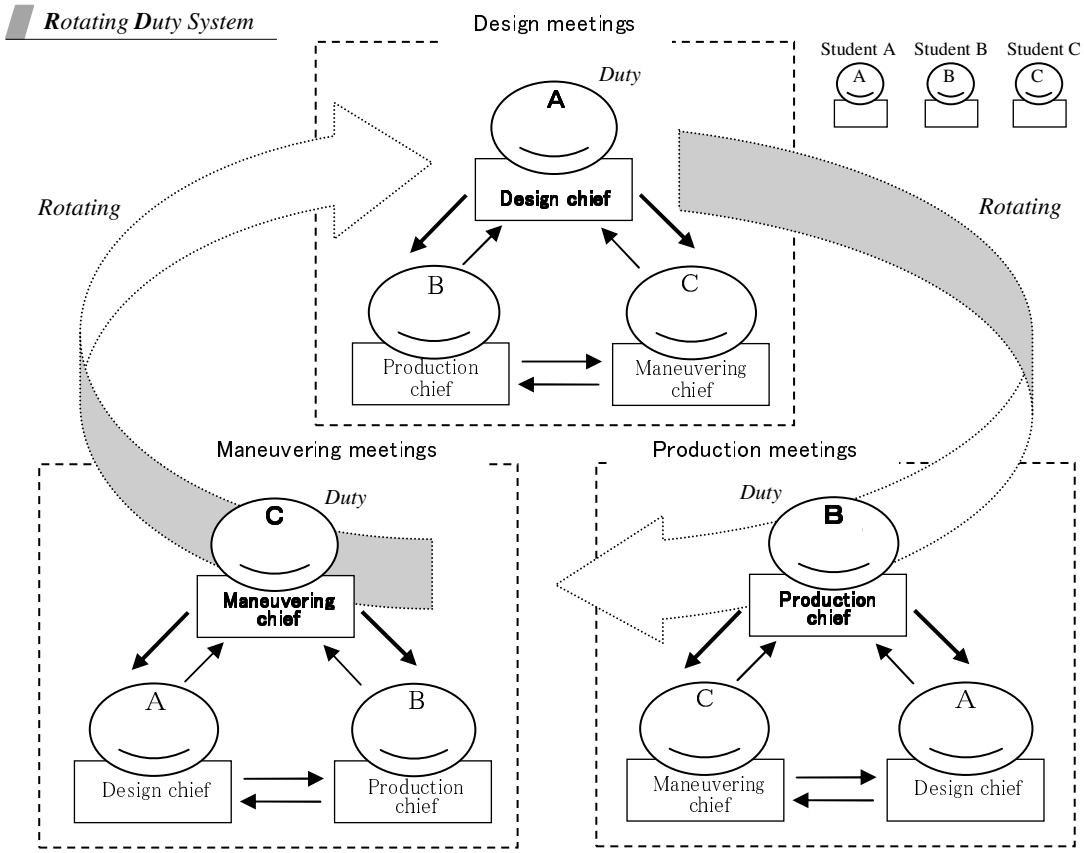


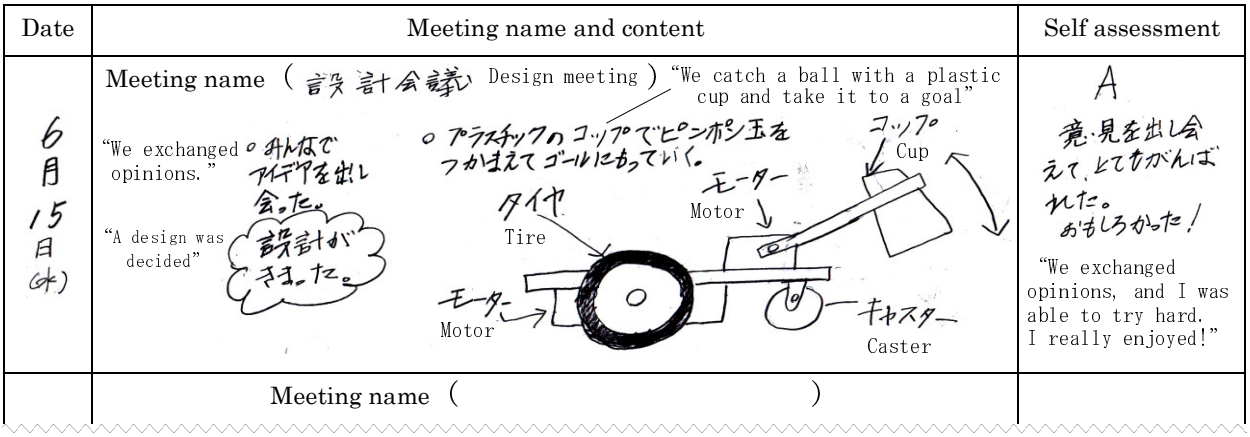
Figure 1. RD system design

The design chief holds design meetings, collects opinions from group members and carries out the design. Design change meetings are usually held frequently as there are many initial design flaws and many design changes and improvements are carried out. Once the robot reaches the final stage, the design chief often reflects the opinions of the maneuvering chief.

The production chief holds production meetings where working arrangements and the division of labor is discussed and ensures each group member is involved in the production.

The maneuvering chief holds maneuvering meetings where discussion is held regarding how the robot should be maneuvered efficiently to achieve success in the contest. These meetings are practical meetings where strategy is discussed. Demands for improvement from the person controlling the robot at these meetings are often carried over into design and production meetings.

In the early stages of learning, students are be instructed to hold at least one 5-10 minute meeting per class in order to form a habit of holding meetings. If group activities are progressing smoothly, the group members are left to decide when they hold their meetings. All group members submit a report after a meeting is held, an example of which can be seen in figure 2. The design chief holds design meetings, collects opinions from group members and carries out the design. Design change meetings are usually held frequently as there are many initial design flaws and many design changes and improvements are carried out. An example of a students' work is shown in figure 3. Once the robot reaches the final stage, the design chief often reflects the opinions of the maneuvering chief. A scene of meeting is shown in figure 4, and a scene of robot contest is shown in Fig. 5.



Date	Meeting name and content	Self assessment
6月15日(水)	Meeting name（設計会議 Design meeting） "We catch a ball with a plastic cup and take it to a goal" "We exchanged opinions." ○みんなでアイデアを出し会った。 "A design was decided" 設計がきまった。 ○プラスチックのコップでピンポン玉をつかまえてゴールにもっていく。 コップ Cup モーター Motor タイヤ Tire モーター Motor キャスター Caster	A 意見を出し会えて、とてもがんばれた。おもしろかった！ "We exchanged opinions, and I was able to try hard. I really enjoyed!"
	Meeting name（　　）	

Figure 2. Example meeting report

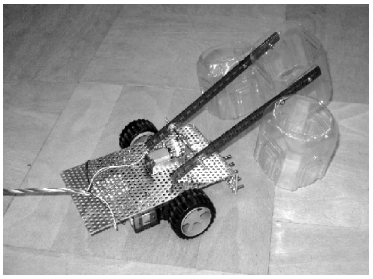


Figure 3. An example of student' work

Figure 4. A scene of meeting

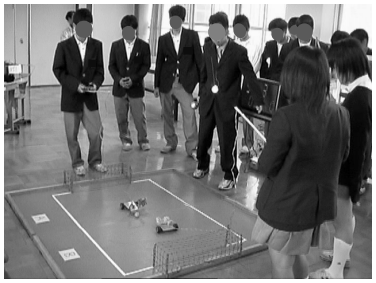


Figure 5. A scene of robtt contest

B. Outcome of the Educational practice –

The SIR curriculum was practiced on 30 third-grade students of X Junior High School, X City, Japan in 200X. 30 students were then asked in a questionnaire survey. 4 items of the survey are shown in Table 2, and outcomes of them are shown in Fig. 6.

Table -2 Items of the survey

Q.1: Was the cooperation between members achieved?
Q.2: Was the exchange of opinions generated actively?
Q.3: Was a good idea created?
Q.4: Were you able to play your role?

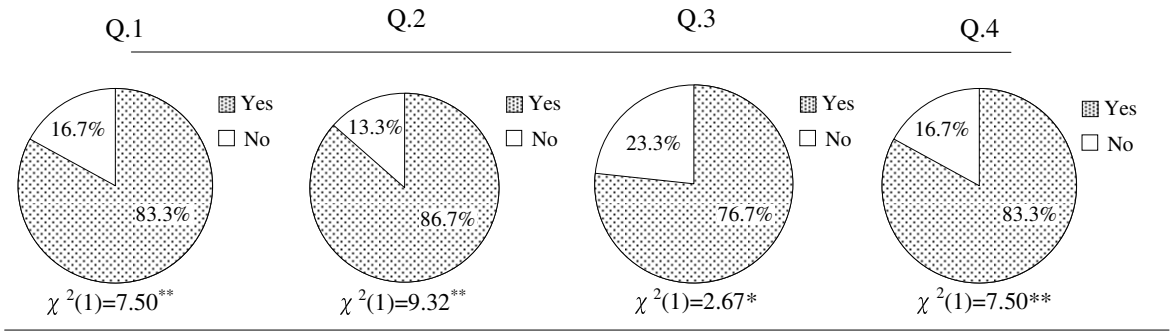


Figure 6. Outcomes of them survey

As a result of the questionnaire, many students showed an affirmative answer in all items. In addition, students gave feedback after the exercise such as "we were able to create good ideas because everyone played a role and took part in discussion", etc. and the RD system was often seen to nurture students' abilities to devise and create as a result of them learning from each other. It was confirmed that a highly complete robot and fulfilling robot contest could be achieved through repetition of the meeting-design-production-practice series with the RD system. Furthermore, feedback often seen before the incorporation of the RD system such as "we spent an hour just looking at the materials", "xxx was just sitting there not doing anything" and "xxx did whatever he wanted and wouldn't let us do anything", etc. was significantly reduced. The RD system had a clearly noticeable effect from the perspective of discussion as well as the effect of allowing students to under-stand their role and take responsibility

IV. Enhansement of Language Activities under the RD system

A. *Comparison with MEXT's report –*

In their report (2008, Improvements of Course of Study in kindergartens, elementary schools, junior high schools, senior high schools and special needs schools) [15]. MEXT indicated six essential learning methods in language activities to foster students' ability to think, judge and express themselves, etc. These methods are listed in table 3.

RD system intentionally and systematically incorporates "language activities" such as discussion or summarizing in text, etc. From this perspective, it is believed that the RD system fulfills all the "six essential learning methods in language activities" displayed in table 3. However, table 3 consists of prerequisites only and effective language activities aren't necessarily developed spontaneously by merely satisfying these. Accordingly, it is necessary to intentionally and systematically incorporate effective language activities into the learning activities of each subject.

Table -3 Learning methods in language activities

1. Expressing feelings experienced
2. Accurately understanding and conveying facts
3. Interpreting, explaining and applying concepts, rules and intentions, etc.
4. Analyzing, evaluating and disserting information
5. Creating and implementing a concept in response to a problem and assessing and improving it
6. Communicating ideas to one another, developing one's own ideas and a collective opinion

The RD system successfully incorporates a "trigger" to enhance teamwork as all group members are given the role of presiding over meetings as the chief and contains elements whereby individual language activities are actively implemented.

B. *Comparison with basic theory of pedagogy –*

Under the RD system, the group representative changes depending on the meeting content and each member of the group is given responsibility. From this perspective, it is believed that RD system can be applied to learning situations where a project is carried out collaboratively. In addition, it's easy to establish mutual support and learning because the goal of each group member is the same. For example, even with an incompetent leader, it's

necessary for all group members to provide support in order to achieve the group's goal. This feature is common to Vygotsky's "zone of proximal development" theory. In Vygotsky's theory, as it was previously mentioned, the zone in between the "stage that can be reached on one's own" and the "stage that be reached with the aid of others" is called the "zone of proximal development" and he advocates the importance of learning within this zone. According to Vygotsky (1978) [16], in his theory of the zone of proximal development, students are capable of performing at higher intellectual levels when asked to work in collaborative situation than asked to work individually. Reviewing the above effectiveness that feedback often seen before the incorporation of the RD system such as "xxx was just sitting there not doing anything" was significantly reduced, it is believed the RD system is highly likely to provide dynamic learning to individual students in their "zone of proximal development". Features of the RD system are also common to Slavin's perspective, as it was previously mentioned, that there must be "group goals" and "individual accountability" for effective collaborative learning. Reviewing the above effectiveness that feedback often seen before the incorporation of the RD system such as "we spent an hour just looking at the materials" was significantly reduced, it is believed the RD system is highly likely to develop effective learning under tractions of "group goals" and "individual accountability". Comparing the RD system with basic theory of pedagogy, it is suggested that the RD system can be applied to all technology education in activities where a project is carried out collaboratively as well as robot contest study.

C. Possibilities of the RD system –

The possibilities of the RD system were examined in light of the findings of practical education, MEXT's language activity requirements and basic theory of pedagogy. From the above observation, the results can be summarized by the following three points:

1. The RD system can be applied to activities where a single project is jointly carried out
2. The RD system has noticeable effects from the perspective of discussion as well as the effect of allowing students to understand their role and take responsibility.
3. The RD system provides dynamic learning to individual students in their "zone of proximal development" and develops effective learning under tractions of "group goals" and "individual accountability"

As a result of having considered RD system from a viewpoint of the language activities, it is suggested that the RD system has various possibilities of teaching method in technology education.

V. CONCLUSION

In this paper, the authors employ the RD system for developing collaborative learning in robot contest study, and as a method of enhancing "language activities in a technical field". Reviewing students' reports and scrutinizing outcomes of the practical education, the authors concluded that the RD system is noticeable effect from the perspective of discussion as well as the effect of allowing students to understand their role and take responsibility. Furthermore, comparing it with basic theory of pedagogy, we inferred that this system can be applied to all technology education in activities where a project is carried out collaboratively as well as robot contest study.

Based on the above, we have been successful in explaining educational effectiveness of the RD system. However, the outcome has not enough evidence. It is necessary to carry out practical activities utilizing the RD system in various works in technology education and undertake detailed verification based on data in order to further clarify these possibilities. This is something we wish to pursue in the future. We want to clarify the problem in next paper.

ACKNOWLEDGMENT

The authors would like to thank Dr. Fumitaro Sekine of Kyoto University of Education for his matchless technical competence and his unfailing loving assistance. In addition, the authors wish to thank Takemi Mizukami of Hokkaido University of Education for his personal qualities and his friendly support. Thanks also to Toshihide Enomoto of Kyoto City Board of Education for his great instruction in technology education. This paper is based on the note "The development of language activities to enhance learning in a robot contest study, proposal of RD system" (Fujikawa, S., 2011) appearing in a "Kinki edition of document collection according to the areas in the subject of technology and home economics" (KAIRYUDO Pub Co., Ltd., pp.6-7) and reorganized adding new points of view. The authors would like to thank Harumichi Hidaka of KAIRYUDO publishing for their support

concerning to write this paper. Finally, the authors are grateful to teachers of Kyoto city and students of Kyoto municipal junior high schools, for assistance with educational practices.

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