Emerging Role of Primary Leader in Group Interaction with Mechanics Problems During Upper−level Mechanics Course

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Abstract: According to social constructivism, group interaction is very important when students construct their knowledge. Many researchers have developed methods of teaching on the basis of group interaction because they recognized the importance of group interaction. There are a large variety of issues related to group interaction including group size, the gender and ability composition of groups, seating arrangements, textbook use, gestures, and role assignments. However, research on group interaction in science learning is still insufficient. In this study, we focused upon the emerging role of the primary leader. We investigated the primary leader's diverse role when students are solving mechanics problems. The participants were one group composed of three students in an upper-level mechanics class. To analyze these students' group interactions, their verbal interactions during meetings were videotaped and audiotaped during one-semester period. We also conducted interviews with the three students and analyzed their reports. As a result, we could find a special student who had the role of primary leader. We could also find the leader's three different leadership roles in different problem situations by inductively; explainer, facilitator and evaluator. Group interaction had different aspect according to the different role of leaders. The group interactions were the most active when the leader played the role of facilitator.

Key words: primary leader's role, group interaction, mechanics problem solving, explainer, facilitator and evaluator

Ⅰ. Introduction

Social constructivists argue that knowledge is constructed by individuals through social interaction and experiences with the physical environment (Driver and Oldham, 1986). Thus, group interaction has been one of important methods constructing student knowledge from constructivists' point of view. They have thought "learning communities can be critical in helping the less able student learn thinking patterns that the more able student possesses"(Hassard, 2005). We can also explain the importance of group interaction using the ZPD (Zone of Proximal development) concept suggested by Vygotsky (Vygotsky, 1978). According to Vygotsky's theory, "a child's social partner is critical to the zone of proximal development"(Driscoll, 2005) and students' ZPD could be extended by group interaction.

Many researchers have developed methods of teaching on the basis of group interaction, such as cooperative learning, because they recognized an importance of social and group interaction (Aronson and Partnoe, 1997; Johnson and Johnson, 1999; Kagan, 1994; Slavin, 1980). Recently, group interaction is also being emphasized in physics education through teaching methods such as Peer Instruction developed by Mazur (Mazur, 1997). Researchers have interested in group interaction not only because of the effects of group interaction (Acar and Tarhan, 2008; Heller *et al.*, 1992), but also because of the dynamics of group interaction (Bianchini, 1997; James, 2006). However, research on group interaction in science learning is still insufficient. There is a little study on investigating the inner process of group interaction (Enghag *et al.*, 2007).

There are many factors which seem to influence group interaction including group size (Alexopoulou and Driver, 1996), the gender (Alexopoulou and Driver, 1997) and ability of

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composition of groups (Lim *et al.*, 1999), seating arrangements, role assignments, textbook use, and group testing as well as individual testing (Heller and Hollabaugh, 1992). Many researchers have grown interested in these factors for the purpose of improving group interaction. Among the various factors, some researchers have become particularly interested in the role of members in group interaction because the interaction is social process. Some researchers classified group members' roles into two categories such as the learner and the learning facilitator (Horn, 1998), other researchers classified group member's roles into three categories such as the learner, the learning facilitator, and the leader (Stamovlasis *et al.*, 2006).

Although there are many roles in group interactions, participation among group members is not equal (Bianchini, 1997). The strong influence of leaders has led to interest in their roles during group interaction (Li *et al.*, 2007; Richmond and Striley, 1996; Yamaguchi, 2001). Stamovlasis et al. (2006) define a leader as follows: "The leader in a working group is defined as the person who takes the initiative to propose an answer or explanation, and often leads the discussion" (p.556).

However, the researchers do not agree an idea that a particular person is nominated as the permanent leader (Stamovlasis *et al.*, 2006). In similar aspect, Li *et al.* (2007) focus on leadership behavior – such as turn management, argument development, planning and organizing, topic control, and acknowledgment – instead of the leaders themselves, as they think leadership is distributed among group members. They use the term 'primary leader' to refer to the group member who expresses the greatest amount of leadership behavior. The primary leader's role is important because the primary leader's leadership style determines the nature of the group interaction (Richmond and Striley, 1996). Although they suggested interesting idea, they thought the primary leader's role was fixed when once a group is composed.

Group interaction has also been researched in domestic studies recently (Kim *et al.*, 2006; Lee and Kang, 2008; Lee *et al.*, 2008; Ryu *et al.*, 2008; Seong and Choi, 2007;). The researchers conducted diverse contexts of experiments using everyday materials (Kim *et al.*, 2006), scientific inquiry experiments (Seong and Choi, 2007), MBL experiment (Ryu *et al.*, 2008), SWH Application (Lee and Kang, 2008) and body physics activity (Lee *et al.*, 2008). They focus on students' verbal interaction and try to find out what is going on in a process of group interaction. However, there is a little research on changing of group interaction process in various situations. In many cases, the studies just classify a category of verbal interaction and count the frequency.

At the preliminary of this research, we intended to know diverse group interaction in different situation. Thus we just observed the group interaction at first. However in the process of this study, we could observe that one student wielded major influence on the group interactions. After we found that fact, we observed the group interaction focusing on the student. We referred to the student as the primary leader, using the term according to Stamovlasis's and Li's definition. The purpose of this study is to show how the role of the primary leader emerged during the group interaction process and how the leader had influence on group interaction. Note that we simply indicate other members except the leader as just member though leader is also the member of group.

This study has limitation, because we observed just one group. Thus, we need to investigate the roles of leaders and members in diverse contexts and groups. We also have to investigate a leader's role in wide variety of contexts such as problem solving situations and concept discussion situations. We need to perform research in diverse group settings. Although we focused on the leader's role in this study, to study members' roles would be also important in understanding group interaction.

Ⅱ. Method and Research Context

Our research context was an upper level mechanics course where second grade university student attended. To emphasize group activity, we organized an upper level mechanics class into eight small groups. These groups were consisted of three or four members each, and were assigned a group homework problem every week for the purpose of solving the problem by each group. All of the students in the class were encouraged to discuss the group homework problems with their group members. Thus they had a group homework meeting once a week. The course had eight students who were retaking the course. As these students had more experience than the others, we assigned one of them to each group. Other students were assigned randomly into each group except focus group.

We focused on one group among eight groups in the class. Three students, all male, in the class participated in our study: John, Tom, and Chally (the names are fictitious). We selected them with purposeful sampling method (Patton, 1990). We conducted several tests because we did not know about our students at first. We conducted three tests; motivational beliefs (Pintrich and De Groot, 1990), scientific attitude (Kim *et al.*, 1998) and Maryland physics expectations survey (Redish *et al.*, 1998). From the result of the tests, we composed focus group with high motivational beliefs points and diverse scientific attitude points. We expected that students with high motivational beliefs were participated in group meeting actively and we wanted to know an influence of group meeting on students' scientific attitude. Although they were participated in group meeting actively, we could not find an influence of group meeting on students' scientific attitude.

Table 1 shows all of group meetings in which we collected data. The date category contains the time of data collecting, the problem category contains the topics of the given homework problems, and time category contains the time elapsed to collect data. We videotaped six offline homework meetings and the students behaved naturally in the videotaping situations. The students also had two online homework meetings which they organized to meet their own needs. The students have all their meeting out of their regular lecture time. During observation in offline meeting, we tried to be a passive observer not intervening in group interactions, which was conceptualized by Spradley (Spradley, 1980).

We also conducted individual interviews with three participants, which included their opinions about such topics as group meetings, their thoughts about the other members, and the effects of the group discussions. The average interview time was about an hour each student. All of the data was audiotaped, transcribed and analyzed. As supplemental data, we collected each participant's weekly reports which was developed by Etkina (Etkina, 2000). We also collected special reports which we named 'story of My Mechanics' reports, in which the students described their

Table 1

The group meetings in which data was collected

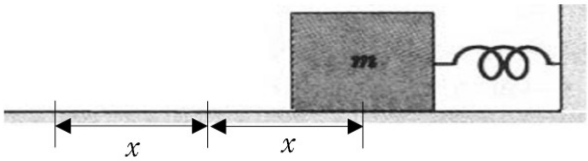
Meetings	Date	Problems	Time
Offline meeting	'08.03.12	Car in an inclined plane	1:24:59
	'08.03.19	Pull the self	39:48
	'08.03.26	Spring	37:26
	'08.04.16	Satellite	44:06
	'08.05.21	Spring-two body	59:45
	'08.05.28	Conveyor belt	44:26
Online Meeting	'08.04.13	Spring-jump	·
	'08.05.18	Attraction of two planets	·

Table 2

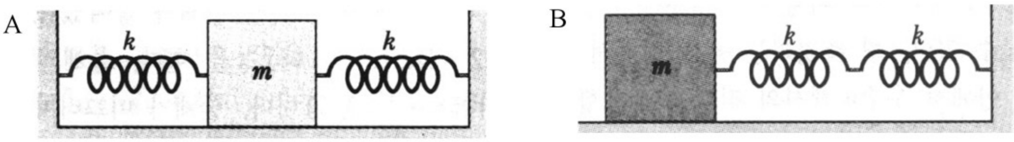
The three mechanics problems among the nine problems

Spring Problem

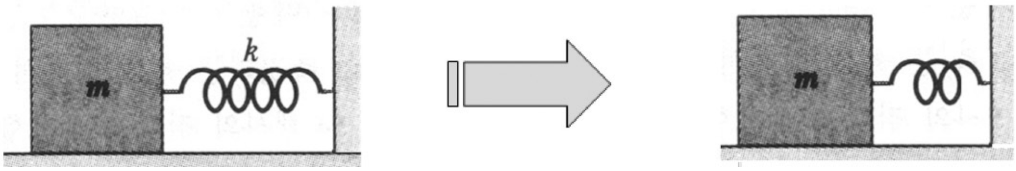
① A body with a mass of m is attached to a spring. Compare following physical amounts when the body is pulled x and 2x from equilibrium point: Amplitude, Period, Frequency, Maximum kinetic energy, Maximum potential energy.



② Find the period of system when the body oscillates in the below spring.



③ A body with a mass of m is attached to a spring and is oscillating. When you severe half of the spring and oscillate again, what's the period of the spring, comparing with the initial state?



Satellite Problem

Water leans toward the outside when you rotate a water jar. However, a man in a satellite would not lean toward the outside as the satellite rotates the earth. Explain the reason for these two different situations.

Spring-two body Problem

① A body with a mass of m is attached to a spring vertical to the surface of the earth. What is the equation of motion and period of the body?

② Two bodies with a mass of m1, m2, respectively, are attached to either end of a spring and horizontally oscillate. What is the equation of motion and period of the system if the spring constant is k?

③ Is it possible to explain the difference of ① and ②? Can you explain the result of ① using the result of ②? Explain the reason for your answers in detail.

learning environment, their difficulties in learning freely, as well as a questionnaire about the group meetings. The questionnaire was composed of questions such as how students feel about group meeting and if they conduct group meeting well. From these diverse data sources, we tried triangulation to improve reliability (Merriam, 1998; Mills, 2003).

In this study, we could observe that one student have major influence on the group interactions. We call the student primary leader and three different leadership roles were found in different problem situations by inductively. Researchers discuss the validity of the categorization repetitively. The three different leadership roles were embossed in three problems: the 'Spring

Problem', the 'Satellite Problem' and the 'Spring-two body Problem'. Thus, we show our research result through the three problems. Table 2 describes these three problems. The Spring Problem and the Spring-two body Problem are quantitative problems. The Satellite Problem is a qualitative problem.

Ⅲ. Result

Here, we present the result of this study as follows. First, we describe the general characteristics of each group member. Next, we describe the diverse roles of the primary leader in different situations. We will discuss the meanings of the roles of the primary leader in discussion section.

1. The Leader and Other Members during Group Interaction

The primary leader of this group was John. Note that we did not set the role of primary leader. We just observed the group meeting, and the primary leader's role was founded. The leader had showed different leadership styles in different problem situations. The different situations were occurred naturally and we did not intend that. Although the other members did show a little leadership, we just focused on John's special leadership.

John is male and he was twenty two years old at the research context. He had much knowledge of physics, and he expressed his thinking very logically and clearly. Although he was the youngest of the three group members, he participated in the group activity actively. In many cases, the other students relied on John's explanations. As we can see from next interview results, the members recognized the special role of John in group interaction.

> *In many aspects, John had good ideas about physics. (……) In many cases, he formed a conclusion and solved the problems. (Chally's interview, 7/2/2008)*

> *John organized his thoughts about the problem very logically. (Tom's interview, 6/25/2008)*

Tom is male and he was twenty six years old at the research context. He was the oldest of the three group members. He sometimes show regulate action, giving directions such as "Hurry up, we do not have enough time." Tom frequently asked the other students for explanations, because he had no convictions about his own ideas and he thought the other students were better able to solve the physics problems than him.

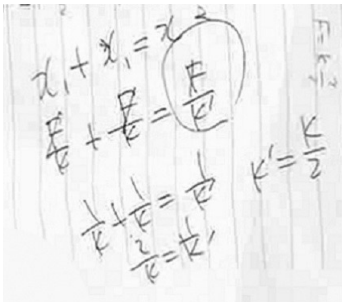
Chally is male and he was twenty four years old at the research context. Chally was a very careful student. He did not express his own thoughts until he believed that his thinking was clear. He thought he did not understand other students' idea well and he organized his thinking slowly. However he suggested interesting idea to group when he have the idea. Now, we describe the primary leader's role in the process of group interaction.

2. The Leader as an Explainer

Next is an example of group interaction in the Spring Problem when the leader has the role of explainer.

1	Tom	Hey, hurry up!
2	Chally	John! I think you need to solve the problem.
3	Tom	(Tom reads the stated problem)
4	John	Then, the amplitude is twice as large, the period is the same, the frequency is the same, and the maximum kinetic energy is four times as large.
5	Tom	That's O.K. Let's finish.
6	John	Yeah. (Laugh)
7	Tom	I agree.
8	John	Why don't you solve the next problem?

9	Tom	Do you agree?
10	Chally	Yes.
		......
178	John	The period of this one becomes $\sqrt{2}$ times more.
179	Tom	What?
180	John	The period becomes $\sqrt{2}$ times more.
181	Tom	Why?
182	John	I think the spring constant is k/2. The left spring stretches half and the right spring stretches half. The total force is half in comparison with the spring, which is alone. Wait...
183	Tom	I think it is solved by the energy method. $2\times\frac{1}{2}k(\frac{1}{2}x) = k'\frac{1}{2}x^2$ when this spring stretches by half. Thus k' is $\frac{k}{2}$ from energy relation.
184	Chally	When force is acting... and... force is F and F...
		......
224	John	Wait. Wait. Wait. The problem can be solved by this numerical formula. (John calculated and wrote down the right answer.)



225	Tom	Yeah. Good.
226	John	Yeah.
		......
236	John	Yes. I think it's good.

(Spring Problem)

In Turns 1~10, the students solve Spring Problem-①.* In Turns 178~236, the students solve Spring Problem-②-B. As we can see above, the group solves Spring Problem-① easily. However, they have some trouble with Spring Problem-②-B. They think that solving Spring Problem-②-B is important because Spring Problem-③ can be solved by the same method used for solving Spring Problem-②.

In Turn 1, Tom suggests that the others try to solve the problem quickly. Tom sometimes showed this kind of regulating behavior. In Turn 2, we can see the role of John when nobody has any concrete idea about the problem. The other members rely on John's idea because they wanted to know the first step toward the solution of the question. In Turn 4, John suggests solution of the problem. However we think that Turn 4 might have had negative effects on the developing members' ideas. John did not give an opportunity for the members to think about the solution. In Turns 5, 7, 10, Tom and Chally simply agree with John's idea. They do not suggest any ideas or ask any questions about John's idea. Interestingly, Tom and Chally do not initially propose any idea, even though it is a simple problem for them.

In Turn 178, John proposes an answer to Spring Problem-②-B without explanation. In Turns 179 and 181, Tom asks for greater explanation from John because he does not understand the problem by himself. In Turn 182, John proposes an initial idea about the problem. Although we think that the statement is relevant, he wants more time to find the relevant explanation of the problem. In Turn 183, Tom proposes another idea to solve the problem. However, the other students are not interested in his solution. In Turn 184, Chally wants to propose another idea, but he cannot explain this new idea because it is not fully shaped. After Turn 184, John starts solving the problem by himself instead of participating in group interaction. Eventually, in Turn 224, he solves the problem by the numerical method. In Turn 225, Tom simply agrees with John and in Turn 236, John judges that the solution is sufficient.

In this problem situation, John has relevant knowledge about the subject. Thus, he explains

*1) Note that Spring Problme-① means the first part problem of Spring Problem in Table 2.

his idea to the other members. In this situation, the leader has the role of explainer. Among the group meeting cases, this kind of situation is the most frequent.

Although the other members have some of their own ideas about the problem, they cannot well express nor effectively develop these ideas. In this situation, the group member's interactions are limited and they just respond to the leader's opinion with responses such as "yes" or "no". The other members do not have sufficient opportunities to express their own opinions.

However, when a leader has the role of explainer, the other members had the benefit of being able to listen to right explanation and the leader had the benefit of being able to elaborate his thinking by explaining his answers to others. Even though the interaction is constrained, this situation is preferable to simply relying on the teacher's explanation because the students can express their own ideas in their own words. There would have been no interaction if none of the members had any idea about the given problem.

It is interesting that one of the group members later explained that he wanted John to have the role of explainer.

> *I intended for John to suggest his ideas first. In many cases, he had a good idea, so I just wanted to listen to his idea. Then, if it was right, everything was okay. We gained time by this approach. (Tom's interview, 6/25/2008)*

We think that this kind of student attitude is similar to teacher's behavior which is conceptualized as 'the optimization of teacher's behavior' (Cho, 2001). In the Cho's research situation, teachers show the best appropriate act in the given education environment. Students as well as teachers have intention and reason to behave.

3. The Leader as a Facilitator

We can observe another of the primary leader's roles in the group interactions during the solving of the Satellite Problem. In this problem, John has right idea and Chally has the wrong idea about the problem. However, Chally does not change his opinion easily.

> *In the Satellite Problem, a magnitude of the centrifugal force and the centripetal force are the same. But in the water jar case, the centrifugal force is larger than the centripetal force. So, the water is leaning to the outside. (Chally's first idea about the problem)*

Next is an example of the group discussion during the solving of the Satellite Problem.

142	John	OK. Now do not think about velocity and central force. Why do you think that it is leaning to one side?
143	Chally	That's why the centrifugal force is larger than the centripetal force.
144	John	What do you mean by that?
145	Chally	The force acting on the outside is larger than the one inside.
146	John	Then, how about the water jar?
147	Chally	In the water jar case, um, if...
148	John	OK. Then water?
149	Chally	The water jar, the water jar, um... velocity. um... the water jar and the velocity.
150	John	Wait. If the centrifugal force is larger than the centripetal force, why does the water not move outside? Is it possible the water has a circular motion when they move outside?
151	Chally	It could be possible, because of the fast velocity,
152	John	Why? Why does the fast velocity matter? If the centrifugal force is larger than the centripetal force, the water would move outside. But why does the water not move outside? Why? The earth pulls the water inside. And the force is centripetal force. So, it rotates the water.

153	Chally	I see. The water jar is pulled, but the water is not pulled. So, the water gets out of the water jar.
154	John	Yes! I said the same thing. In the satellite case, everybody is pulled, so nobody gets out.
		......
160	John	If we could bind every water particles with a rope and rotate them, but they are not leaning to one side, relatively.

(Satellite Problem)

In this situation, the two students are certain in their thinking at first. Thus, they assert their opinions throughout the group meeting. At the beginning of the discussion, the two students strongly disagree with each other, just insisting on their own idea. After a while, John proposes a question to Chally instead of insisting on his own idea. In Turns 142, 144, 146, 148, 150, we can see that John proposes a question to Chally. In Turns 147 and 149, Chally does not express his idea well.

The reason for John's question is not to ask for information. The reason is to clarify Chally's own idea in greater detail. By doing so, John wants Chally to recognize that he has the wrong idea. This interaction represents the highest level discussion skill that we could find in this study. In the following excerpt from the interviews, John explains his intention during the Satellite Problem discussion:

> *I knew the answer, and expressed my opinion, but Chally did not agree with me. So, I expressed my argument in another way in order to persuade him. I considered how to make him understand. The reason for proposing questions was to elaborate Chally's thinking and to find his wrong idea by himself. I thought he had to find why his idea was wrong by himself. Although the other students proposed the correct answer to him, he had to organize his thinking by himself. (John's interview, 7/2/2008)*

This kind of interaction is the only one situation among all of group meetings. John knows the answer to the problem, but he does not explain his thinking in Turns 142~150. Instead, he proposes a question in order to persuade Chally more effectively. John's question helps Chally realize his mistake and turn to the right answer. As we see in Turn 153, Chally finally reaches the right answer through his own expression. In this case, the leader's role is that of a facilitator because the leader helps to facilitate a member's reasoning process in reaching the right answer.

The two students' discussions were meaningful to not only Chally, but also to John. As a result of the discussion, John manages to express his understanding through rewording (Turn 160). It is very interesting that John expresses his idea with everyday language. This expression is easily understood by not only to John, but also to Chally.

In the following excerpt from the interviews, Chally explains what he thought of John's final expression. Chally thought that it was the most effective interaction situation within all of group meetings.

> *I usually could not understand the other students' ideas. However, John's final explanation was so concrete that I could understand his idea for the Satellite Problem. It was the first time where I learned something from others during the group meetings. (Chally's interview, 7/2/2008)*

4. The Leader as an Evaluator

We identified a third kind of role for the leader during the solving of the Spring-two body Problem. The students had no difficulty in solving Spring-two body Problem-①. However, they had difficulty in solving the Spring-two body Problem-②. In this case, Tom and Chally thought that the spring could be divided into two sides and that the problem could be solved by considering only one side of the center of mass of the spring. This was a very interesting idea because the problem could be solved using the idea. They proposed the idea to John. However, John disagreed with their idea without providing any concrete explanation of his opinion. The next excerpt is an example of the two students' ideas and the responses of leader to them during Spring-two body Problem.

156	Tom	We should consider only the right side of the center of mass of the spring only. In this case, we do not need to consider the left side.
157	John	Why?
158	Tom	I think here is just a fixed wall...
159	John	Why do you think that?
160	Tom	The center of mass does not move because the right side of the spring is pulling as much as the left side of the spring is pulling.
161	John	That is impossible.
		(Silence for about ten minutes)
		......
185	Chally	To solve the length of it is to solve the center of mass.
186	John	Yeah.
187	Chally	So, we set the center to the zero point and set this as x1, L, x2, separately. Then we can solve the center of mass.
188	John	Yeah.
189	Chally	Then we can think about the problem according to the center of mass and we can divide the spring constant. Then if the spring constant is k...
190	John	But why should we divide the spring constant?
191	Chally	We would be able to say m1x1=-kx1 if the spring constant can be divided.
192	John	But, first, we should confirm if they can be divided.
193	Chally	Can we use this idea if that possible?
194	John	But, I think it is not possible.

(Spring-two body Problem)

In Turns 156, 158, and 160 Tom suggests his idea to John. In Turns 157, 159 and 161, however, John disagrees with Tom based on his intuition without providing any concrete evidence. After Turn 161, the students do not talk to each other about ten minutes. They solve the problem individually without any interaction.

In Turns 185~194, a similar process is produced between John and Chally. In Turns 190, 192, and 194, John disagrees with Chally in a resolute manner. After Turn 194, the students do not propose another idea for solving the problem.

We think John's disagreement disturbed the continuing of the other members' discussion. In this problem, Tom and Chally did not develop their ideas, because John disagreed with them. John simply disagreed with the other members and offered no alternative idea about the topic. Thus, throughout the group meeting, they could not reach a conclusion. It is interesting that, although two members had similar idea, they were unable to deepen each other's ideas without the leader's agreement.

We have to distinguish John's form of expression in this case from that in the satellite case. Although the form of John's question was similar in both of the two cases, the purpose of the question was different between these cases. In the Satellite Problem case, John knew the answer, and he helped Chally come to know the answer through Chally's own thought processes. In contrast, in the Spring-two body Problem case, John just expressed his intuition about the other's ideas.

Unlike the other problem situations, John did not possess sufficient knowledge to solve the problem. Thus, he could not suggest any idea to the other members. Instead, he evaluated whether or not the others' ideas had value. When the leader estimates other member's ideas, the leader plays the role of what we call the evaluator.

Although the group could not solve the problem, John thought the problem was very interesting. From this next interview excerpt, we can see that John liked the fact that the problem was challenging.

It was a very interesting problem. Although it was an obscure and difficult problem, through the group discussion, I developed curiosity toward and interest in the problem. (John's interview, 7/2/2008)

Ⅳ. Discussion & Implication

As a result of this study, we identified the existence of a primary leader in a group. We simply observed the group interaction at first. After we found a leader, our attention was focused on the leader's role because the group interaction had different aspects when the leader took on different roles. Indeed, the leader had a major influence on the group interaction. From observations of the group interactions, we identified three different roles for the primary leader by inductively: explainer, facilitator, and evaluator. The group interaction was the most active when the leader played the role of facilitator.

Richmond and Striley (1996) has reported there are three types of leadership styles: inclusive, persuasive, and alienating. They found different leadership styles in six groups and one group's leader show just one leadership style. However in this study, one leader can show diverse leadership styles in different problem situations.

In this study, the group interaction was the most active when the leader had the role of facilitator. Through the process of questioning and answering, the member had to think about what they knew and did not know. As a result, the member could elaborate their thinking more clearly. This process also affected the leader. In the process of argument, the leader was stimulated by the member to elaborate his ideas.

Relevant discussion and argument, which promoted group interaction, were induced when the leader had the role of facilitator. We think an importance of the role of facilitator is to lead relevant discussion and argument. This result is consistent with previous research explaining the role of argument. For instance, Newton et al. (1999) argued that argument plays a central role in effective science education. Chinn and Anderson (1998) insisted that "Discussions featuring reasoned argumentation among students have the potential to increase students' motivation and to help students learn to reason well" (p.315). An effect of argument is also revealed following interview result.

Group meetings were helpful for me. Especially, it was helpful listening to other member's idea or having an experience other members refute my suggestion. (Chally's interview, 7/2/2008)

From the result of the Satellite Problem, we need to investigate a role of refuter. Although the role of refuter was not embossed in our research situation, it seemed to have a special role in the Satellite Problem. The role had influence on meaning making process.

Members had the opportunity to propose some ideas during the Satellite Problem discussion and the Spring-two body Problem. The Satellite Problem used in this study sufficiently allowed the other members to be able to propose their own ideas. Although Spring-two body Problem was a difficult problem, the members were able to propose their own ideas because the leader did not propose any idea for solving the problem.

It is important to give opportunity to all students talking about science (Lemke, 1990). Thus, we should guarantee members' equal participations (Seong and Choi, 2007). Thus, teachers have to make an effort to offer a relevant problem. If the problem is too difficult to discuss with each other, the students cannot suggest relevant ideas and one student might dominate the group interaction. If a problem were to be overly easy, however, the students would not have the opportunity to think about the problem deeply. It is important to develope group problem suitable for group interaction not only level of the problem but also form of the problem.

We can see the leader has major influence on the group interaction from the role of evaluator.

In the spring-two body problem, other members did not develop their idea because of the leader's evaluation, though the idea was possible idea to solve the problem. The role of evaluator in this study was undesirable because the leader evaluate other member's idea from his feeling. Because evaluation potentially involves the students' feelings, we need to guide students when they evaluate someone else's ideas: the process should be conducted very carefully, using evidence as the basis for the evaluation.

There are some studies reported that leader has negative influence on group interaction (Seong and Choi, 2007). However leader also has positive influence on group interaction as we can see our study. Moreover investigating leader has implications in classroom context. When students' leadership is more investigated, small group methods may be more possible in classroom by reducing teacher's burden (Li *et al.*, 2007).

To promote positive group interaction, teachers themselves have to become desirable kinds of leaders and demonstrate relevant models for leading. The teachers' role is important because the teacher mediate the students' group science learning (Shepardson, 1996). In many cases, teachers themselves have the role of explainer in a classroom; thus, students also tend to become explainers. When teacher become desirable kinds of leaders themselves, students also could be desirable leaders.

We need to understand what elements affect group interaction. In previous study, many possible variations influenced group interaction. However, there is little research explaining the inner processes of group interaction. If we could explain these processes, it would be possible to more effectively understand and guide group interaction in science classes.

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