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Development of Design Principles of Group Awareness Tool for Facilitating Computer-supported Collaborative Argumentation

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Abstract

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With the advancement of society and the rapid development of technology, every community member of society often needs to collaborate with others to solve problems together. In school education, collaborative learning is widely used in the actual teaching activities. As one of the forms of collaborative learning, collaborative argumentation can improve students' argumentation skills, promote effective content learning and cultivate critical thinking. However, it is challenging to apply collaborative argumentation to the actual teaching activities, and there are many situations where collaborative argumentation activities cannot be carried out efficiently.

Especially in the field of Computer-supported Collaborative Learning (CSCL), such as conflicts between group members, free-riding behavior, and unequal participation occur frequently. At the same time, in the CSCL environment, it is difficult to coordinate one's actions with other group members' actions, which can also exacerbate the occurrence of these problems. These problems are mainly caused by learners who cannot obtain group awareness information about accompanying learners and the current group. Group awareness information specifically includes cognitive, behavioral, and social awareness information.

Previously, there are many studies on group awareness tools that provide group awareness information. Still, few group awareness tools can provide cognitive, behavioral, and social awareness information simultaneously. Moreover, some group awareness tools mainly monitor and evaluate collaborative learning results and cannot to conduct deep analysis on the study activity process.

In the design and support research of collaborative argumentation activities, most of whom research face-to-face environments. There is not much research on the scheme design or specific guidelines in computer-supported collaborative argumentation.

Therefore, according to the limitations of the group awareness tool in current research, combined with the research necessity of specific guidelines in computer-supported collaborative argumentation, this study has developed design principles and specific guidelines for group awareness tool in computer-supported collaborative argumentation. The issues of this study are：1) what are the design principles and specific guidelines for group awareness tool in computer-supported collaborative argumentation? 2) what are the responses of learners to group awareness tool reflecting the design principles and specific guidelines?

This study was carried out to explore the questions according to Type 2 of the design and development research. First of all, according to the previous research, the initial design principles and initial specific guidelines for the group awareness tool were identified. After that, three educational technology experts reviewed the initial design principles and guidelines. The modified specific guidelines were applied to the two-week classroom teaching of 45 first-year students in a class. In addition, a learners' response survey was conducted on the students who actually participated in the computer-supported collaborative argumentation activities. Finally, the results of questionnaire surveys (n=45) and interviews (n=5) were analyzed, and the final specific guidelines were developed.

The group awareness tool in this study can provide cognitive, behavioral, and social awareness information at the same time and focus on exploring the process of online study activities deeply. According to the research results, collaborative argumentation based on group awareness tool solves the problem that general collaborative argumentation activities can't obtain timely information on the cognitive, behavioral, and social awareness of accompanying learners and the current group study situation. It can continuously maintain their study motivation and promote interaction among learners to improve the quality of computer-supported collaborative learning. Suppose the results of this study are applied to actual teaching activities. In that case, students can develop their ability of argumentation and solving problems together, and promote students' understanding and mastery of curriculum knowledge.

Keywords: computer-supported collaborative argumentation, group awareness, group awareness tool, interaction among learners

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I. INTRODUCTION

1. Problem statement and purpose

Argumentation is the active discussion conducted by people holding different opinions, and is a strategy for learning how to solve problems and a method for assessing problem-solving abilities (Jonassen & Cho, 2011; Sampson & Clark, 2009). Argumentation is commonplace in all aspects of our lives. In accordance with the study of Mirza and Perret-Clermont (2009), argumentation begins when problems appear or when a divergence of opinion is noted. The forms of argumentation activities can be factionalized into individual and collaborative argumentation. Collaborative argumentation is the form where many people participate in the dialogue and teaching level, and it is the form of a more active argumentative study. In collaborative argumentation, learners can enjoy and assess their opinions and then expand and develop their own proposals.

Collaborative argumentation activity has teaching value in improving students' argumentation skills, effective analyzing skills and social skills development. In the collaborative form of argumentation activity, when learners face dubious opinions, they must try their best to form an educated opinion through interpretation and discussion. During this process, learners can master and internalize knowledge, which means evolving from knowledge structure to cognition structure (Nussbaum, Sinatra, & Poliquin, 2008). In addition, from the perspective of the function of argumentation, researchers are averring that the argumentation skills should be made the target of study, for it is the essential skill of solving daily issues (Kuhn, 1993; Sadler & Donnelly, 2006). The teaching value of collaborative argumentation in learners' communication capacity and the development of critical thinking capacity has been proved (Jeong, 2015; Lee, Choi, & Bae, 2002; Lee, Park, & Kim, 2016).

However, although the research results show that the collaborative argumentation holds significance, there are difficulties in applying it to the actual teaching field. Therefore, collaborative argumentation has not been actively involved in pedagogy. The main reasons can be roughly branched into three levels. Firstly, students' uneven participation is a problem worth discussing (Lee et al., 2016). In addition, in many cases, even if the time allocated for oral debate is extended, opinions remain cagey (Kwon, 2013). Thirdly, even if students can effectively construct argumentation, it is challenging for them to improve their knowledge through mutual communication. This is the critical issue with collaborative argumentation (Kwon, 2013; Lee & Yang, 2009; Seo, 2016).

In the current research, in order to solve the difficulty in application, the factors influencing the collaborative argumentation have been studied and multiple specific guidelines have been tried. However, among collaborative argumentation activities and supporting research, most of them

have geared the research towards a face-to-face environment. There are very few research endeavouring on the design and supporting methods of collaborative argumentation activity under the CSCL environment.

In Computer-Supported Collaborative Learning (CSCL), CSCL means the collaborative study activity through computer technology. CSCL thinks the study is a process of social interpersonal relations and logical reasoning. It emphasizes the interaction between learners. During the process of CSCL, it is often the issue of taking a free ride. If the interaction among learners is not conducted actively, the effect of collaborative study will decline to a large extent (Kwon, Liu, & Johnson, 2014). Although the above issues exist in the face-to-face learning environments, due to the lack of non-verbal cues such as actions and facial expressions, these issues are presented more prominently within the CSCL environment. According to the study, providing the information of accompanying learners for online collaborative learners can promote interaction and is an essential means to improve the learning quality of CSCL (Janssen, Erkens, & Kanselaar, 2007; Janssen, Erkens, Kanselaar, & Jaspers, 2007; Jermann & Dillenbourg, 2008). During the collaborative study, only when learners can acquire information from the aspects of cognition, behavior, and society, can achieve good communicate with accompanying learners. The information is called group awareness information (Pifarré, Cobos, & Argelagós, 2014).

With the advent of study analysis technology, online collaborative learners can acquire more and more diverse awareness information. However, there are very few group awareness tools that penetrate group awareness information from three aspects - cognition, behavior and society. In addition, although some group awareness tools have analyzed the learners' behaviors to a certain extent (such as login times and study time), they have not explored online study activity deeply and not conducted profound analysis on the process of study activity process. This study has developed design principles and specific guidelines for computer-supported collaborative argumentation based on group awareness tool to address this research gap.

This study proposes the research theme on design principles for group awareness tool in computer-supported collaborative argumentation. The aims of this study can be divided into practical and theoretical levels. Firstly, the research aims to formulate the design principles of promoting computer-supported collaborative argumentation based on group awareness information provided by the group awareness tool. In addition, developed specific guidelines can solve the issues that occur during the course of computer-supported collaborative argumentation, the collaborative learning efficiency is not high due to insufficient group awareness information from accompanying learners. It is expected that the specific guidelines can help learners conduct practical computer-supported collaborative argumentation activities.

From the theoretical level, its purpose is to transfer the focus of group awareness tools in current research, which no longer focuses on the supervision and judgment of collaborative learning results but pays more attention to the online collaborative learning process. Then deep exploration and analysis on learners' behavioral modes will be carried out.

2. Research questions

1) What are the design principles and specific guidelines for group awareness tool in computer-supported collaborative argumentation?

2) What are the responses of learners to group awareness tool reflecting the design principles and specific guidelines?

3. Definition of terms

Computer-supported collaborative argumentation

Collaborative argumentation is the study activity that two or more learnersto participate in together, who respectively come up with proposals and acquire solutions after describing and verifying (Clark, 2013). It is necessary to distinguish the connotations of collaborative argumentation and adversarial argumentation in the research. The goal of adversarial argumentation is that learners hold different opinions to one question and let the other side accept their views by means of persuading the other side with their standpoints. Collaborative argumentation, on the other hand, achieves the best solution by collecting and verifying multiple opinions.

Computer-supported collaborative argumentation is a collaborative argumentation activity that uses the computer as a medium to conduct discussions online (Baker, 1999).

Therefore, this study will define computer-supported collaborative argumentation as a collaborative learning activity in which two or more learners participate in online discussions using computers as a medium. Multiple opinions are collected through argumentation activity, and the best solution is found through a verification process.

Group awareness tool

In the CSCL environment, because group awareness information cannot be directly obtained, tools or mechanisms need to be integrated to provide learners with group awareness information. In addition, some group awareness information cannot be understood now and need further interpretation with the group awareness tool. This tool is called group awareness tool

(Buder & Bodemer, 2008). In this study, the group awareness tool can improve group awareness information of learners in a CSCL environment in order to promote the cohesion of collaborative content space and relationship space and further interpret specific group awareness information.

II. LITERATURE REVIEW

1. Collaborative argumentation

1.1 Concept of computer-supported collaborative argumentation

Before discussing the concept of computer-supported collaborative argumentation, we explore the significance of explorative argumentation first. It is well-know that argumentation is based on facts and is a communicative behavior to come to a conclusion through discussion or proving one's own standpoints.

On the other hand, some scholars translate "Argument" and "Argumentation" into "Argumentation". They just use the two words to express the same concept. Although "argument" and "argumentation" have close relations, the two cannot be identical. In accordance with Walton's (2009) opinions, an argument can be divided into a dialectical argument and a non-dialectical argument. For example, the argument appearing during the activity of solving problems is non-dialectical.

On the contrary, lawsuits, seminars, medical conferences and other arguments belong to the dialectical argument. Because dialectical argument has divergences on opinions, argument participates are trying to defend their own proposals, as they are also refuting the proposals of other argument participants. From this perspective, the dialectical argument is indeed argumentation.

Argumentation is just a unique form of argument. The relationships and differences between argumentation and argument are that argumentation often includes argument, at least two arguments. The reason being there is that at least two people taking part in the argument, and each participant has their argument about the proposal. However, the argument may not include a dialectical argument. For example, there is also a non-dialectical argument form. In addition, the argument is a static process, and argumentation is a dynamic process.

According to Walton's (2009) study, the several components of argumentation include

premise, conclusion and inference. Driver and colleagues (2000) mainly analyze this issue according to the differences of logistics and argumentation. Argumentation draws a conclusion from the relevant principles in specific situations. Logistics is an inference without being limited by the context (Driver, 2000). The definition of argumentation by Golanics and Nussbaum (2008), argumentation is the process of composing critical thinking abilities and social interactions based on the constructivism study theory.

In the multitudes of argumentation models, the most broadly known ones are the Wigmore model and Toulmin's (1958) model. Wigmore model uses graphic factors such as box and arrows, which defines the structure and process of argumentation (Rowe & Reed, 2006). Although the argumentation process can be described synoptically, it is quite complicated. Toulmin's (1958) model has proposed the factors of composing argumentation, which mean the claims of discussants' standpoints or conclusions, materials (data) having the proposal legalized, logistical argument (warrant) connected logistically between materials and proposals, logistical backing for proving the argument another side, essential conditions (qualifiers) of materializing the assurance level of the proposal and rebuttal when there are no proposals, exceptional conditions appear. Toulmin's (1958) model is shown as followings Figure 2.1.

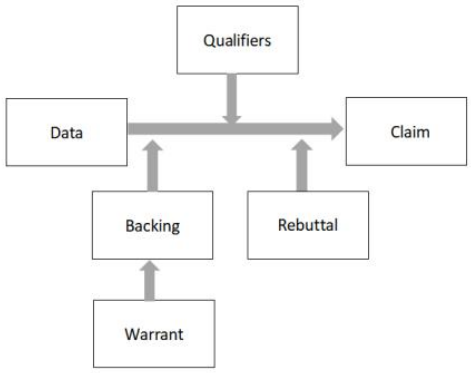


Figure 2.1 Toulmin's argument model (Toulmin, 1958)

However, there are researchers proposing that Toulmin's (1958) model is the logistic structure of describing a single argument, which means it only focuses on argumentation itself, but ignores the description of the dialogue process. Kunz and Rittel (1970) have improved Toulmin's model and came up with Issue-Based Information System (IBIS) model. Firstly, confirm the topic, raise one issue from the topic and express your own standpoints (Position) about the issue and come up with different reasons for different standpoints (Argument). For the reasons put forward, one can express supports or objections. The argumentation process has formed the tree-shaped structure taking "issue" as the main focus.

Argumentation can be classified according to different standards. O'Keefe (1992) divided argumentation into two kinds. The first argument (argument 1) is taken as the outcome, and the

second argument (argument -2) is taken as the process (Nussbaum et al., 2008; O'Keefe, 1992). According to the participating bodies, Driver et al. (2000) divided argumentation into individual arguments and social arguments, which means the former has only one participant and the latter is under the joint collaboration. Moreover, based on the purposes of argumentation, it can be divided into adversarial argumentation and collaborative argumentation (Golanics & Nussbaum, 2008). The purpose of adversarial argumentation is to solve issues and make your opinion superior to thers or prove your standpoints from many perspectives, then persuade others. On the contrary, collaborative argumentation is the collaborative learning activity where learners can collect and verify various opinions for solving common issues, synthesize discussion issues and find the best solution.

Mercer (1996) divided the dialogue into three categories - exploratory discourse, cumulative discourse, and disputational discourse according to the nature of collaborative study dialogue. Disputational discourse is antagonistic and cumulative discourse has no other opinions. The collaborative argumentation belongs to exploratory discourse. Members of the team can criticize opinions in unison, co-build knowledge, and promote the development of critical thinking (Golanics & Nussbaum, 2008). The classification of argumentation is summed up as shown in Table 2.1.

Table 2.1 Classification of Argumentation

Researcher	Classification
O'keefe(1992)	Argument-1
	Argument-2
Driver et al.(2000)	Individual argumentation
	Social argumentation
Nussbaum(2008)	Adversarial argumentation
	Collaborative argumentation
Mercer(1996)	Disputational discourse
	Exploratory discourse
	Cumulative discourse

The concept of computer-supported collaborative argumentation can be summarized as a collaborative learning activity that uses the computer as a medium to conduct discussions online, in which two or more learners come up with verify and criticize their proposals respectively and find the best solutions for issues discussed.

1.2 Teaching value of computer-supported collaborative argumentation

The values of collaborative argumentation can be supported by the Constructionism Paradigm. Constructionism Paradigm emphasizes that the understanding of the world from each other has formed its own unique framework. Learners construct knowledge during the process of participating in and solving significant issues. In the argumentation process, learners can take part directly in the construction of significance and knowledge and promote the acquisition of knowledge (Lee et al., 2002). Therefore, argumentation activity can be considered an effective way of promoting learning. In addition, in order to express and interpret team members' ideas logically, learners from connection between the issues and their prior knowledge and enrich their own knowledge in the argumentation activity (Nussbaum et al., 2008). During the process, new arguments can be constructed, learners' own defects can be discovered, and development and progress of knowledge can be promoted (Nussbaum et al., 2008; Von Aufschnaiter, Erduran, Osborne, & Simon, 2008).

Mercer (1996) has also emphasized the important teaching values of collaborative argumentation (i.e., ex,ploratory discourse). Compared with cumulative discourse, exploratory discourse holds different opinions. Therefore, team members can criticize one another's ideas and adopt the ideas of the other side constructively.

Compared with disputational discourse, exploratory discourse is not just to show that one's own argument is better than others, but further deepens your argument through cognitive conflict and understanding of topics and expand your opinions (Alexopoulou & Driver, 1996; Bell & Linn, 2000). In addition, collaborative argumentation can promote complicated critical thinking, which is manifested by the capacity of identifying, constructing, and assessing arguments (Fmino,2005).

Moreover, collaborative argumentation has major significance in the science and education field. Inference and argumentation ability can help scientists deeply understand how to create, prove and assess (Sampson & Clark, 2009). The researchers suggest that opportunities of scientific argumentation should be provided to let learners participate directly in the logical inference composing their own proposal (Driver et al., 2000; Duschl, 2000; Sandoval & Reiser, 2004). In addition, introducing in argumentation in scientific study promotes learners' social interaction through which their understanding of science knowledge is enhanced (Duschl & Osborne, 2002; Jiménez-Aleixandre & Erduran, 2008; Kelly, Druker, & Chen, 1998; Zohar &

Nemet, 2002). Therefore, collaborative argumentation can promote the development of critical thinking and let students adapt to scientific and cultural practice activities (Erduran & Jiménez-Aleixandre, 2008).

Computer-supported collaborative argumentation uses the computer as a medium to provide learners with text-based communication tools, and learners can conduct collaborative writing and online discussion activities at the same time (Baker, 1999).

Especially in a computer-supported collaborative argumentation environment, it can provide learners with learning support based on technological means. In this way, the time and space limitations of the interaction between learners can be expanded, deep cooperation can be enhanced, and the adjustment of learners' learning behaviors and reflective activities can be promoted (Koschmann, 1996; Stahl, Koschmann, & Suthers, 2006).

Summarizing the propositions of the theories, it can be concluded that computer-supported collaborative argumentation is an online discussion activity with a computer as the medium. It can actively construct knowledge through logical expression and explanation of arguments, and the time and space limitations of the interaction between learners can be expanded. In addition, during the process of seeking the best solution, due to the form of cognitive conflict, learners' communication abilities can be improved, and the development of metacognition and critical thinking capacity can be promoted.

1.3 Application of computer-supported collaborative argumentation

Although computer-supported collaborative argumentation has teaching values, it has not been actively applied to the actual teaching. In order to effectively apply the computer-supported collaborative argumentation, we need to assess the difficulty in application.

Firstly, in collaborative learning, all members should undertake the common cognitive responsibility to study the process (Scardamalia, 2002). The research result shows that there are more situations, in which learners cannot realize effective interaction and active participation during collaborative learning (Cohen, 1994; Fischer, Bruhn, Gräsel, & Mandl, 2002; Kreijns, Kirschner, & Jochems, 2003). In the collaborative argumentation activity, learners' negative study attitude and resulting unbalanced participation can weaken the study motivation of team members (Kerr, 1983). Students' unbalanced participation is one of the difficulties of collaborative argumentation.

Secondly, because learners cannot organize high-level arguments very well, it is much more common to choose the initial solutions. The reason is that it is hard for learners to prove the rationality between proposals and evidence (Erduran, Simon, & Osborne, 2004;

Jiménez-Aleixandre & Erduran, 2008; Sandoval, 2003; Sandoval & Millwood, 2005). In addition, in the collaborative argumentation, when others put forward wrong statements, it is very common that dissenting opinions cannot be put forward or critical verification cannot be performed at the beginning. However, coming up with dissenting opinions is the premise of solving common issues (Mallin & Anderson, 2000).

Moreover, the goal of collaborative learning is to construct collaborative knowledge. The interaction among learners is one of the factors, which influence the collaborative learning effect (Jonassen & Kwon, 2001). Therefore, if the interaction among learners is not active, it cannot construct collaborative knowledge. In addition, some researches stressing that in collaborative activity, even if students can organize arguments, it is hard to co-improve knowledge level through interaction (Kwon, 2013; Lee & Yang, 2009; Seo, 2016). On the other hand, knowledge construction is blocked, for learners quickly reach the unified opinion by relying on their own contribution (Clark, 2013). Therefore, in the collaborative learning, it cannot lead to collaborative knowledge very often.

2. Group awareness

2.1 Concept of group awareness

The difficulties in applying collaborative argumentation in teaching activities include the unbalanced participation of learners, and learners failing to organize high-level arguments, and cannot construct collaborative knowledge. It can be seen that the quantity and quality of interaction between learners play an important role in collaborative argumentation.

In order to create active interaction between learners, it is necessary to hold multiple opinions on the topic (Jonassen & Cho, 2011; Noroozi et al., 2012). This diversity can expand the scope of group discussion and improve the quality, in order to obtain a better learning effect (Clark, D'Angelo, & Menekse, 2009).

Järvelä and colleagues (2013) have put forward the concept of adjusting the study. Adjusting study is in process, in which learners consciously negotiate task goals and standards, strategically adopt tools and strategies, and monitor study process and progress in time and when the result surpasses expected goals or comes across difficulties, adjust and rectify study. The proposal of revising learning has significant teaching value in the collaborative learning field. Volet and colleagues (2009) think that during collaborative learning, it is a must to master how team members adjust the study process.

Therefore, if team members do not agree with the opinions or solutions raised by other team

members, they need to negotiation and adjustment (Volet, Vauras, & Salonen, 2009). When the clues of social context such as body shape, voice and intonation, eyesight contact, and group integrity are insufficient, due to the decrease of learners' attention and motivation towards discussion and argumentation, the effect of collaborative argumentation may be hindered (Coffin & O'Halloran, 2009).

Although in current research, collaborative argumentation factors have been analyzed, and various instructing support methods for collaborative argumentation have been tried. From the social context of interaction between learners, the reason of ineffective or inefficient collaboration is due to the lack of group awareness (Janssen, Erkens, & Kanselaar, 2007; Jermann & Dillenbourg, 2008). Because in collaborative learning scenarios, awareness of partners' cognitive and social activities is a relevant variable, group awareness can help learners overcome the problems related to communication, participation, and coordination of group work (Carroll, Neale, Isenhour, Rosson, & McCrickard, 2003). Cognitive awareness focuses on the knowledge level of group members. Behavior awareness focuses on learners' behavior in the CSCL environment. Social awareness can promote mutual understanding among group members in order to develop a better learning group and solve problems together (Kreijns, Kirschner, & Jochems, 2003).

It can be seen from these current researches that interaction between learners in collaborative argumentation is significant. Moreover, when learners lack social context clues for group awareness, the effect of collaborative argumentation will be descended. Therefore, in computer-supported collaborative argumentation, learners need to perceive accompanying learners' cognitive, behavioral, and social information, so that they can overcome communication barriers with accompanying learners, promote interaction and improve the quality of collaborative argumentation activities ultimately.

Awareness is to understand others' activities. These activities provide scenes connecting their own various activities (Dourish & Bly, 1992). Nova and colleagues (2007) think that awareness is the consciousness and perception of other members' actions in the same environment. The information perceived can provide the clues related to own learners' own actions. "Awareness" was firstly proposed in the CSCW (Computer-Supported Cooperative Work, CSCW) field. CSCW is the environment supported by the computer, which promotes the mutual coordination and collaboration through a collaborative working environment, to maximize the overall working efficiency.

Recently, there have been more and more researches introducing the concept of "awareness" into the CSCL field. Awareness can be divided into multiple types, which are Workspace Awareness, Social Awareness, Knowledge Awareness, and Group Awareness (Buder & Bodemer, 2008; Gutwin & Greenberg, 1995). Knowledge awareness focuses on how accompanying learners perceive knowledge composition. Group awareness centers on social interaction awareness among learners. Bodemer (2011) argues that it should also include the awareness of accompanying learners' study behavior. Although the forms and definitions these awareness are different, they both focus on relevant information about team members, such as activities in progress, interests or

self-recognition.

In fact, there are many meanings of group awareness. Group awareness is information about group members' behavior, knowledge skills, and social activities in collaborative learning (Schmidt, 2002). According to Gross and colleagues (2005), group awareness means acquiring the information about team members, as well as the relevant information about the situation of group activities at present, so as to execute some task effectively. In addition, group awareness means acquiring the activity information of team members and activity space (Kimmerle & Cress, 2008). Group awareness can also be equal to the social presence (Gunawardena, Lowe, & Anderson, 1997), for social presence is defined as "perceiving the interactive partners" (Kreijns et al., 2003).

In conclusion, group awareness is to perceive what in the current situation, including activity information of members and environmental status information, such as whether group members are online or not, who are the active participants in the group discussion, and how the current situation is in solving the task. The information perceived may come from the study progress of several group members, maybe the information reflecting the collaboration status of the whole group. Group awareness can be divided into three types (Bodemer & Dehler, 2011), as shown in Table 2.2.

Table 2.2 Classification of Group Awareness

Classification	Explanation
Cognitive awareness	Paying attention to knowledge level of group members and know about group members' understanding level of knowledge such as group members' prior knowledge, interest, skills equipped,etc. (Bodemer, 2011; Dehler et al., 2011; Sangin et al., 2011).
Behavioral awareness	Paying attention to learners' behavior, including the roles of learners in group coordination, what they have done and how many study tasks they have completed (Janssen et al., 2011).
Social awareness	Paying attention to the operation of the group and know about the interaction among group members, such as learners' feelings about collaboration among group members,etc (Phielix et al., 2011).

In the FTF (Face-To-Face) , group awareness can be acquired very easily. However, if team members are separated spatially, which means in a CSCL environment, technical support is required if members want to acquire group awareness information. In conclusion, group awareness provides learners with their accompanying learners' cognitive information, behavioral awareness information, and social awareness information through technical support, inducing the mutual awareness among learners, promoting the interaction among learners and finally improving the effect of collaborative learning in the CSCL environment.

2.2 Necessity of group awareness in computer-supported collaborative argumentation

Firstly, in the CSCL environment, because the medium of information interaction is the computer, group members can not directly acquire group awareness information. The lack of group awareness information may lead to conflicts among group members and unbalanced participation (Erkens, Jaspers, Prangsma, & Kanselaar, 2005; Janssen, Erkens, & Kanselaar, 2007; Jermann & Dillenbourg, 2008).

From the perspective of the role and purpose of group awareness information in collaborative learning, firstly, group awareness mainly provides information interaction space for collaborative members. The shared information in the group is about group awareness (Briggs, 2006). The information includes who participated in the collaborative learning, when, where, how, and why to do it, etc. In addition, group awareness can be led by teachers or students. Teachers utilize group awareness to lead collaborative learning better. Learners can know about the teaching of accompanying learners, discover their insufficiency and help to promote practical understanding through group awareness. Although there is no explicit instruction on adjusting their study behavior, learners can adjust by themselves according to group awareness information and actively influence the progress and results of collaborative learning (Bodemer & Dehler, 2011).

According to the Cognitive Load Theory (CLT), when the study task is more complicated, and the collaboration efficiency is higher, cognitive load can be reduced. On the contrary, if one person can solve the task very easily, the efficiency of collaborative learning is lower, for the interaction among learners can bring extra cognitive load to group members (Paas & Van Merriënboer, 1994). Therefore, as the learning task becomes more complicated, it will be easier to solve study topics through collaboration. At the same time, group awareness information can reduce the effort that group members make to coordinate the action, improve their efficiency and reduce the chance of making mistakes (Gutwin & Greenberg, 2005). Therefore, acquiring group awareness information can reduce learners' cognitive load to a certain extent.

Moreover, collaborative argumentation takes the computer as the medium and has been given more and more support, for asynchronous online discussion can give students the opportunity of reviewing their own opinions (Murphy & Epps, 1998), compared with face-to-face discussion. Researchers find that computer-supported collaborative argumentation can help students find good arguments (Andriessen, Baker, & Suthers, 2003; Cho & Jonassen, 2002). Group awareness can provide information exchange for group members. Therefore, group awareness can help learners better organize arguments during the period of computer-supported collaborative argumentation. In addition, Sangin and colleagues (2011) clearly express that group awareness can trigger verification and judgment and help with collaborative learning.

Summarizing the propositions of the theories mentioned above, it can be concluded that in a CSCL environment, group awareness can reduce the conflicts among group members and reduce

the occurrence of issues of unbalanced participation. Group awareness can help learners adjust by themselves and play the role of an implicit instructor. In addition, group awareness can reduce learners' cognitive load to a certain extent. Furthermore, group awareness can trigger verification and negotiation, which can help learners organize better arguments. Therefore, the premise of conducting the effective computer-supported collaborative argumentation is to allow learners to acquire group awareness information in time.

2.3 Group awareness tool

In the CSCL environment, information is insufficient because it is generally difficult to know what other learners are doing, thinking and are going to do (Gutwin & Greenberg, 1995).

During the collaborative learning process, group members often encounter having a free rider in the group, which means a learner relies on other members of the group to do most work (Salomon, 1989). However, if proper information cannot be acquired, it will be tough to determine a free rider.

Collaborative learning is a complicated job in CSCL environment because collaborative learning not only requires learners to implement their tasks but also need collaboration regulation and coordination, like discussing who can do it, who needs help, whether it is going smoothly or not, and whether it needs to change strategies or not. This means it requires information about collaborative content space (for solving problems) and relationship space (creating an active collaboration atmosphere and ensuring the efforts of effective collaboration) among learners (Barron, 2003; Erkens et al., 2005).

There are two ways of developing group awareness, one is the results of natural interaction, the other one is acquired utilizing a specific group awareness tool. If there is no support from group awareness tools, group awareness can be developed only in the collaborative process (Schmidt, 2002). When learners have arguments during the collaborative learning, group members know about accompanying the learner's opinions through his argument content and his voice and tone, his emotional status and collaboration satisfaction. It is not hard to find out that it is very common that group awareness information cannot be achieved directly and it needs explaining (Kraut, Fussell, Brennan, & Siegel, 2002).

Therefore, CSCL environment integrated tools or mechanisms can provide group awareness information to learners and promote the collaborative content space and the relationship space. In addition, it can explain group awareness information and help learners know about the information about other group members and the collaboration process. This tool is called a group awareness tool (Buder & Bodemer, 2008).

Group awareness tool has significant meanings to CSCL. Firstly, in a CSCL environment, learners need to collect and interpret a significant amount of information. According to the Cognitive Load Theory (CLT), the collaboration in the CSCL environment produces high-level internal and external cognitive load (Kirschner, Paas, & Kirschner, 2009). Therefore, it should use group awareness tools to collect and explain the necessary information. The method of collecting and presenting necessary information is visualization because visualization can effectively collect and interpret information and reduce the cognitive requirements of individuals (Sweller & Chandler, 1994; Ware, 2005).

Secondly, group awareness tools can strengthen learners' group awareness and improve participation awareness (Gutwin & Greenberg, 2005; Kirschner, Strijbos, Kreijns, & Beers, 2004). It can motivate learners to set higher standards and facilitate participation when comparing themselves with group members (Michinov & Primois, 2005). According to Zumbach and colleagues (2004), research and group awareness tools have positively influenced learners' motivation in executing tasks.

Moreover, because the awareness information is concealed, during the collaborative learning, we can use a group awareness tool, which can present awareness information explicitly. The explicit information can help to instruct learners' behavior and help them reflect (Bodemer & Dehler 2011) and can improve the collaborative efficiency of the group (Schreiber & Engelmann, 2010), as well as promote effective knowledge share (Dimicco et al., 2007).

According to the prior research on group awareness, most representative researches are shown as follows in Table 2.3.

Table 2.3 Group Awareness Tools

Tool	**Group awareness**			**Displaying**	**Functions features**
	Cognitive awareness	**Behavioral cognitive**	**Social cognitive**		
ShrEdit (Dourish & Bellotti, 1992)	√	√	√	Shared window	Learners' activities can be collected in a shared working space by shared feedback. Then learners can acquire the in-time information of the study of accompanying learners and then adjust their own activities accordingly.

GAW (Kreijns & Kirschner, 2001)	√		√	Timeline diagram	Track the learners' ID, record the activities of each learner and show the time length of learners taken on the platform.
GroupKit (Gutwin & Greenberg, 2002)	√	√		Social relation network diagram	Mark the edition of content from group members and changes of object of study, assist learners to predict the intention of group members.
Augmented Group Awareness Tool (Buder & Bodemer, 2008)			√	Evaluate two-dimen sional table	Learners grade the performance of the partner. The grading mainly aims at two indexes : contribution degree and innovation degree. The platform collects and summarizes the assessment results of all members, which will be given feedback to each learner.
SAM (Govaerts et al., 2012)	√	√		line chart, pie chart, tag cloud	The time that visual learners spent on study activities and resource usage help learners reflect and discover potential issues.
PT (Janssen et al., 2011)			√	scatter diagram, social network chart	Pay attention to the contribution from each leaner to group cooperation and update learners' performance in real time.
StepUp! (Santos et al., 2013)	√	√	√	bar chart, pie chart	Provide more social interaction information and let learners see others' performance in the community and reflect their own activities.
Radar (Phielix, 2011)			√	radio chart	Show the cognition of learners to group members and the assessment result of social behavior and help

					learners reflect study process.
Reflector (Phielix, 2011)			√	text	Let learners reflect the feedback information and think about whether they understand and agree with the feedback results or not, so that learners can more clearly know about their behaviors.
Narcissus (Upton & Kay, 2009)	√		√	tree diagram	Follow the document use among learners and help learners discover the contribution the group members have done.

In order to summarize the prior research of group awareness tools, it can be analyzed from the following aspects:

1) Awareness content

At present, the study on group awareness tools has focused on providing social awareness information. And there are fewer researches on behavioral awareness and cognitive awareness. Among cognitive awareness, behavioral awareness, and social awareness, there is no research proving that they play a significant role in CSCL. Therefore, it is necessary to study the three kinds of awareness information. In addition, in effective collaborative learning, learners can sort out various types of awareness information, knowing more about the collaboration process, and improve collaboration (Ghadirian, Ayub, Silong, Abu Bakar, & Hosseinzadeh, 2016; Janssen & Bodemer, 2013).

2) Displaying

At present, the awareness tools developed concentrates on implicit feedback, dynamic, accessible, and closed display. The opening degree of awareness display is low. The display of group awareness tools is shown in Table 2.4. The opening degree of current awareness tools is related to the information content provided. For example, the reason why ShrEdit and Reflector can provide opening awareness information because ShrEdit is about the content edition of the text studied, and Reflector is self-reflection to study. The awareness information is open. And awareness information provided by other tools such as learners' behavior, contribution degree of a team, and participation degree can be strictly quantified and is not open.

Table 2.4 Display of group awareness tools

Tool	Explicit display	Implicit display	Static display	Dynamic display	Free display	Forced display	Closed display	Open display
ShrEdit		√		√	√			√
GAW		√		√	√		√	
GroupKit		√		√	√			√
Augmented Group Awareness Tool	√		√			√	√	
SAM		√		√	√		√	
PT		√		√	√		√	
StepUp!		√		√	√		√	
Radar	√		√			√	√	
Reflector	√		√			√		√
Narcissus		√		√	√		√	

Explicit display vs. Implicit display

There are two ways of explicit feedback. One is shown in Bodemer's research, where participants can actively layout the graphic element in the collaborative task to reflect the understanding degree of the concept of statistics (Bodemer, 2011). The other one is explicit feedback, which is realized by means of learners' evaluation. For example, the study of Dehler et al. (2011) has adopted learners' self-assessment. Phielix's (2011) study has adopted learners' self-assessment and others' assessment.

The system can automatically give awareness information in the implicit feedback, so it does not require learners' participation. Most researchers support implicit feedback. The reason is that implicit feedback can privately collect awareness information without intervening in learners' study.

Static display vs. Dynamic display

Bodemer (2011) developed the awareness tool to display awareness information in real-time according to study activity. On the other hand, Phielix's (2011) and Sangin's (2011) awareness tool is extracted in advance when awareness information is provided, which can not be updated during the study process.

One of the advantages of the dynamic display is that it can provide the latest information about the collaboration process to learners, and the adjustment of learners' behavior should match the current activity status of the group, which will not delay. However, if the awareness tools adopt the explicit feedback, the awareness information displayed dynamically will require learners to provide their information many times, increasing learners' burden to a certain extent. Therefore, researchers must weigh between the real-time awareness information and the work load that is increased.

Free display vs. Forced display

Phielix's (2011) awareness tool adopts forced means learners cannot acquire awareness only when they give a mark. The forced display can increase the burden of learners to a certain extent and lead to resistance to awareness tools.

Closed display vs. Open display

The typically closed display and open display cases are Radar and Reflector, developed by Phielix (2011). Radar firstly lets learners give a mark on the scale, which has been prepared in advance. This is the closed display. Reflector can reflect their performance and the performance of the group through the textbox. The learners can edit the text by themselves. This is the open display. Research results show that although Reflector can display group awareness finely, the available display of Reflector is not valid. However, these results cannot be confirmed until studied profoundly (Phielix, Prins, & Kirschner, 2010).

3) Evaluation on the effectiveness of group awareness tools

The effectiveness assessment of group awareness tools can be divided into two levels. The effectiveness assessment on the individual level shall take learners' test grades as criteria (Bodemer & Dehler, 2011). The effectiveness assessment in the group shall take the completeness of cooperated tasks (Janssen et al., 2011) or awareness of collaborative effectiveness (Fransen et al., 2011) as criteria. In all, the effectiveness of group awareness tools has positive influence on the effectiveness of CSCL. Firstly, it can help learners to understand and interpret their arguments (Bodemer, 2011). Secondly, the application of inference knowledge is more proficient (Janssen et al., 2011). Thirdly, it can promote verification and negotiation, and learners' roles can be differentiated more clearly (Dehler et al., 2011; Janssen et al., 2011; Sangin et al., 2011). Fourthly, it can allow learners to open up further the decision-making process (Buder & Bodemer, 2008).

III. METHODOLOGY

The research methodology in the study follows the Design and Development Research. Design and Development Research is about confirming teaching or non-teaching outcome or tool and leads systematical research methods generated by the newly developed or improved model including the process of design, development, and evaluation based on the empirical foundation (Richey & Klein, 2007).

Design Development Research can be divided into two types - outcome and tool Research (Type 1) and Model Research (Type 2). The model research consists of three processes: model development, model validation, and model use. In this study, the design principles and specific guidelines developed will be generally applicable to computer-supported collaborative argumentation activities based on group awareness tool. Thus, it is suitable to use Model Research (Type 2) of the Design and Development Research.

1. Research procedure

The design principles and specific guidelines in the research are the instructional guidelines in different phases of study activities. The research has experienced 5 phases in order to promote the computer-supported collaborative argumentation based on group awareness tool. The specific research procedure and research activities are shown in Table 3.1.

Table 3.1 Research procedure and research activities

Research procedures	Research activities
Reviewing previous literature	• Develop the design principles for group awareness tool (initial design principles) • Develop the function model of group awareness tool in computer-supported collaborative argumentation • Develop specific guidelines of computer-supported collaborative argumentation (initial specific guidelines)

Expert validation	• The expert evaluation for initial design principles • The expert evaluation for initial specific guidelines • Analyze expert validation results and modify the design principles for group awareness tool (final design principles) • Analyze expert validation results and modify specific guidelines (modified specific guidelines)
Course application	• Design activities of applicable specific guidelines and develop the teaching tools • Apply the specific guidelines in the actual computer-supported collaborative argumentation activity
Investigation on Learners' Responses	• Investigate learners' response through questionnaires and interviews
Final specific guidelines	• Modify the specific guidelines based on the response from learners (final specific guidelines)

Firstly, through reviewing the previous literature, the design principles for group awareness tool and the functional model of group awareness tools in computer-supported collaborative argumentation were developed.

Secondly, the initial specific guidelines for group awareness tool in computer-supported collaborative argumentation activity through the research of prior literature were developed. Then confirm learners' difficulties during the process of collaborative argumentation through prior literature and develop computer-supported collaborative argumentation activity teaching tools.

Thirdly, the validation of experts on the initial design principles for group awareness tool and initial specific guidelines was implemented. For the expert validation of the design principle of group awareness tool and initial specific guidelines, three educational technology experts participated. In addition, the design principle of group awareness tool and initial specific guidelines were revised based on revising suggestions by experts.

Fourthly, the course application preparation stage of learners' response investigation was progressed, in which the design of reasonable argumentation activity applicable to specific guidelines was conducted. In the first class, specific interpretation is given and significance is introduced, including the importance, good collaborative argumentation conditions of

collaborative argumentation, how to use group awareness tools to acquire group awareness information under CSCL environment. In addition, in the teaching activity, it was necessary to develop the collaborative argumentation topic based on group awareness tool in the teaching activity. The teacher gave specific collaborative argumentation examples. Students were divided into 9 groups in total, 4-6 people in each group. Students acquire the final solutions by exchanging opinions and discussions with group members. After the discussion, the teacher told students that collaborative argumentation time has ended and they should present solutions of each group in front of the whole class. Finally, in order to evaluate learners' responses, questionnaires and in-depth interviews were conducted.

Then, learners' response was collected. The learning environment was analyzed and confirm by participants were confirmed through a pre-test questionnaire. In addition, the researcher would analyze students' sense of self-efficacy and study attitude towards collaborative argumentation through pre-test questionnaire and post-test questionnaire. Through a questionnaire, the response of learners was collected to examine the overall effect and individual factors of supporting methods. Finally, in order to explore the questions, which were not reflected in the questionnaire, extra-deep interviews with partial learners were conducted.

Lastly, the specific guidelines were modified based on learners' questionnaire results and feedback collected from the interviews.

2. Participants

In this study, three educational technology experts participated in the expert evaluation. All three experts hold relevant doctoral degrees, and have relevant research experience in the field of educational technology. Table 3.3 shows the personal information of the three experts.

In addition, the implementation of this course is carried out in the "Basic Knowledge of Computer" course offered by W University in the first semester of 2021. The participants involve 45 students and an instructor from a class of the first year of W University. The 45 students who participated in the course implementation activities all participated in the learners' response survey. Moreover, five of the learners who agreed to participate in the interview were selected for an interview, who came from five different discussion groups.

Table 3.2 Expert Profile

Expert	Final	Occupation	Experience	Major	Participation

	Education		(in years)		Initial design principles for group awareness tool	Initial specific guidelines
A	PhD	Researcher in the Institute of Education	10	Educational Technology	☑	☑
B	PhD	Researcher in the Institute of Education	6	Educational Technology	☑	☑
C	PhD	Professor in W University	11	Educational Technology	☑	☑

3. Research tools

3.1 Expert validation tool

The expert validation tool was revised according to the study of Nile and Jung (2001), as shown in Table 3.4 below. A scale was used to measure the responses ranging from 1 indicating "totally disagree" to 4 indicating "agree".

Table 3.3 Expert Validation Questionnaires for the Specific Guidelines

Item	Content	4	3	2	1

Feasibility	The specific guideline is an applicable and reasonable guideline to promote computer-supported collaborative argumentation based on group awareness tool.				
Explanatory	The specific guideline has interpreted the applicable guideline for promoting computer-supported collaborative argumentation based on group awareness tool very well.				
Usability	The specific guideline can be effectively applied in order to promote computer-supported collaborative argumentation based on group awareness tool.				
University	The specific guideline is in order to promote computer-supported collaborative argumentation based on group awareness tool and can be broadly used.				
Understanding	The specific guideline is the applicable guideline for promoting computer-supported collaborative argumentation based on group awareness tool and can be understood easily.				

3.2 Course application tool

The course application tool consists of three aspects as introduction of activity, collaborative argumentation activity, and group reflection. The activity introduction developed study materials and introduced the significance, good conditions of collaborative argumentation, the concept of group awareness, usage of Moodle platform, and usage of group awareness tool. At the same time, examples of providing collaborative argumentation will be given, so that learners can grasp the argumentation activity well. The discussion summary letter during the collaborative argumentation activities was revised by referring to the study of Lee and Yang (2009). And a record paper of the argumentation process was developed.

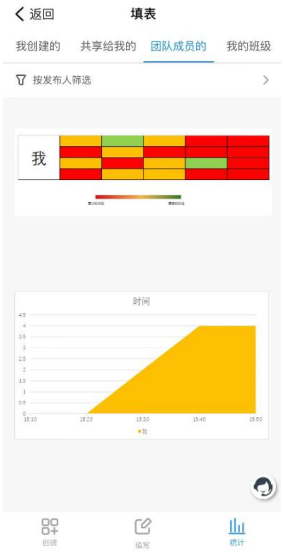
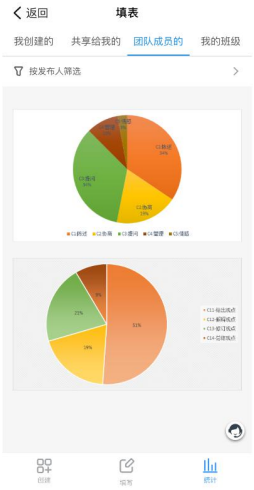
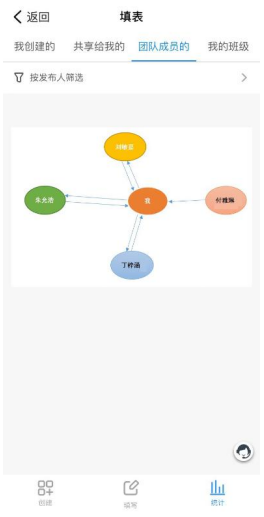
In addition, the individual assessment paper was developed with reference to “clear statement”, “reasonable reasons”, “specific basis”, “considering opposed opinions”, “applying teaching theories”, “original opinion” (Jonassen & Cho, 2011).

Golanics and Nussbaum (2008) have evaluated students' argumentation quality from argument development, balance, and exploratory discourse and considered if it included students' rebuttals, whether the argument passes the verification level or not, and whether they accept other standpoints and change their own opinions from the balanced level. Discussion summary letter, record paper of argumentation process, individual assessment paper and group assessment paper can be confirmed in Appendix 1, Appendix 2, Appendix 3, Appendix 4.

The computer-supported collaborative argumentation activities of this research are carried out on the Moodle platform of W University, which can provide real-time group awareness information for learners. The main functions of the collaborative argumentation activities conducted on the Moodle platform of W University are summarized in the following table 3.5.

Table 3.4 The Main Functions of Moodle Platform of W University Applied in Computer-supported Collaborative Argumentation Based on Group Awareness Tool

	Description	**Example**
Chatting Room	Learners can discuss online in the chatting room of the current group	Ex: 
	Check the cognitive awareness information provided by the group awareness tool	Ex:

Provide learners with group awareness information		 
Check the behavior awareness information provided by the group awareness tool		Ex: 
Check the social awareness information provided by the group awareness tool		Ex:  

Teacher interface	The teacher can check the discussion of all discussion groups	Ex: 

3.3 Learners' response tool

In order to confirm the response of learners to supporting methods applicable to computer-supported collaborative argumentation study activity, the pre-test questionnaire and post-test questionnaire are respectively composed of 14 questions and 37 questions.

The pre-test questionnaire, it consists of 14 questions about the study attitude and sense of self-efficacy to collaborative argumentation activity and group awareness tool. The self-efficacy questionnaire about computer-supported collaborative argumentation activity and group awareness tool were selected and modified in the academic self-efficacy questions from the Motivated Strategies for Learning Questionnaire (MSLQ). The questionnaire about study attitude was revised and developed according to the questions about learning attitude in the Learning and Study Strategies Inventory (LASSI). A scale was used to measure the responses ranging from 1 indicating "totally agree" to 5 indicating "totally disagree". The pre-test questionnaire is shown in Appendix 6.

Based on the questionnaire on learners' study attitude and sense of self-efficacy to collaborative argumentation activity and group awareness tool, who use the post-test questionnaire during the period of pre-test questionnaire, 23 questions on satisfaction related to supporting methods and overall satisfaction with collaborative argumentation activity have been added extra. Shin (2003) defines the satisfaction degree as follows: for one's learning experience, the degree of

positive relevance that learners felt. Therefore, this study defines satisfaction degree as the learner's positive or negative cognition between the computer-supported collaborative argumentation based on group awareness tool and learning experience. The post-test questionnaire is shown in Appendix 7.

4. Data collection and analysis

4.1 Expert validation

Expert validation was conducted before the teaching activities. Thus, 3 educational technology experts shall be invited to implement expert validation through one-to-one interviews or e-mails. The expert evaluation results were analyzed with the Content validity index (CVI) and Inter-rater-agreement (IRA). CVI is the index of measuring the validity of project content. IRA is the index of consistency between evaluators. CVI is the value that the number of evaluators who conduct the positive evaluation of the project is divided by the number of overall evaluators. It is an effective method of verifying the validity of project content. And IRA is the value that the number of projects, which is evaluated to be consistent, among evaluators, is divided by the overall number of projects, which represents evaluation reliance degree. If CVI and IRA respectively surpass .80, it can achieve the conclusion that content validity and confidence level of expert evaluation are high (Davis, 1992; Grant & Davis, 1997).

4.2 Course Development

Specific course content is shown as follows. Firstly, before the application course, the learners, who agree to take part in the study, will be taken as the objects of the study. They completed the questionnaire on their prior experience and sense of self-efficacy of collaborative learning as well as gender, grade, and major. After conducting the pre-test questionnaire investigation, the researcher introduced to the learners the significance of computer-supported collaborative argumentation, conditions of good collaborative argumentation, the concept of group awareness, Moodle platform, and usage of group awareness tool, as well as provided them with sufficient prior training opportunities.

In the study, computer-supported collaborative argumentation activities took around 90 minutes every week according to the procedure mentioned in Figure 3.1, and computer-supported

collaborative argumentation activities were implemented for two weeks. The question used in the study selected the non-structure question does not have right answers, for collaborative argumentation is the effective method of the actual non-structure question, which have no right answers (Jonassen & Cho, 2011). Therefore, the study has selected the argumentation question of "What is the influence of Artificial Intelligence on school education", which is given to learners.

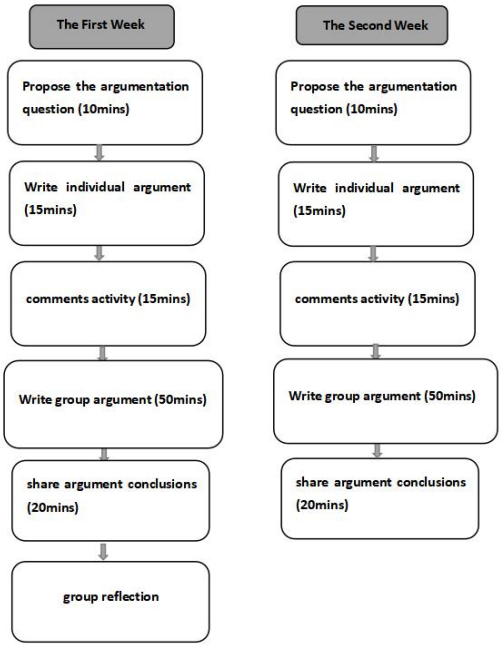


Figure 3.1 Computer-supported Collaborative Argumentation Procedure

Later, the computer-supported collaborative argumentation activity was implemented for around 100 minutes. In order to promote the interaction among learners, before writing group arguments, they needed to independently write the argument and review it in the group (Cho, Park, Kim, Mi, & Lee, 2015). Therefore, learners firstly utilized their smart devices and independently write their argument within around 15 minutes and then share individual arguments by the Moodle platform. They made comments on the argument written by group members and revised their argument content. In addition, they confirmed the information provided by the group awareness tool, conducted group arguments within around 50 minutes and achieved consensus on group concluding arguments. After finishing discussions, the conclusions of all groups were demonstrated in the class.

In the computer-supported collaborative argumentation lasting for 2 weeks, learners can acquire group awareness information about the cooperative process by checking the group awareness tool. To avoid that learners neglecting the information provided by group awareness tools, the teacher reminded learners of checking the group awareness tool twice.

In order to effectively improve interactive quality among learners, the instructor should provide the opportunities for them to reflect upon the difficulties and improvement plan during the collaborative learning (Anaya, Luque & Peinado, 2016; Cho et al., 2015). Therefore, after the first week of argumentation activity, students reflected on collaborative learning with group members. Furthermore, this study is centered on the activities of learners. In order to realize effective activity-centered learning, it is necessary to reflect on the learners' learning process and learning results of learners (Lim et al., 2013). Thus, the group reflection in this study should not only on the results of the collaborative argumentation, but also reflect on the well-done parts, insufficient parts, and the difficulties encountered. The argumentation activity in the second week was conducted according to the collaborative argumentation procedure in Figure 3.3.

4.3 Learners' Response

In order to investigate learners' responses, the researcher conducted the course design at first. Firstly, the researcher explained to the teacher the purpose of the study. The teacher confirmed the purpose of teaching, learners' characters, teaching plans, teaching mode, and evaluation methods. After the researcher and teacher negotiated for the specific topics and activities, the collaborative argumentation activity applicable to the supporting methods lasted for 2 weeks. The researcher observed learners' study activities within two weeks. In addition, when the argumentation activity ended in the second week, the researcher conducted the subsequent investigation through online questionnaire investigation. And within a week of the end of the collaborative argumentation activity, the learners' response to the specific guidelines was investigated through interviews, a total of five learners who agreed to participate in the interview were involved inin-depth interviews.

Questionnaire responses were analyzed to confirm the changing trend based on average values. In addition, the responses were analyzed to calculate the score gap between the pre-test questionnaire and post-test questionnaire through t-verification by SPSS. The results of the interview are analyzed according to Creswell's (2012) material analysis procedure: 1) material exploration and coding. 2) narration and topics acquired. 3) results and report acquired.

Ⅳ. RESULTS

1. The Initial Design Principles for Group Awareness Tool

The purpose of this research is to develop design principles and specific guidelines for group awareness tool to promote computer-supported collaborative argumentation. According to Buder (2011), the development of group awareness tools should tconsider the following three questions. (1) Under the specific background, what way to the display is the most appropriate? (2) What information should be provided? (3) What behaviors should be monitored during collaborative learning? Therefore, this research considered these three elements to develop the design principles for the group awareness tool. The Initial design principles for group awareness tool applicable to the research are shown in Table 4.1.

The group awareness tool presents the awareness information with the visualized charts, which can be easily understood, so that students can check the awareness information in real-time in the collaborative argumentation, to find issues appearing during the collaborative learning process, conduct the corresponding adjustment and promoting knowledge construction and efficient collaborative learning.

In addition, according to the design principles for group awareness tool, the functional model of group awareness tool developed in computer-supported collaborative argumentation is shown in the following Figure 4.1. Moreover, according to the design principles for group awareness tool and functional model of group awareness tool in computer-supported collaborative argumentation, the visualized charts of group awareness tool were designed. The visualized charts of the group awareness tool are shown in Figure 4.2.

Table 4.1 The Initial Design Principles for Group Awareness Tool

Design principle	Explanation		Actual display
1.Provide cognitive, behavioral, and social awareness information at the same time.	cognitive awareness information	Present with the visualized chart on group discussion focus, topic, activation degree, and knowledge novelty.	As shown in Figure 4.2.1, Figure 4.2.2, Figure 4.2.3, Figure 4.2.4.
	Behavioral awareness information	Present with the pie chart of the behavioral model, as shown in Figure 4.2.5, Figure 4.2.6.	As shown in Figure 4.2.5, Figure 4.2.6.
	Social awareness information	Present with the interactive relations chart regarding the number of messages left, time of leaving the messages. As shown in Figure 4.2.7, Figure 4.2.8, Figure 4.2.9.	As shown in Figure 4.2.7, Figure 4.2.8, Figure 4.2.9.

2.Adopt implicit, dynamic, free, and closed display	By the comparative analysis on various ways of presentation of typical events of group awareness tools in the above text, the research will adopt implicit, dynamic, free, and closed ways of presentation.	
3.Appropriately monitor study activities	①Monitor knowledge generation and construction.	As shown in Figure 4.2.1, Figure 4.2.2, Figure 4.2.3, Figure 4.2.4.
	②Monitor what learners' behaviors are during the collaborative learning.	As shown in Figure 4.2.5, Figure 4.2.6.
	③Monitor the interaction among learners.	As shown in Figure 4.2.7, Figure 4.2.8, Figure 4.2.9.
4.The way of comparing awareness information among learners should be simple.	Most group awareness tools have the functions of comparing the knowledge and participation degree of learners. If the way of comparison is complicated, it will cause burden on learners and wrong understanding to awareness information will hinder study. Therefore, the way of comparison of awareness information must be simple.	As shown in Figure 4.2.2, Figure 4.2.3, Figure 4.2.4, Figure 4.2.7, Figure 4.2.8.
5.During the process of collaborative argumentation, remind learners of checking group awareness tools twice.	During the collaborative study, learners should adjust behaviors decidedly after acquiring the awareness information. In this way, it can make the teamwork towards one direction. Therefore, the study will remind learners of checking group awareness tool twice during the collaborative argumentation.	

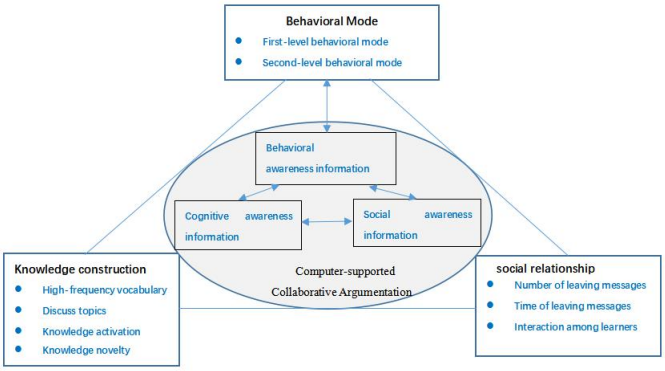


Figure 4.1 Functional Model of Group Awareness Tool

Figure 4.2.1

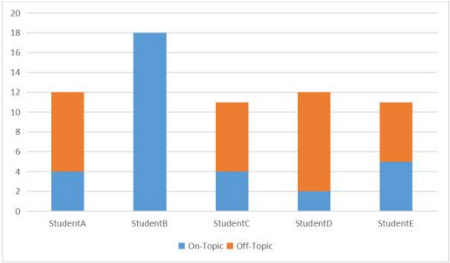


Figure 4.2.2

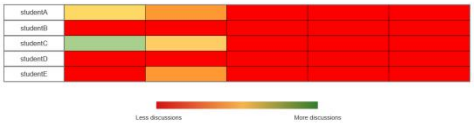


Figure 4.2.3

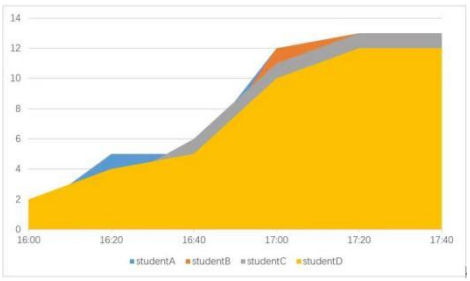


Figure 4.2.4

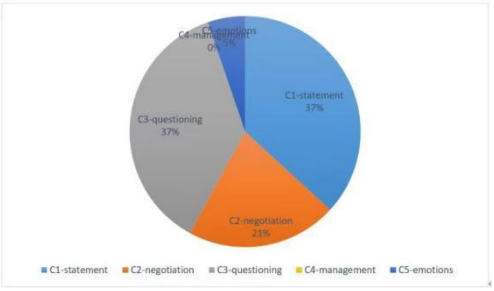


Figure 4.2.5

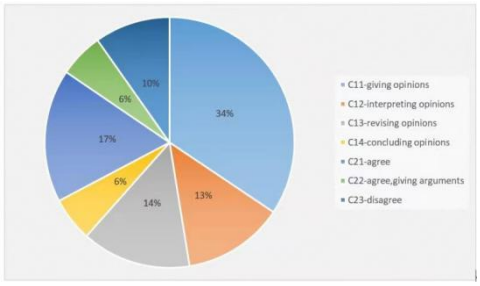


Figure 4.2.6

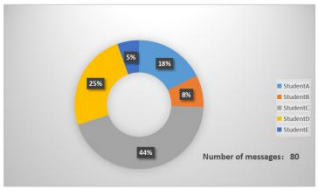


Figure 4.2.7

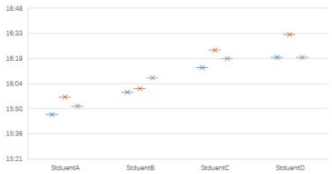


Figure 4.2.8

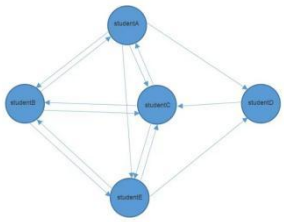


Figure 4.2.9

Figure 4.2 Visualized Charts of the Group Awareness Tool

Cognitive awareness information pays attention to knowledge generation and knowledge construction during collaborative argumentation. The specific content is as follows:

1) High-frequency words in discussion. In Figure 4.2.1, students showed the high-frequency vocabulary related to task solving during computer-supported collaborative argumentation. Learners can quickly acquire the key content discussed right now through these words.

2) Discussion topics. During the collaborative process of group members, confirm whether the discussion content veers away from topics or not. As shown in Figure 4.2.2, it can be seen that Student D has seriously veered away from topics.

3) Knowledge activation. Reflect whether group members have mastered the knowledge points presented by teachers and confirm the next collaborative study direction. Axis X includes the knowledge points, which need discussing. And Axis Y represents the group members. As shown in Figure 4.2.3, when it is greener, the discussion times of the group members on knowledge points will be more. On the contrary, the members, who are closer to red, have less discussion of knowledge points. If there are many red square grids in Figure 4.2.3, it can be considered that the group discussion is in the initial phase.

4) Knowledge novelty. This is the assessment of promotion contribution value discussed by current group members, which means the statistics of some knowledge point are proposed by the group members for the first time. As shown in Figure 4.2.4, Axis Y is the number of knowledge points firstly mentioned by group members and Axis X is the time of referring to knowledge points for the first time.

Through behavioral awareness information, we can get to know what behavior the learner is presenting during the collaborative argumentation. Behavioral modes can be divided into two types. Firstly, as shown in Figure 4.2.5, the first-level behavioral mode includes 5 behaviors during the cooperation process, which are the statement, negotiation, questioning, management, and emotions. Through behavioral awareness information, we may know the role preference of group members. For example, the people who have more management behaviors are probably leaders in groups. Secondly, in Figure 4.2.6, the second-level behavioral mode is the segment of the first-level behavioral mode and aims at describing the behavioral status of learners during the cooperation process in detail. For example, in the statement in the first-level behavioral mode, the statement can be divided into 4 second-level behavioral modes-giving opinions/programs, interpreting, revising, and concluding opinions.

Social awareness information is reflected in interaction and is composed of three parts. The first thing is leaving messages, including the number of left messages and time of leaving messages, which can intuitively reflect the activity of learners taking part in the discussion, as shown in Figure 4.2.7, Figure 4.2.8. Secondly, interactive relationships among learners. For example, in Figure 4.2.9, if learners have formed two-way interactive relationships, it means good interaction.

The visualization charts of the group awareness tool were presented after programming through python before the course is applied. The data collection and visualization design of group awareness information are as follows.

Cognitive awareness information provided by group awareness tools includes group discussion focus, discussion topic, knowledge activation, and knowledge novelty. The data analysis and calculation of cognitive awareness information mainly use natural language word

segmentation processing technology, and use the Chinese word segmentation system of the Chinese Academy of Sciences to segment the discussion text in the discussion process to identify keywords in the discussion process of students. The visual charts are generated after matching the knowledge concept map provided by the teacher on collaborative discussion issues.

Behavioral awareness information uses content analysis to encode collaborative behavior into five first-level categories, and further refines each category into 14 second-level categories. Then embed these codes in the online discussion area of the Moodle platform. When students submit messages, they can choose behavior classification, then the frequency of first-level and second-level behavior patterns will be generated. After calculating the distribution ratio, it is presented through pie charts.

Social awareness information is first extracted from the Moodle platform, such as the number of messages left by learners and the time of leaving messages. Then these data are calculated and visualized.

2. The Initial Specific Guidelines

The specific guidelines were collected and organized on the basis of prior literature, which promotes computer-supported collaborative argumentation, as shown in the following Table 4.2. In addition, the researcher divided the computer-supported collaborative argumentation activities according to phases and developed the initial specific guidelines. Initial specific guidelines are shown as the following Table 4.3.

Table 4.2 Literature Analysis of the Specific Guidelines for Computer-supported Collaborative Argumentation

Phase	Detailed guideline
Preparation stage	• Analyze learners' intrinsic tendency or prior knowledge level (Nussbaum, 2000).
	• In order to know the knowledge level of accompanying learners, accompanying learners' knowledge structure and background information should be acquired (Schreiber & Engelmann, 2010)

	• In order to design an argumentation study environment in scientific education, start from several aspects-students, teachers, courses, evaluation, information, and communication (Jimeenez-Aleixandre, 2007).
Implementation stage	• Raise useful and open questions for learners in order to promote effective argumentation (Veerman et al., 2002).
	• Implement explicit teaching to argumentation structure (Bensley & Haynes, 1995).
	• Select some examples and put forward the argumentation model (Cross et al., 2008; Kollar et al., 2014).
	• Allocate roles of learners (Schellens, Van Keer, De Wever & Valcke, 2007; Veerman et al., 2002).
	• Provide learners with task allocation information, which helps to propose critical opinions (Bodemer, 2011).
	• Provide group members' participation and contribution degree and encourage learners to actively take part in collaborative activities (Kimmerle & Cress, 2009).
	• Provide assessment grade information of group members' contribution level to improve collaborative satisfaction and reduce conflicts among group members (Phielix et al., 2011).
	• Provide current working focuses and participating intention information to improve the cohesive force and participation activity of the team (Jongsawat & Premchaiswadi, 2010).

	• Ask students to inspect and evaluate their argumentation composition and development by themselves by means of providing self-argumentation analysis, self-assessment, colleagues' assessment, and collaborative reflection, to support students' cognitive participation during the process (Cobb, Boufi, McClain & Whitenack, 2020; De Wever et al., 2009; Martínez & Valdivia, 2016; Toth, Suthers & Lesgold, 2002).
	• After conducting the collaborative argumentation activity, when learners take part in the feedback body of group activities, learners' interaction of study participation and cognition will get improved meaningfully (Lee, 2015).
Reflection and assessment stage	• Meta-cognition activities of supporting collaborative argumentation can be helpful to improve students' cognitive participation level, improve discussion quality and keep tracks on discussion topics and develop them critically and extensively (Han & Oh, 2005; Jeong, 2015).
	• In order to increase the number of questioning and interpretation behavior, assess the accompanying learners whether they have interpreted the study content in detail (Dehler et al., 2011).

Table 4.3 The Initial Specific Guidelines

Phase	**Segmented activities**	**Specific guideline**	**Tool**
Activity introduction	Collaborative argumentation activity introduction	1.1. Introduce the significance of collaborative argumentation activity, goals, good conditions of collaborative argumentation, and the importance of group awareness tools in the CSCL environment.	Introducing PPT
		1.2. Introduce the usage of Moodle platform, the usage of group awareness tools, and try to use group awareness tool.	

		1.3. Provide examples of collaborative argumentation activity.	
	Formulating the rules of collaborative argumentation activities	2.1. State the steps and rules of collaborative argumentation activities to better understand the activity	
Collaborative argumentation activity	Prior preparation of activity	3.1. Put forward unstructured discussion topics without standard answers and provide relevant prior knowledge related to the discussion topic to promote effective collaborative argumentation.	Introducing PPT
		3.2. Describe Toulmin's argumentation model (1958) and make learners better understand the composing factors of argumentation.	Introducing PPT
		3.3. Before the activity of collaborative argumentation activity, allocate roles among group members.	
	Collaborative argumentation activity	4.1. Structure the argumentation process and record, with the premise of not lowering active interaction among learners.	Record paper of argumentation process
		4.2. Provide learners' cognitive, behavioral, and social awareness information at the same time.	Group awareness tool
		4.3. Provide the contribution level and participation information of group members.	Group awareness tool
		4.4. Provide learners' understanding level of prior knowledge.	Group awareness tool
		4.5. Provide information about the progress of group discussion.	Group awareness tool

		4.6. Provide learners' information about which behavior they are in.	Group awareness tool
		4.7. Provide information about the interaction among group members.	Group awareness tool
		4.8. Provide comparative information of knowledge and participation among learners.	Group awareness tool
		4.9. Teacher reminds learners to check group awareness tools.	
Group reflection and plan revision	Conclusion publication	5.1. Publish the argumentation conclusion of the group in the whole class.	
	Group reflection	6.1. For the process and results of the argumentation activity, first conduct the individual assessment, and then conduct group assessment.	Individual assessment paper and group assessment paper
		6.2. During the group reflection, discuss the difficulties experiencing during the collaborative argumentation, well-done parts, insufficient parts, and improvement plan.	
	Feedback is given by teacher	7.1. The teacher not only need to give feedback to the argumentation activity, but also give feedback about the same difficulties coming across during the argumentation activity.	
Plan revision	Plan revision	8.1. Review the argumentation activities last week and revise the plan of argumentation for the next week.	

3. Expert Validation Result

3.1 Expert Validation Result of Design Principles for Group Awareness Tool

In order to determine the validation of the overall and individual design principles for group awareness tool obtained through previous literature, email exchanges and interviews were conducted with three experts in the field of educational technology. The scale ranges from 1 indicating “totally disagree” to 4 indicating “agree”. The results of the overall evaluation of the design principles for group awareness tool are shown in Table 4.4. The overall evaluation is based on the average value, standard deviation, content validity index (CVI), and inter-rater agreement (IRA). As seen from Table 4.4, the average value of 2.33 to 4.00, CVI value exceeds the 0.8 proposed by Davis (1992) in addition to the feasibility and universality. Besides, the IRA value is 0.80, indicating that the design principles for group awareness tool need to be modified and improved in terms of feasibility and university.

Table 4.4 Expert Validation Result for Overall Design Principles

	Expert			M	SD	CVI	IRA
	A	B	C				
Feasibility	3	2	2	2.33	0.47	0.33	0.80
Explanatory	4	4	3	3.67	0.47	1	
Usability	4	3	4	3.67	0.47	1	
University	3	3	2	2.67	0.47	0.67	
Understanding	4	4	4	4	0	1	

Then, the validation for individual design principles for group awareness tool was discussed by experts, and the results are shown in Table 4.5. The expert validation mainly analyzed 9 items of five design principles, among which the CVI value of 6 items exceeds 0.8, indicating that the individual design principle is reasonable as a whole. However, the CVI value of 3 items is less than 0.8, and the IRA value also exceeds 0.8, which interpreted that only individual items need to be modified.

Table 4.5 The Expert validation Result for Individual Design Principles

Design principle	Explanation	Expert	M	CVI	IRA

			A	B	C			
1.Provide cognitive, behavioral, and social awareness information at the same time.	cognitive awareness information	Present with the visualized chart on group discussion focus, topic, activation degree, and knowledge novelty. As shown in Figure 4.2.1, Figure 4.2.2, Figure 4.2.3, Figure 4.2.4.	4	4	4	4	1	0.89
	Behavior awareness information	Present with the pie chart of the behavioral model, as shown in Figure 4.2.5, Figure 4.2.6.	3	4	4	3.67	1	
	Social awareness information	Present with the interactive relations chart the of number of messages left, time of leaving the messages. As shown in Figure 4.2.7, Figure 4.2.8, Figure 4.2.9.	3	4	3	3.33	1	
2.Adopt implicit, dynamic, free, and closed display	By the comparative analysis on various ways of presentation of typical events of group awareness tools in the above text, the research will adopt implicit, dynamic, free, and closed ways of presentation.		4	4	3	3.67	1	
3.Appropriately monitor study activities	①Monitor knowledge generation and construction.		3	2	3	2.67	0.67	
	②Monitor what learners' behaviors are during the collaborative learning.		3	3	3	3.00	1	
	③ Monitor the interaction among learners.		2	4	4	3.33	0.67	

4.The way of comparing awareness information among learners should be simple.	Most group awareness tools have the functions of comparing the knowledge and participation degree of learners. If the way of comparison is complicated, it will cause learners burden and wrong understanding to awareness information will hinder study. Therefore, the way of comparison of awareness information must be simple.	3	4	3	3	1	
5.During the process of collaborative argumentation, remind learners of checking group awareness tools twice.	During the collaborative study, learners should adjust behaviors decidedly after acquiring the awareness information. In this way, it can make the teamwork towards one direction. Therefore, the study will remind learners of checking group awareness tools twice during the collaborative argumentation.	2	3	3	2.67	0.67	

The experts think that an issue related to feasibility and usability is to ensure that each group member will only see the information of themselves and the whole group, but not information of other individual members. Therefore, design principle 3 “Appropriately monitor study activities” can be embodied as appropriately monitor study activities of group members themselves and the whole group.

In addition, the three types of group awareness information in study activities do not need to be divided. They coexist and will all have an impact on study activities. However, according to the different stages of the discussion activity, the group awareness information that learners should focus on is different. For example, the initial stage of the discussion reminds learners to focus on observation of cognitive awareness information; the discussion stage reminds learners to focus on cognitive, behavioral, and social awareness information; the discussion summary and reflection stage remind learners to focus on cognitive, behavioral, and social awareness information. Therefore, in the design principle of group awareness tool, “teacher reminds learners to check group awareness tool twice” can be changed to “teacher reminds learners to check group awareness tool three times in the initial stage of discussion, discussion progress stage, and discussion summary reflection stage”. The expert’s revising suggestions and content are shown in Table 4.6.

Table 4.6 The Revising Suggestions for Design Principles by Experts

Category	Suggestions	Revised content
Design Principle 3	Each group member should only see the information of themselves and the whole group, but not information of other individual members.	“Appropriately monitor study activities” can be modified as “ appropriately monitor study activities of group members themselves and the whole group”.
Design Principle 5	According to the different stages of the discussion activity, the three types of group awareness information that learners should focus on are different.	“Teacher reminds learners to check group awareness tool twice” can be changed to “Teacher reminds learners to check group awareness tool three times in the initial stage of discussion, discussion progress stage and discussion summary reflection stage”.

3.2 The Final Design Principles for Group Awareness Tool

According to the revising suggestions for initial design principles by experts, the final design principles for group awareness tool are summarized as shown in Table 4.7.

Table 4.7 The Final Design Principles for Group Awareness Tool

Design principle	Explanation	
1.Provide cognitive, behavioral, and social awareness information at the same time.	cognitive awareness information	Present with the visualized chart on group discussion focus, topic, activation degree, and knowledge novelty. As shown in Figure 4.2.1, Figure 4.2.2, Figure 4.2.3, Figure 4.2.4.
	Behavior awareness information	Present with the pie chart of the behavioral model, as shown in Figure 4.2.5, Figure 4.2.6.

	Social awareness information	Present with the interactive relations chart of the number of messages left, time of leaving the messages. As shown in Figure 4.2.7, Figure 4.2.8, Figure 4.2.9.
2.Adopt implicit, dynamic, free, and closed display.	By the comparative analysis on various ways of presentation of typical events of group awareness tools in the above text, the research will adopt implicit, dynamic, free, and closed ways of presentation.	
3.Appropriately monitor study activities of group members themselves and the whole group.	①Monitor knowledge generation and construction.	
	②Monitor what learners' behaviors are during the collaborative learning.	
	③Monitor the interaction among learners.	
4.The way of comparing awareness information among learners should be simple.	Most group awareness tools have the functions of comparing the knowledge and participation degree of learners. If the way of comparison is complicated, it will cause burden on learners and wrong understanding of awareness information will hinder study. Therefore, the way of comparison of awareness information must be simple.	
5.Teacher reminds learners to check group awareness tool three times in the initial stage of discussion, discussion progress stage, and discussion summary reflection stage.	During the collaborative study, learners should adjust behaviors decidedly after acquiring the awareness information. In this way, it can lead the teamwork towards one direction. Therefore, the study will remind learners of checking group awareness tools three times during the collaborative argumentation.	

Based on the revised opinions on the design principles for the group awareness tool given by experts, the design of the group awareness tool was improved, and the revised group awareness tool was applied to the two-week collaborative argumentation activity. The following Figure 4.3 is the screen displayed by one of the learners during the collaborative argumentation activity on the Moodle platform after the first week of the activity. From Figure 4.3.1, it can be seen that the learner has seriously veered away from topics. In the discussion of prior knowledge related to the topic of discussion, there are more red squares, indicating that the number of discussions on the prior knowledge is less, which may be related to the learner's seriously veering away topics. From the statistics of knowledge novelty in Figure 4.3.2, it can be seen that the number of knowledge points mentioned by this learner at 15:30 is two, and the number of knowledge points mentioned

at 15:40 rises to 4. This learner performed well in the latter part of the discussion and contributed a lot to the group during this period. In addition, it can be seen from the behavioral model diagram (Figure 4.3.3) that the main behavior of this learner is to make statements and ask questions. The number of left messages of the learner (Figure 4.3.4) shows that the learner accounts for 35% of the total number of left messages by the group. The number of messages is the largest between 15:30 and 15:40. And the interaction between this learner and other learners is very good, shown in Figure 4.3.5.

Figure 4.3.1

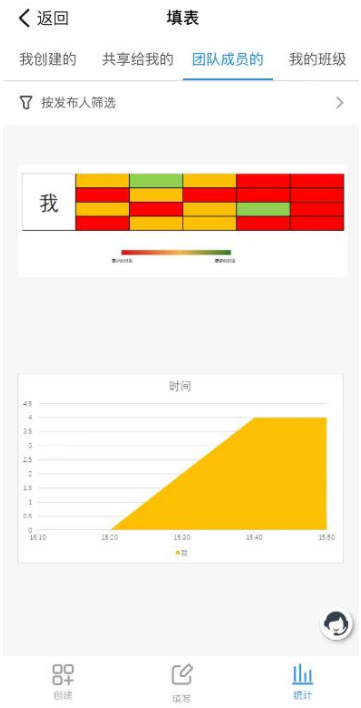


Figure 4.3.2

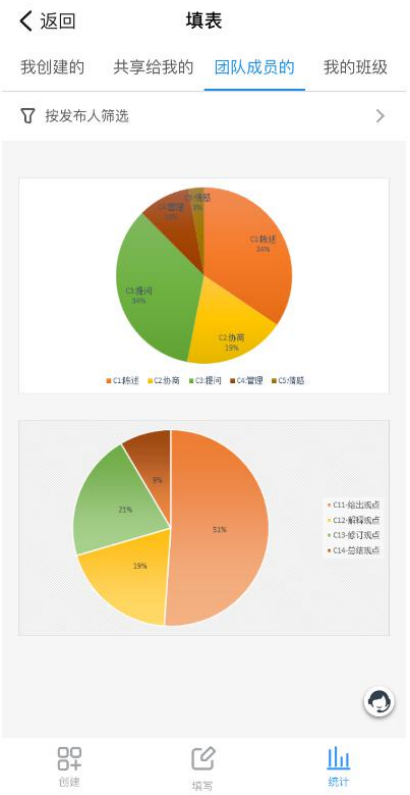


Figure 4.3.3

Figure 4.3.4

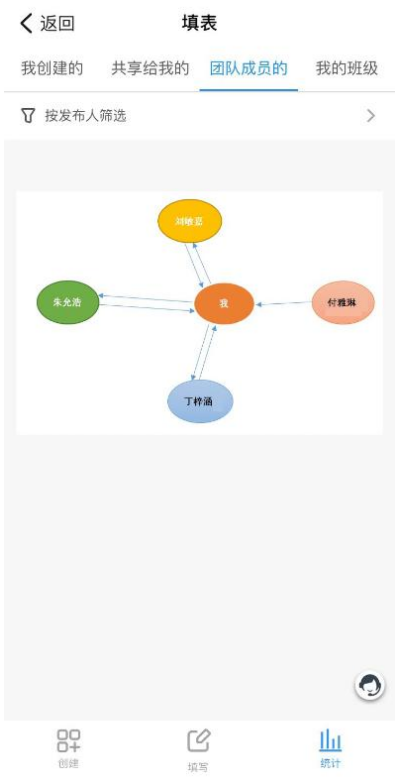


Figure 4.3.5

Figure 4.3 Computer-supported Collaborative Argumentation Activity on the Moodle Platform

3.3 Expert Validation Result of Specific Guidelines

In terms of the expert validation of the specific guidelines, the researchers also followed the same procedures through emails and interviews with three educational technology experts. The scale ranges from 1 indicating “totally disagree” to 4 indicating “agree”. The expert validation of the supporting methods was judged from five aspects: feasibility, explanatory, usability, university, and understanding. It can be seen from Table 4.7 that as for the feasibility, usability, and university, the CVI value do not exceed 0.8, the other two items exceed 0.8, and the IRA value is 0.80, which means that the specific guidelines need to be modified in terms of feasibility, usability, and university. Besides, the experts emphasize that it would increase the universality of the specific guidelines if the group awareness tool can be adaptable to a variety of open-ended discussion topics in different disciplines (e.g., educational technology, language studies, psychological studies). The results of the overall evaluation of specific guidelines in shown in Table 4.8.

The expert validation result for individual specific guidelines is shown in Table 4.9. It can be seen that 17 items of CVI value exceed 0.8, but 4 items less than 0.8, which interpreted that experts agreed that these initial specific guidelines had some difficulties in usefulness. The IRA value of 0.94 can be seen that the comments of experts are relatively consistent.

The experts agree that this research is a developmental study of group awareness tool based on specific guidelines in computer-supported collaborative argumentation, and some of the specific guidelines are not related to the group awareness tool, so the association with the group awareness tool should be strengthened. And at the same time, some of the specific guidelines should be added or modified, and unnecessary specific guidelines should be deleted. For example, when introducing the activity, students’ understanding of the activity is very important, and the difference between the general collaborative argumentation and the computer-supported collaborative argumentation activity based on group awareness tool should be emphasized to facilitate students’ better understanding. And the specific guideline 1.3. that provides examples of general collaborative argumentation can be deleted. Besides, “state the steps and rules of collaborative argumentation activities” should be changed to “state the steps and rules of computer-supported collaborative argumentation based on group awareness tool”.

And the experts also pointed out that some of the specific guidelines need to be further specified, such as the specific guideline 3.3., it should clarify how the roles among group members will be allocated. Therefore, the role assignments of group members can be designated as leader, organizer, time controller, and summary publisher.

Besides, for learners to better review and summarize the argumentation activity in the reflection phase, “record when they checked the group awareness tool and how to adjust their study activities after checking” should be added. According to the revised design principles for group awareness tool, the specific guideline 4.9. should be revised to “remind the learners to

check the group awareness tool three times in the initial stage of discussion, discussion progress stage, summary and reflection stage". The contents in Table 4.10 below are summarized. The revised specific guidelines are shown in Table 4.11.

Table 4.8 Expert Validation Result for Overall Specific Guidelines

	Expert			M	SD	CVI	IRA
	A	B	C				
Feasibility	3	2	3	2.67	0.47	0.67	0.80
Explanatory	3	4	3	3.33	0.47	1	
Usability	3	3	2	2.67	0.47	0.67	
University	3	2	3	2.67	0.00	0.67	
Understanding	4	3	4	3.67	0.47	1	

Table 4.9 The Expert Validation Result for Individual Specific Guidelines

Phase	Segmented activities	Specific guidelines	Tool	Expert			M	SD	CVI	IRA
				A	B	C				
Activity introduction	Collaborative argumentation activity introduction	1.1. Introduce the significance of collaborative argumentation activity, goals, good conditions of collaborative argumentation, and the importance of group awareness tool in the CSCL environment.	Introducing PPT	3	3	4	3.33	0.47	1	
		1.2. Introduce the usage on Moodle platform, the usage of group awareness tools, and try to use group awareness tool.		4	3	4	3.67	0.47	1	

		1.3. Provide examples of collaborative argumentation activity.		3	3	2	2.67	0.47	0.67	
	Formulate the rules of collaborative argumentation activities	2.1. State the steps and rules of collaborative argumentation activities, to better understand the activity.		3	3	2	2.67	0.47	0.67	
Collaborative argumentation activity	Prior preparation of activity	3.1. Put forward unstructured discussion topics without standard answers and provide relevant prior knowledge related to the discussion topic to promote effective collaborative argumentation.	Introducing PPT	3	2	3	2.67	0.47	0.67	0.94
		3.2. Describe Toulmin's argumentation model (1958) and make learners better understand the composing factors of argumentation.	Introducing PPT	3	3	3	3	0	1	
		3.3. Before the activity of collaborative argumentation activity, allocate roles among group members.		2	3	3	2.67	0.47	0.67	
	Collaborative	4.1. Structure the argumentation process and record, with premise of not lowering active interaction among learners.	Record paper of argumentation process	3	4	4	3.67	0.47	1	
		4.2. Provide learners' cognitive, behavioral, and social awareness information at the same time.	Group awareness tool	3	4	4	3.67	0.47	1	
		4.3. Provide the contribution level and participation information of group members.	Group awareness tool	3	3	4	3.33	0.47	1	

	argumentation activity	4.4. Provide learners' understanding level to prior knowledge.	Group awareness tool	3	4	3	3.33	0.47	1	
		4.5. Provide information about the progress of group discussion	Group awareness tool	3	4	3	3.33	0.47	1	
		4.6. Provide learners' information about which behavior they are in.	Group awareness tool	4	4	4	4	0	1	
		4.7. Provide information about the interaction among group members.	Group awareness tool	3	4	4	3.67	0.47	1	
		4.8. Provide comparative information of knowledge and participation among learners.	Group awareness tool	3	4	4	3.67	0.47	1	
		4.9. Teacher reminds learners to check group awareness tools.		3	3	3	3	0	1	
Group reflection and plan revision	Conclusion publication	5.1. Publish the argumentation conclusion of the group in the whole class.		3	3	4	3.33	0.47	1	
	Group reflection	6.1. For the process and results of the argumentation activity, first conduct the individual assessment, and then conduct group assessment.	Individual assessment paper and group assessment paper	3	3	4	3.33	0.47	1	
		6.2. During the group reflection, discuss the difficulties experiencing during the collaborative argumentation, well-done parts, insufficient parts, and improvement plan.		3	4	3	3.33	0.47	1	
	Feedback is given by teacher	7.1. The teacher not only need to give feedback to the argumentation activity, but also give feedback about the same difficulties coming across during		3	4	4	3.67	0.47	1	

		the argumentation activity.								
Plan revision	Plan revision	8.1. Review the argumentation activities last week and revise the plan of argumentation activities next week.		4	3	4	3.67	0.47	1	

Table 4.10 The Revising Suggestions for Specific Guidelines by Experts

Category	Suggestions	Revised areas
Activity introduction	When introducing the activity, students' understanding of the activity is very important, and the difference between the general collaborative argumentation and the computer-supported collaborative argumentation activity based on group awareness tool should be emphasized to facilitate students' better understanding.	Add appropriate specific guideline.
	This activity is a computer-supported collaborative argumentation activity based on group awareness tool, so the specific guideline that provides examples of general collaborative argumentation activity can be deleted.	Delete unnecessary specific guideline.
	State the steps and rules of computer-supported collaborative argumentation based on group awareness tool.	"State the steps and rules of collaborative argumentation activity" should be changed to "state the steps and rules of computer-supported collaborative argumentation based on group awareness tool".
	Before the activity, it should clarify how the roles among group members will be allocated.	The role assignments of group members can be designated as leader, organizer, time controller,

		and summary publisher.
Collaborative argumentation activity	For learners to better review and summarize the argumentation activity in the reflection phase, "record when they checked the group awareness tool and how to adjust their study activities after checking" should be added.	Add appropriate specific guideline.
	According to the initial stage of discussion, discussion progress stage, and discussion summary reflection stage. It is necessary to modify the specific guideline.	"Teacher reminds learners to check group awareness tool twice" can be changed to "Teacher reminds learners to check group awareness tool three times in the initial stage of discussion, discussion progress stage and discussion summary reflection stage".

Table 4.11 Modified Specific Guidelines

Phase	Segmented activities	Specific guidelines	Tool
Activity introduction	Collaborative argumentation activity introduction	1.1. Introduce the significance of collaborative argumentation activity, goals, good conditions of collaborative argumentation, and the importance of group awareness tool in the CSCL environment.	Introducing PPT
		1.2. Introduce the usage on Moodle platform, the usage of group awareness tools, and try to use group awareness tool.	
		1.3. Introduce the difference between the general collaborative argumentation and the computer-supported collaborative argumentation activity based on group awareness tool.	

	Formulate the rules of collaborative argumentation activities	2.1. State the steps and rules of computer-supported collaborative argumentation based on group awareness tool, to better understand the activity.	
Collaborative argumentation activity	Prior preparation of activity	3.1. Put forward unstructured discussion topics without standard answers and provide relevant prior knowledge related to the discussion topic to promote effective collaborative argumentation.	Introducing PPT
		3.2. Describe Toulmin's argumentation model (1958) and make learners better understand the composing factors of argumentation.	Introducing PPT
		3.3. Before collaborative argumentation activity, allocate roles as leader, organizer, time controller, and summary publisher among group members.	
	Collaborative argumentation activity	4.1. Structure the argumentation process and record, with the premise of not lowering active interaction among learners.	Record paper of argumentation process
		4.2. Learners record when they checked the group awareness tool and how to adjust their study activities after checking.	Record paper of argumentation process
		4.3. Provide learners' cognitive, behavioral, and social awareness information at the same time.	Group awareness tool
		4.4. Provide the contribution level and participation information of group members	Group awareness tool
		4.5. Provide learners' understanding level to prior knowledge	Group awareness tool
		4.6. Provide information about the progress of group discussion	Group awareness tool

		4.7. Provide learners' information of which behavior they are in.	Group awareness tool
		4.8. Provide information about the interaction among group members.	Group awareness tool
		4.9. Provide comparative information of knowledge and participation among learners.	Group awareness tool
		4.10. Teacher reminds learners to check group awareness tool three times in the initial stage of discussion, discussion progress stage, and discussion summary reflection stage.	
Group reflection and plan revision	Conclusion publication	5.1. Publish the argumentation conclusion of the group in the whole class.	
	Group reflection	6.1. For the process and results of the argumentation activity, first conduct the individual assessment and then conduct group assessment.	Individual assessment paper and group assessment paper
		6.2. During the group reflection, discuss the difficulties experiencing during the collaborative argumentation, well-done parts, insufficient parts, and improvement plan.	
	Feedback is given by the teacher	7.1. The teacher not only need to give feedback to the argumentation activity, but also give feedback about the same difficulties coming across during the argumentation activity.	
Plan revision	Plan revision	8.1. Review the argumentation activities last week and revise the plan of argumentation activities next week.	

Finally, experts believe that in the process of collaborative argumentation, the activities involving the teacher and learners are different and need to be controlled within a limited time. The activities of the teacher and learners need to be clarified. Therefore, according to the steps of the collaborative argumentation activity and the instructional requirements, the researcher designed teaching and learning activities as shown in Table 4.12 below.

Table 4.12 The Design of Instructional Activities for Collaborative Argumentation

The first week			
Stage	**Teacher Activities**	**Group Activities**	
Preparation Phase	• Introduce the activity and provide introduction materials • Distribute discussion summary letter and record paper of argumentation process	• Participate in learners' response through a questionnaire(pre-test) • Write individual argument • Comment activity • Assign roles to group members	40mins
Collaborative argumentation activity	• Observe collaborative argumentation activity and provide appropriate guidance when necessary • In the collaborative argumentation activity, remind learners to check the group awareness tool • Teacher checks the argumentation situation of each group through the teacher interface and records the problems that need attention and improvement of the learners.	• According to the role assignments, conduct collaborative argumentation activity within the specified time • Each group member can check the information provided by the group awareness tool at any time	50mins
Group publication	• Teacher listens to the argument conclusion of each group and gives feedback	• Each group publishes the argument conclusion of the group.	20mins
Group reflection	• Teacher gives feedback on the difficulties encountered by each group in collaborative argumentation activity • Distribute individual assessment paper and group assessment paper	• Each group member first conducts the individual assessment, and then conduct group assessment. • Discuss what what did well, what did not do well, and what needed improvement in the first week's collaborative argumentation activity.	20mins

Plan revision for next week	• Each group plans revision for next week based on the results of group reflection and the feedback given by the teacher.		10mins

The second week			
Stage	**Teacher Activities**	**Group Activities**	
Preparation Phase	• Teacher explains the collaborative argumentation activity this week.	• Write individual argument • Comment activity • Each group can redistribute group roles according to the learning characteristics of group members.	40mins
Collaborative argumentation activity	• Observe collaborative argumentation activity and provide appropriate guidance when necessary. • In collaborative argumentation activity, remind learners to check group awareness tool.	• According to the role assignments, conduct collaborative argumentation activity within the specified time. • Each group member can check the information provided by the group awareness tool at any time.	50mins
Group publication	• Teacher listens to the argument conclusion of each group and gives feedback	• Each group publishes the argument conclusion of the group.	20mins
Investigate learners' response		• Participate in learners' responses through a questionnaire(post-test). • Those who agree to participate in the interview participate in the interviews.	

4. Responses of the Learners

4.1 Questionnaire results

In order to confirm the responses of learners on specific guidelines, questionnaire surveys were conducted among 45 learners who participated in the computer-supported collaborative argumentation activity, and a total of 45 questionnaire responses were received. Among the four questions set concerning learners' satisfaction with computer-supported collaborative argumentation activity, the average values are between 3.84 and 4.17, it can be seen that the overall satisfaction is higher. In terms of specific guidelines, the lowest average value is 3.71, and the highest average value is 4.24. The following Table 4.13 is a summary of the learners' responses. As for the study attitude and self-efficacy of computer-supported collaborative argumentation activity and group awareness tool, questionnaire questions are consisted of study attitude towards computer-supported collaborative argumentation activity (1~3), self-efficacy of computer-supported collaborative argumentation activity (4~6), study attitude towards group awareness tool (7~8) and self-efficacy of group awareness tool (9~14). It can be seen that there have been obvious positive changes before and after the computer-supported collaborative argumentation activity. The results of the score gap between the pre-test and post-test through t-verification are shown in Table 4.14.

Table 4.13 The Result of the Learners' Response

Category	Statements	M	SD
Overall satisfaction with collaborative argumentation activity	1. I feel very satisfied with the overall course focusing on collaborative argumentation.	3.84	0.68
	2. I can happily study the content of the course through collaborative argumentation activity.	3.89	0.50
	3. I can better understand the study content in the course through collaborative argumentation activity.	4.13	0.47
	4. I can know about other learners' ideas in the collaborative argumentation activity, which is a very good study experience.	4.17	0.49
Satisfaction with specific guidelines	1. The Introducing PPT on collaborative argumentation activity and group awareness tool provided in advance are useful.	4.20	0.55
	2. Introduce the difference between the general collaborative argumentation and the computer-supported collaborative argumentation activity based on group awareness tool is useful.	4.11	0.57
	3. The procedures and rules stating collaborative argumentation activity based on group awareness tool are useful.	4.23	0.47

	4. The prior knowledge on discussion topics provided is useful.	3.91	0.69
	5. Explaining the argumentation model is useful.	3.77	0.68
	6. Allocating roles before collaborative argumentation activity is useful.	4.19	0.59
	7. Recording the argumentation activity is useful.	4.20	0.52
	8. Learners record when they checked the group awareness tool and how to adjust their study activities after checking are useful.	4.06	0.67
	9. cognitive, behavioral, and social awareness information simultaneously provided by group awareness tool is useful.	4.03	0.48
	10. The information on group members' contribution level and participation provided by the group awareness tool are useful.	3.83	0.65
	11. The information on learners' understanding level of prior knowledge provided by the group awareness tool is useful.	3.91	0.65
	12. Group discussion progress information provided by the group awareness tool is useful.	4.19	0.50
	13. Information of learners' behavioral situations during the discussion provided by the group awareness tool is useful.	4.03	0.56
	14. Interaction among group members provided by the group awareness tool is useful.	4.24	0.50
	15. Comparative information about knowledge and participation among learners provided by the group awareness tool is useful.	3.74	0.69
	16. Teacher reminding learners of checking group awareness tool is useful.	4.06	0.52
	17. The procedure when students conduct the individual assessment first and assess with the group members in the group reflection is useful.	3.71	0.56
	18. During the group reflection, it is useful to discuss the difficulties coming across in the collaborative argumentation, well-done parts, insufficient parts, and improvement plan.	4.04	0.53
	19. The teacher provide feedback not only of argumentation	3.74	0.55

	activities, but also difficulties experienced by learners during the collaboration activities are very useful.		
	20. Reviewing the argumentation activity in the first week and revising plans are useful.	4.11	0.46

Table 4.14 The Result of Study Attitude and Sense of Self-efficacy to Computer-supported Collaborative Argumentation Activity and Group Awareness Tool

Category		M	SD	t	p
Study attitude towards computer-supported collaborative argumentation activity	pre-test	3.92	0.62	5.14	<0.01
	post-test	4.25	0.74		
Self-efficacy of computer-supported collaborative argumentation activity	pre-test	4.06	0.59	4.09	<0.01
	post-test	4.28	0.63		
Study attitude towards group awareness tool	pre-test	3.81	0.73	3.44	<0.01
	post-test	4.13	0.83		
Self-efficacy of group awareness tool	pre-test	3.65	0.64	3.82	<0.01
	post-test	4.10	0.76		

4.2 Interview results

Among the learners who participated in the computer-supported collaborative argumentation activity, five of whom participated in the interview. And the five learners came from five different discussion groups. They all stated that they had participated in online collaborative argumentation activities before, but this is their first time to participate in computer-supported collaborative argumentation activities based on group awareness tool. The content of the interview involved four aspects: overall satisfaction of computer-supported collaborative argumentation based on group awareness, satisfaction with group awareness tool, satisfaction with specific guidelines for computer-supported collaborative argumentation based on group awareness tool, and improvement plans. In their opinions, they were all highly satisfied with the computer-supported collaborative argumentation activity overall.

Firstly, some learners believed that this kind of online collaborative argumentation activity can help learners understand the course content and the ideas of other learners. In addition, it can maintain their study motivation, especially for learners who are not motivated to participate, when group members work together to develop solutions, their participation is enhanced.

I didn't like to refute other people's opinions. In this collaborative argumentation activity, this state seems to have been improved. I will question different views and try to refute them. (Student D)

Because it is the first time to participate in the computer-supported collaborative argumentation activity based on group awareness tool, it is necessary to provide an introduction to this activity in advance, to enhance our understanding of it. (Student B)

In my opinion, it is very important to assign roles before activities. In this way, we can make clear what we need to do and improve the efficiency of solving problems. (Student A)

When conducting group discussions, it may be difficult to continue the discussion because there is no role assignment. (Student C)

From my point of view, because we need to carry out the group reflection after the argumentation activity, I may not remember the specific situation of the argumentation activity without a record paper, and can not provide the basis for the group reflection. (Student B)

Generally speaking, when the discussion meets difficulties, we will check the group awareness tool, while when the discussion goes smoothly, we will forget to check the group awareness tool. Therefore, recording when the group awareness tool was checked is helpful for individual assessment and group reflection. (Student D)

In my opinion, group awareness tool can provide cognitive, behavioral, and social awareness information at the same time. I think it is very comprehensive. In this way, we can fully grasp the progress of the discussion. (Student A)

Because the discussion time is limited, I think the group awareness tool can provide useful information about the progress of group discussion. When we find that the progress of the discussion is lagging, we can adjust it in time. (Student B)

When conducting online group discussion, effective interaction among group members is very important. So I think the interaction among group members provided by the group awareness tool has a positive impact on promoting efficient interaction among group members. (Students E)

If there is no reminder from the teacher, it may lead to forgetting to check the group awareness tool during the discussion. (Student C)

During the discussion, the teacher reminded us to check the group awareness tool before I went to check it. (Student D)

I think group awareness tool can help learners summarize and reflect on their performance, and improve the efficiency of group reflection. (Student A)

Because individual assessments can review and summarize our learning behavior, we can improve our efficiency in group reflection without taking time to review our performance. (Students E)

As far as I am concerned, the teacher's feedback on the difficulties we encountered in the collaborative argumentation activities is very helpful to me. In this way, I can work out specific solutions to improve the efficiency of the collaborative argumentation in the second week. (Student B)

When inquiring about the weakness of the specific guidelines, the learners who participated in the interview mentioned their opinions from these aspects: providing a priori knowledge of the topic of discussion, explaining the argumentation model before the activity, recording the argumentation process, and group awareness tool provide information of the contribution and participation of group members.

Regarding the improvement plan of specific guidelines, learners believe that the introduction materials provided in advance should be more intuitive and easy to understand; we should avoid increasing the psychological burden on learners through the mastery of prior knowledge provided by group awareness tool; each group can select one group member to record the argumentation process; sufficient time should be provided for group reflection. The specific content is as follows Table 4.15.

Table 4.15 Learners' Response of the Specific Guidelines

Category	Statement	Description
	Overall satisfaction with computer-supported collaborative argumentation activities	Through computer-supported collaborative argumentation activities, we can better understand the content of the course and the opinions of other learners.
	Introduction to the activity provided in advance	Learners can more accurately understand the concept, steps, and rules of computer-supported collaborative argumentation activities based on group awareness tool.
	Role assignment before the	Role assignment before the activity can make clear what

	activity	need to do and improve the efficiency of solving problems.
	Record argumentation process and record when the group awareness tool was checked	Recording the argumentation process and when the group awareness tool was checked is helpful for individual assessment and group reflection after the activity.
Strengths	Information provided by group awareness tool	The information of cognitive, behavioral, and social awareness at the same time can reflect the situation of discussion more comprehensively.
		The progress information of the group discussion can help the group members confirm the progress of the discussion and make adjustments in time.
		The interaction among group members can promote efficient interaction among learners after mastering the information of interaction.
	The teacher remind learners to check the group awareness tool.	If the teacher does not remind, learners may forget to check the group awareness tool during the discussion.
	After the activity in the first week, first, conduct the individual assessment, and then conduct group reflection.	It is helpful for learners to summarize and reflect on their performance and improve the efficiency of group reflection.
	The teacher gives feedback about the same difficulties coming across during the argumentation activity.	It is helpful for learners to develop specific solutions to the difficulties experienced in the first week of argumentation activity, which can improve the quality of discussion.
	The eacher can check students' discussions through the teacher interface, so that there is an objective basis for giving feedback.	The contribution and participation information of the group members that the teacher knows helps the teacher to assess the students and give feedback more objectively.
	Provide prior knowledge related to discussion topic	It will cause a burden on learners, especially those with poor mastery of prior knowledge, perhaps leading to a lack of self-confidence and failing to express their views boldly in the discussions.
	Explain the argumentation model before the activity	Discussion should not be stereotyped, and free discussion is better.

Weakness	Each group member record the argumentationin process	Learners may not be able to focus on what the group members are saying, and their thoughts will be interrupted.
	Group awareness tool provides information about the contribution and participation of group members	It will cause psychological burden on the learners with a low degree of contribution and participation.
Improvement	The introduction materials provided in advance should be more intuitive and easy to understand	Compared with PPT, video is more intuitive and easier to understand.
	The learner's mastery of prior knowledge provided by the group awareness tool should avoid psychological burden on learners.	It is better to provide the mastery of the prior knowledge of the whole group, which can avoid the psychological burden on learners who do not grasp well.
	Select one member from each group to record the argumentation process.	If group members all record the argumentation process, they may not be able to concentrate on listening to the opinions of the group members and their thinking will be interrupted. Therefore, it is better to arrange for a group member to record.
	Sufficient time should be provided for group reflection.	After the first-week discussion, learners need to conduct individual assessments first and then conduct group assessments. They also need to discuss the difficulties encountered in the activity with group members, to revise the plan for the argumentation activity next week. Therefore, there may not be enough time for them.

In order to obtain the final specific guidelines, the specific guidelines were modified and improved based on the results of the learners' responses. The comprehensive revision comments for specific guidelines are shown in Table 4.16 below.

Table 4.16 The Comprehensive Revision Comments for Specific Guidelines

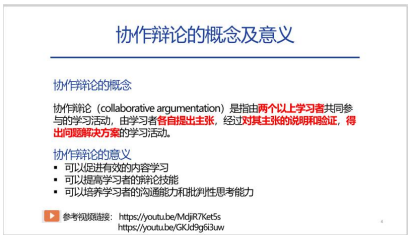
Phase	Segmented activities	Revision Comments

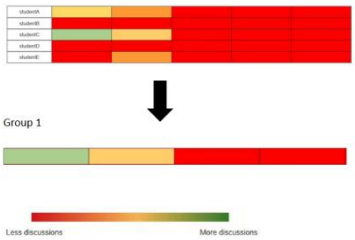
Activity introduction	Collaborative argumentation activity introduction	"PPT introduction materials provided in advance" should be changed to "PPT and video introduction materials provided in advance".
Collaborative argumentation activity	Prior preparation of activity	"Provide relevant prior knowledge related to the discussion topic for learners" should be changed to "Provide relevant prior knowledge related to the discussion topic for the whole group".
		"Explain to the argumentation model before the activity" should be deleted.
	Collaborative argumentation activity	"Each group member records the argumentation process" should be changed to "Assign a group member to record the argumentation process"

5. The Final Specific Guidelines

According to the results of expert validation and learners' response survey, the specific guidelines were finally derived as the following Table 4.17.

Table 4.17 The Final Specific Guidelines

Phase	Segmented activities	Specific guidelines	Tool
Activity introduction	Collaborative argumentation activity introduction	1.1. Introduce the significance of collaborative argumentation activity, goals, good conditions of collaborative argumentation, and the importance of group awareness tools in the CSCL environment.	Introducing PPT & Introduction video Ex: 
		1.2. Introduce the usage on Moodle platform, the usage of group awareness tools, and try to use group awareness tool.	

		1.3. Introduce the difference between general collaborative argumentation and computer-supported collaborative argumentation activity based on group awareness tool.	
	Formulate the rules of collaborative argumentation activities	2.1. State the steps and rules of computer-supported collaborative argumentation based on group awareness tool, to better understand the activity.	
Collaborative argumentation activity	Prior preparation of activity	3.1. Put forward unstructured discussion topics without standard answers and provide the group's mastery of prior knowledge related to the discussion topic to promote effective collaborative argumentation. (Provide the group's mastery of prior knowledge) Ex:  	Introducing PPT
		3.2. Before the collaborative argumentation activity, allocate roles as leader, organizer, time controller, and summary publisher among group members.	
		4.1. Structure the argumentation process and record, with the premise of not lowering active interaction among learners. (Assign a group member to do the record work)	Record paper of argumentation process

	Collaborative argumentation activity	4.2. Learners record when they checked the group awareness tool and how to adjust their study activities after checking. (Assign a group member to do the record work)	Record paper of argumentation process
		4.3. Provide learners' cognitive, behavioral, and social awareness information at the same time.	Group awareness tool
		4.4. Provide the contribution level and participation information of group members	Group awareness tool
		4.5. Provide learners' understanding level of prior knowledge	Group awareness tool
		4.6. Provide information about the progress of group discussion	Group awareness tool
		4.7. Provide learners' information of which behavior they are in.	Group awareness tool
		4.8. Provide information about the interaction among group members.	Group awareness tool
		4.9. Provide comparative information of knowledge and participation among learners.	Group awareness tool
		4.10. Teacher reminds learners to check group awareness tool three times in the initial stage of discussion, discussion progress stage, and discussion summary reflection stage.	
	Conclusion publication	5.1. Publish the argumentation conclusion of the group in the whole class.	
	Group reflection	6.1. For the process and results of the argumentation activity, first conduct the individual assessment and then conduct	

Group reflection and plan revision		group assessment.	Individual assessment paper and group assessment paper
		6.2. During the group reflection, discuss the difficulties experienced during the collaborative argumentation, well-done parts, insufficient parts, and improvement plan.	
	Feedback is given by the teacher	7.1. The teacher not only need to give feedback to the argumentation activity, but also give feedback about the same difficulties coming across during the argumentation activity.	
Plan revision	Plan revision	8.1. Review the argumentation activities in the last week and revise the plan of argumentation activities for the next week.	

Ⅴ. DISCUSSION AND CONCLUSION

1. Discussion

This study aims to promote computer-supported collaborative argumentation based on group awareness tool through the design principles and specific guidelines developed. This study is learner-centered, focusing on exploring the learning process. In addition, in order to improve the quality of computer-supported collaborative argumentation in the second week, this study focuses on learners' self-reflection, group reflection, and feedback given by the teacher to assess the process of collaborative argumentation activities.

According to the survey of learners' responses, it can be seen that the developed design principles and specific guidelines have a positive impact on learners' learning attitude, self-efficacy and knowledge construction.

First of all, although this study is still insufficient in scientifically demonstrating its effectiveness, it can be verified in the content of the learners' response survey. Because this study

is learner-centered, the participation of learners is essential. It can be seen from the results of the learners' response that the learner has changed from a skeptical attitude to a positive attitude towards computer-supported collaborative argumentation activities based on group awareness tool. The research of Bodemer & Dehler (2011) also confirmed that in collaborative learning, group awareness information could have a positive impact on learning progress and results. This study can prove that the actual carrying out of computer-supported collaborative argumentation activities has instructional significance, because the computer-supported collaborative argumentation can deeply learn knowledge related to the discussion topics and better understand the course's content.

Furthermore, the point of most learners is that they can fully express their position and listen to the opinions of other learners through computer-supported collaborative argumentation activities. This study aims to develop design principles and specific guidelines for computer-supported collaborative argumentation activities based on group awareness tool. Therefore, the learners' satisfaction with group awareness tool is also an essential part of the learners' response survey. Through questionnaires and interviews, learners indicated that group awareness tool had played a positive role in computer-supported collaborative argumentation activity. For example, learners have affirmed that the cognitive, behavioral, and social awareness information provided by group awareness tool can fully grasp the learning status of accompanying learners and the current group and adjust learning behavior in time. The feedback of discussion progress can enhance the sense of self-efficacy and significantly affect learners to maintain learning motivation continuously. In addition, the interactive information between group members provided by the group awareness tool can promote the team's collaboration relationship closer. And it can help group members discuss collaboration strategies, evaluate and reflect on their collaborative methods. This is consistent with the results of Phielix, Prins, & Kirschner (2010).

Finally, computer-supported collaborative argumentation based on group awareness tool can promote collaborative knowledge construction. Collaborative knowledge construction is a learning process that encourages mutual assistance and mutual encouragement between learners and the collaborative problem-solving of group dynamics and group performance. In this study, computer-supported collaborative argumentation based on group awareness tool can change the situation that learners dare not question the different views put forward by others. It can be seen from the survey of learners' responses that some learners have apparent changes in their study attitude and self-efficacy before and after participating in collaborative argumentation activity based on group awareness tool. In particular, some learners do not like to refute others' opinions. The learners indicated that this situation had been changed to a certain extent in this activity, and they began to question and deny different views. Sangin and colleagues (2011) also indicated that group awareness could trigger verification and judgment and help with collaborative learning. It is worth mentioning that computer-supported collaborative argumentation is the process of constantly proposing opinions, explaining opinions, refuting and verifying different ideas, evaluating and judging the accepted new ideas, and finally proposing the best solution. And the construction of collaborative knowledge is formed to raise objections and verify different views

(Clark, 2013). Therefore, this process can strengthen the depth of interaction between learners and promote collaborative knowledge construction.

2. Conclusion and Suggestions

This study aims to verify the teaching value of computer-supported collaborative argumentation based on group awareness tool, and develop design principles and specific guidelines. Compared with the general computer-supported collaborative argumentation activities, this study provides learners with cognitive, behavioral, and social awareness information in the process of argumentation through the support of group awareness tool to adjust their learning activities in time and improve the interaction between learners. Firstly, the initial design principle of group awareness tool and initial specific guidelines were developed by reviewing the previous literature. Then, expert validation was conducted for the initial design principle of group awareness tool and initial specific guidelines by three educational technology experts. The initial design principle and initial specific guidelines were revised and improved based on the revised opinions proposed by experts. After that, the modified specific guidelines were applied to the two-week teaching activities, and the teacher and researchers observed the argumentation activities. After the activities, the learners' response survey was conducted on the learners who participated in the argumentation activities. The learners were generally satisfied with the specific guidelines but also put forward suggestions for improvement. Finally, considering the disadvantage and improvement plans proposed by the learners, the final specific guidelines were developed.

Firstly, this research aims to confirm the teaching and learning significance of computer-supported collaborative argumentation activity and provide design principles and specific guidelines of great importance. This study organized learners participate in a two-week computer-supported collaborative argumentation activity, which can deeply explore the difficulties encountered in the process of collaborative argumentation. Through individual assessment, group reflection, and feedback is given by the teacher, practical and effective solutions were developed.

Furthermore, in order to address the lack of information of accompanying learners in the CSCL learning process, the group awareness tool in this research deeply explores the online collaborative learning process. It deeply analyzes the behavior pattern and interaction of learners in collaborative learning to provide learners with real-time dynamic group awareness information during learning activities. Therefore, the developed design principles and specific guidelines for group awareness tool in this research can find the way out of difficulty encountered by learners in collaborative argumentation activities to a certain extent, promote the interaction between learners, and improve the efficiency of collaborative learning. Jonassen & Kwon (2001) also confirmed that the interaction between learners is one of the critical factors affecting collaborative learning. In

future computer-supported collaborative argumentation activities, this study's design principles and specific guidelines can be used as reference.

Finally, while carrying out computer-supported collaborative argumentation, this study also explored the role of group awareness tool in computer-supported collaborative argumentation. For example, how learners adjust their learning based on the awareness information provided by group awareness tool, what disadvantages of group awareness tool are, and what impact it has on learners' psychology. The value of group awareness tool in CSCL should be the realization of interactive quality in a non-face-to-face environment. The application of group awareness tool in the CSCL environment is also to test whether group awareness tool will produce better collaborative learning in terms of process and results. Therefore, this study also has particular reference significance for the future research of group awareness tools in CSCL.

The limitations of this study and suggestions for follow-up research are as follows. The first limitation is related to the composition of the group. In computer-supported collaborative argumentation activities based on group awareness tool, the teacher should allocate groups scientifically and reasonably according to the ratio of male to female, academic level, and personality characteristics, and make adjustments when necessary. For example, more extroverted students will dominate the discussion in group discussions, while introverted students will be excluded. For this reason, the teacher is required to allocate appropriate roles according to the characteristics of learners to facilitate the complementary advantages of learners and make the learning resources of each group relatively balanced. As for the role assignment before the discussion can also be based on the characteristics of each learner in the group, so that the learners can clarify the tasks and give full play to their advantages.

Secondly, this study has only been carried out on one course for two weeks, and only 45 students in one class participated in the actual teaching activities. And the study is aimed at first-year university learners. These can influence the universality and promotion value of research conclusions. Therefore, it is necessary to further explore and deepen relevant research in the future to obtain more generalizable data.

Moreover, in the collaborative argumentation activities based on group awareness tool, visual feedback to learners' cognitive, behavioral, and social awareness information may have a negative impact on collaborative learning. Although according to the recommendations of expert validation, each group member can only obtain information feedback from himself and the current group, which somehow reduces the psychological burden on learners, but for learners who do not perform well, it may also increase learners' psychological pressure and even cause learner's rebellious psychology. Therefore, the information feedback in the group should not increase the psychological burden on learners. According to Buder (2011), the main task of group awareness tool is to promote collaboration, not to monitor learners. And the group awareness information may infringe on learners' privacy and disturb their learning.

Finally, because the current research on group awareness tool is still in its infancy, there is no research to confirm which group awareness tool can best match learners' characteristics and

improve learning outcomes. Therefore, these aspects need to be explored in future research urgently: what is the way of group awareness information generation, how to make learners combine the group awareness information with their learning behavior, and finally make decisions according to the group awareness information, whether the learners have made correct decisions on the adjustment of learning behavior, and what is the effect of the adjustment, and how to balance the primary task (collaboration) and the secondary task (monitoring) in the design of group awareness tool.

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APPENDIXES

Appendix 1 Discussion Summary Letter

Appendix 2 Record Paper of Argumentation Process

Appendix 3 Individual Assessment paper

Appendix 4 Group Assessment Paper

Appendix 5 The Expert Validation for Supporting Methods Based on Group Awareness Tool in Collaborative Argumentation

Appendix 6 Questionnaire (pre-test)

Appendix 7 Questionnaire (post-test)

Appendix 8 Interview Outline for Learners

Appendix 1

Discussion Summary Letter

Date			Group: Name:	
Topic				
Background information				
Core concepts				
Target				
Procedure		Content	My opinions	Time
Start		Propose the topic		5min
Confirmation of questions		According to necessity of questions, importance and other information, confirm the questions, which need discussing.		5min
Develop discussion	Understanding of questions	Exchange relevant information and knowledge of questions such as reasons, current status and development trend in the future.		10min
	Discussion on solutions	Conduct multi-level discussion on the program, which can solve problems.		10min
	Achieve solutions	Discuss multiple solutions and achieve the most appropriate		10min

		solutions.		
Arrangement		Arrange the discussion results		10min

Appendix 2

Record paper of argumentation process

Please record the arguments of the group members in computer-supported collaborative argumentation activity, what they did well, what they did not do well, when they checked the group awareness tool and how they adjusted their learning behaviors after checking the group awareness tool in the table below.				
Group		Name		
Discussion topic				
My argument				
Statement				
Based on				
Well done parts				
Limited part				
When did you check the group awareness tool				
How to adjust learning behavior				
Group member's argument				
	Statement	Basis	Well done parts	Limited parts
Name of member				
Name of member				
Name of member				
Final solution of the group				

Appendix 3

Individual Assessment paper

Please assess your performance in the computer-supported collaborative argumentation activity just now. The scale ranging from 1 to 4 points.				
Item	**4 point**	**3 point**	**2 point**	**1point**
Explicitly put forward statement	Have very explicitly put forward statement	Explicitly put forward statement	Although he or she has proposed the statement, but it is not explicit and very unclear.	No statement
Come up with reasonable reasons	Come up with two or more reasonable reasons supporting the statement	Come up with one reasonable reason supporting the statement	Although they have come up with reasons, they cannot support statement	No reasons
Come up with specific bases	Come up with two or more bases upholding rationality	Come up with one basis to specifically explain the rationality of the statement	Although basis is come up with, it cannot specifically explain the rationality of the statement.	No reasons
Consider dissenting opinions	Consider two or more rebuts to the statement and respectively put forward negative arguments to the rebuts	Consider one rebut to the statement and respectively put forward negative arguments to the rebuts	Although it has considered the rebut to the statement, do not come up with negative arguments to the rebuts	Do not consider the rebut to the statement.
Application of teaching theory	Come up with two or more opinions of applying the teaching theory	Come up with one opinion of applying the teaching theory	Although the opinion has proposed, it is insufficient in applying it to teaching theory	The opinions come up with do not apply the teaching theory.
Put forward ingenious opinions	Come up with two or more original opinions for the	Come up with one original opinion for the statement	Although they have proposed opinions, the originality is	Do not come up with opinions to the statement.

	statement		insufficient.	

Appendix 4

Group Assessment Paper

Please make a group assessment of the computer-supported collaborative argumentation activity just now. The scale ranging from 1 to 4 points.				
Item	**4 point**	**3 point**	**2 point**	**1 point**
Equal participation	In the collaborative argumentation activity, the whole group members have all actively participated in.	In the collaborative argumentation activity, although all members have taken part in, in partial process, the participation is not active.	In the collaborative argumentation activity, it is mainly implemented with only one or two members	In the collaborative argumentation activity, all members' participation level is low.
Group members propose different opinions	The members in each group have proposed different specific opinions	Although group members propose two or more opinions, they are not very specific.	Group members only propose one same opinion	No specific opinions.
Discuss the opinions of the other side critically	Members in each group have discussed critically the opinions of the other side.	Members in each group have discussed opinions critically of the other side, but the discussion is not thorough.	Only discuss partial critical opinions proposed.	Do not critically discuss to the opinions proposed.
Propose the changing opinion by verifying and accepting different opinions.	Propose one or two changing opinions by verifying and accepting different opinions.	Propose one changing opinion by verifying and accepting different opinions.	Do not propose the changing opinion after verifying and accepting different opinions.	Do not realize opinions change at all after verifying and accepting different opinions.
Propose comprehensive solution after considering	Acquire the solution after fully considering the	Acquire the solution only considering part of the opinions	Only take one or two opinions in the opinions proposed.	Do not reach consistent opinions for the opinions

multiple opinions	opinions proposed.	proposed.		proposed.

Appendix 5

The Expert Validation Result of Design Principles and Specific Guidelines for Group Awareness Tool in Computer-supported Collaborative Argumentation

The following are the expert validation of the design principles for group awareness tool and the specific guidelines of collaborative argumentation based on group awareness tool, mainly to assess the feasibility of design principles and specific guidelines. Please mark them in applicable places (V), and write down your revising suggestions.

1.Expert Validation Result of Design Principles for Group Awareness Tool

(1) Expert Validation Result of Overall Design Principles for Group Awareness Tool

Item	Content	Quiet disagree (1 point)	Disagree (2 point)	Agree (3 point)	Quiet agree (4 point)
Feasibility	The design principle of group awareness tool is an applicable and reasonable design principles for computer-supported collaborative argumentation based on group awareness tool.				
Explanatory	The design principle of group awareness tool has interpreted the applicable design principles for computer-supported collaborative argumentation based on group awareness tool very well.				
Usability	The design principle of group awareness tool can be effectively applied to computer-supported collaborative argumentation based on group awareness tool.				
University	The design principle of group awareness tool can be broadly used for computer-supported collaborative argumentation based on group awareness tool.				

Understanding	The design principle of group awareness tool is the applicable design principle for computer-supported collaborative argumentation based on group awareness tool and can be understood easily.				

(2) Expert Validation Result of Individual Design Principles for Group Awareness Tool

Item	**Content**			**Quiet disagree (1 point)**	**Disagree (2 point)**	**Agree (3 point)**	**Quiet agree (4 point)**
Design principle	**Explanation**		**Actual display**				
1.Provide cognitive, behavioral and social awareness information at the same time.	cognitive awareness information	Present with the visualized chart on group discussion focus, topic, activation degree and knowledge novelty. As shown in Figure 4.2.1, Figure 4.2.2, Figure 4.2.3, Figure 4.2.4.	Data analysis and calculation of cognitive awareness information should take knowledge chart formulated in advance as criteria and generate visualized chart by comparing the discussion content and knowledge points of learners.				
	Behavioral awareness information	Present with the pie chart of behavioral model, as shown in Figure 4.2.5, Figure 4.2.6.	Behavioral awareness information codes the collaborative discussion content and generates the appearance frequency of level 1 and level 2 behavioral models and calculating proportion graph,				

			which are presented with the pie chart.				
	Social awareness information	Present with the interactive relations chart of number of messages left, time of leaving the message and learners. As shown in Figure 4.2.7, Figure 4.2.8, Figure 4.2.9.	Social awareness information is presented after calculating the number of learners' messages left, learners' interaction,etc. on Moodel platform.				
2.Adopt implicit, dynamic, free and closed display	In accordance with the comparative analysis on various ways of presentation of typical events of group awareness tools in the above text, the research will adopt implicit, dynamic, free and closed ways of presentation.						
3.Appropriately monitor study activities	①Monitoring knowledge generation and construction.		As shown Figure 4.2.1, Figure 4.2.2, Figure 4.2.3, Figure 4.2.4.				
	②Monitoring what learners' behaviors are during the collaborative learning.		As shown in Figure 4.2.5, Figure 4.2.6.				
	③ Monitoring the interaction among learners.		As shown in Figure 4.2.7, Figure 4.2.8, Figure 4.2.9.				
4.The way of comparing awareness information among learners should be simple.	Most group awareness tools have the functions of comparing knowledge and participation degree of learners. If the way of comparison is complicated, it will cause learners burden and wrong understanding to awareness information will hinder study. Therefore, the way of comparison of awareness information must be simple.		As shown in Figure 4.2.2, Figure 4.2.3, Figure 4.2.4, Figure 4.2.7, Figure 4.2.8.				

5.During the process of collaborative argumentation, remind learners of checking group awareness tools twice.	During the collaborative study, learners should adjust behaviors decidedly after acquiring the awareness information. In this way, it can make the team work towards one direction. Therefore, the study will remind learners of checking group awareness tool twice during the collaborative argumentation.					

(3)The Revising Suggestions for Design Principles:

2.Expert Validation for the Initial Specific Guidelines

(1) Expert Validation for Overall Specific Guidelines

Item	Content	Quiet disagree (1 point)	Disagree (2 point)	Agree (3 point)	Quiet agree (4 point)
Feasibility	The specific guideline is an applicable and reasonable guideline to promote computer-supported collaborative argumentation based on group awareness tool.				
Explanatory	The specific guideline has interpreted the applicable guideline for promoting computer-supported collaborative argumentation based on group awareness tool very well.				

Usability	The specific guideline can be effectively applied in order to promote computer-supported collaborative argumentation based on group awareness tool.				
University	The specific guideline is to promote computer-supported collaborative argumentation based on group awareness tool and can be broadly used.				
Understanding	The specific guideline is the applicable guideline for promoting computer-supported collaborative argumentation based on group awareness tool and can be understood easily.				

(2) Expert Validation for Individual Initial Specific Guidelines

Item		**Content**		**Quiet disagree (1 point)**	**Disagree (2 point)**	**Agree (3 point)**	**Quiet agree (4 point)**
Phase	**Segmented activities**	**Specific guidelines**	**Tool**				
Activity introduction	Collaborative argumentation activity introduction	1.1. Introduce the significance of collaborative argumentation activity, goals, good conditions of collaborative argumentation and the importance of group awareness tools in CSCL environment.	Introducing PPT				
		1.2. Introduce the usage on Moodel Platform, the usage of group awareness tools and try to use group awareness tool.					
		1.3. Provide examples of collaborative argumentation activity.					
	Formulating the rules of collaborative argumentation	2.1. State the steps and rules of collaborative argumentation activities, so as to better understand the activity					

	activities						
Collaborative argumentation activity	Prior preparation of activity	3.1. Put forward unstructured discussion topics without standard answers and provide relevant prior knowledge related to the discussion topic in order to promote effective collaborative argumentation.	Introducing PPT				
		3.2. Describe Toulmin's argumentation model (1958) and make learners better understand composing factors of argumentation.	Introducing PPT				
		3.3. Before the activity of collaborative argumentation activity, allocate roles among group members.					
	Collaborative argumentation activity	4.1. Structure the argumentation process and record, record activities will take the premise of not lowering active interaction among learners.	Record paper of argumentation process				
		4.2. Provide learners' cognitive, behavioral, and social awareness information at the same time.	Group awareness tool				
		4.3. Provide the contribution level and participation information of group members.	Group awareness tool				
		4.4. Provide learners' understanding level to prior knowledge.	Group awareness tool				
		4.5. Provide information about the progress of group discussion.	Group awareness tool				
		4.6. Provide learners' information on which behavior they are in.	Group awareness tool				
		4.7. Provide the information about the interaction among group members.	Group awareness tool				

		4.8. Provide comparative information of knowledge and participation among learners.	Group awareness tool				
		4.9. Teacher remind learners to check group awareness tools.					
Group reflection and plan revision	Group reflection	5.1. For the process and results of the argumentation activity, first conduct individual assessment, and then conduct group assessment with group members.	Individual assessment paper and group assessment paper				
		5.2. During the group reflection, discuss the difficulties experienced during the collaborative argumentation, well done parts, insufficient parts and improvement plan.					
	Conclusion publication	6.1. Publish the argumentation conclusion of the group in the whole class.					
	Feedback given by teachers	7.1. Teacher not only need to give feedback to the argumentation activity, but also give feedback about the same difficulties coming across during the argumentation activity.					
Plan revision	Plan revision	8.1. Review the argumentation activities in the last week and revise the plan of argumentation activities of the next week.					

(3)The Revising Suggestions for Initial Specific Guidelines：

Appendix 6

Questionnaire (pre-test)

The following is a survey on the overall satisfaction of computer-supported collaborative argumentation based on group awareness tool.						
	Statements	**Totally Disagree (1 point)**	**Disagree (2 point)**	**General (3 point)**	**Agree (4 point)**	**Totally agree (5 point)**
1	I like discussing logically with other learners.					
2	Through the computer-supported collaborative argumentation activity, I think learning knowledge is fun.					
3	I think computer-supported collaborative argumentation activity helps to my study.					
4	I can consider many opinions in computer-supported collaborative argumentation activity.					
5	I can express my statement better in computer-supported collaborative argumentation activity.					
6	I think I can do better in the computer-supported collaborative argumentation activity in the class.					
7	I should like using group awareness tool during the computer-supported collaborative argumentation activity, which can be reliably used very well.					
8	I think the usage of group awareness tool is simpler.					
9	I think I can acquire the group awareness information what I want with group awareness tool.					
10	I think if I use the group awareness tool, it can help to conduct the collaborative argumentation activity.					
11	I think in the collaborative argumentation activity, it will not hinder my learning activities, and will not cause me a psychological burden by checking group awareness tool.					

12	I think through the collaborative argumentation activity based on group awareness tool, it can help me with knowledge construction.					
13	In the next collaborative argumentation, I can better use group awareness tool.					
14	I can adjust study activities after checking the group awareness tool.					

Appendix 7

Questionnaire (post-test)

Below is the satisfaction questionnaire on specific guidelines applicable to computer-supported collaborative argumentation activity and overall satisfaction with computer-supported collaborative argumentation activity in the past two weeks. A scale was used to measure the responses ranging from 1 indicating "totally disagree" to 5 indicating "totally agree".						
	Statements	**Totally Disagree (1 point)**	**Disagree (2 point)**	**General (3 point)**	**agree (4 point)**	**Totally agree (5 point)**
1	The Introducing PPT on collaborative argumentation activity and group awareness tool provided in advance is useful.					
2	Introduce the difference between the general collaborative argumentation and the computer-supported collaborative argumentation activity based on group awareness tool is useful.					
3	The procedures and rules stating collaborative argumentation activity based on group awareness tool are useful.					
4	The prior knowledge on discussion topics provided is useful.					
5	Explaining the argumentation model is useful.					
6	Allocating roles before collaborative argumentation activity is useful.					
7	Recording the argumentation activity is useful.					
8	Learners record when they checked the group awareness tool and how to adjust their study activities after checking are useful.					
9	cognitive, behavioral, and social awareness information at the same time provided by group awareness tool is uesful.					
10	The information on group members' contribution level and participation provided by group awareness tool is useful.					
11	The information on learners' understanding level to prior knowledge provided by group awareness tool is useful.					

12	Group discussion progress information provided by group awareness tool is useful.					
13	Information on learners' behavior situation during the discussion provided by group awareness tool is useful.					
14	Interaction among group members provided by group awareness tool is useful.					
15	Teacher reminding learners of checking group awareness tool is useful.					
16	The procedure in which students conduct the individual assessment first and assess with the group members in the group reflection is useful.					
17	During the group reflection, it is useful to discuss the difficulties come across in the collaborative argumentation , well done parts, insufficient parts and improvement plan.					
18	Teacher provide feedback not just to argumentation activities, but also difficulties experienced by learners during the collaboration activities, which is very useful.					
19	Reviewing the argumentation activity in the first week and revising plans are useful.					
20	I feel very satisfied at the overall course focusing on collaborative argumentation.					
21	I can happily study the content of the course through collaborative argumentation activity.					
22	I can better understand the study content in the course through collaborative argumentation activity.					
23	I can know about other learners' ideas in the collaborative argumentation activity, which is a very good study experience.					

Appendix 8

Interview Outline for Learners

overall satisfaction of computer-supported collaborative argumentation based on group awareness tool
1.Have you ever participated in computer-supported collaborative argumentation before?
2.Do you think this computer-supported collaborative argumentation activity is helpful to you? If so, what do you think helps you the most?
3.What is the biggest difficulty you encountered in this computer-supported collaborative argumentation activity?
4.When encountering different opinions, did you actively raise questions and refutations?
Satisfaction with group awareness tool
1. What do you think is the role of group awareness tool in this computer-supported collaborative argumentation activity?
2. During computer-supported collaborative argumentation activity, what is the frequency of checking group awareness tool?
3. When the teacher did not remind you to check group awareness tool, would you actively check group awareness tool?
4. Do you think that checking group awareness tool will cause a psychological burden, especially in the case of poor learning performance.
Satisfaction with specific guidelines for computer-supported collaborative argumentation based on group awareness tool
1.Do you think it is useful to introduce the collaborative argumentation activity and group awareness tool?
2.Do you think it is useful to introduce the difference between the general collaborative argumentation and the computer-supported collaborative argumentation activity based on group awareness tool?
3.Do you think it is useful to state the steps and rules of computer-supported collaborative argumentation based on group awareness tool?
4.Do you think it is useful to provide relevant prior knowledge?
5.Do you think it is useful to describe argumentation model?
6.Do you think it is useful to allocate roles among group members before collaborative argumentation activity?

7.Do you think it is useful to record collaborative argumentation activity?

8.Do you think it is useful to record when they checked the group awareness tool and how to adjust their study activities after checking?

9.Do you think it is useful to provide learners' cognitive, behavioral, and social awareness information at the same time?

10.Do you think it is useful to provide the contribution level and participation information of group members?

11.Do you think it is useful to provide learners' understanding level to prior knowledge?

12.Do you think it is useful to provide information about the progress of group discussion?

13.Do you think it is useful to provide information about learners' behavior in the discussion process provided by group awareness tool?

14.Do you think it is useful to provide the information about the interaction with group members?

15.Do you think it is useful to provide comparative information of knowledge and participation among learners?

16.Do you think it is useful to teacher reminds learners to check group awareness tool?

17.Do you think it is useful to conduct individual assessment first, and then conduct group assessment with group members?

18.Do you think it is useful to discuss the difficulties experienced during the collaborative argumentation, well done parts, insufficient parts and improvement plan during the group reflection?

19.Do you think it is useful to teacher not only need to give feedback to the argumentation activity, but also give feedback about the same difficulties coming across during the argumentation activity?

20.Do you think it is useful to review the argumentation activities in the last week and revise the plan of argumentation activities of the next week?

About Improvement

1.What do you think need to be improved in the specific guidelines?

2.What do you think should be improved in the future computer-supported collaborative argumentation?

국 문 초 록

사회와 과학 기술이 발전함에 따라 사회의 모든 구성원들은 타인과 협력을 통해 문제를 해결해야 하는 상황에 직면하게 된다. 협력학습은 학교에서 협력학습은 실제 교육 활동에 광범위하게 사용된다. 협력학습의 한 형태인 협력적 논증 활동은 학생들의 논증기능을 향상시키고 효과적인 내용학습을 촉진하며 비판적 사고력을 향상시킬 수 있다. 그러나 협력적 논증을 실제 교육 현장에서 적용하는 데 어려움이 있어 협력적 논증은 적극적으로 교육 활동에 활용되지 못하는 경우가 많았다.

특히 컴퓨터 기반 협력학습(CSCL) 분야에서는 팀 구성원 간의 충돌, 무임승차자, 학습자 간의 상호작용이 활발하게 이루어지지 못하는 등 문제가 발생하기 때문에 협력학습이 항상 효과적인 것은 아니다. 또한, CSCL 환경의 경우 인지, 행위, 사회 정보 등과 같은 동료 학습자에 대한 집단 인식 정보를 획듯하지 못하기 때문에 그룹 구성원과 협력하는 어려움이 준재한다.

기존의 연구는 CSCL 분야에서 인지, 행위, 사회 정보를 획득하는 데 어려움을 해결하기 위해 다양한 집단 인식 도구에 대한 개발을 시도하였다. 그러나, 대부분의 집단 인식 도구는 인지, 행동, 사회 인식 정보를 동시에 제공하지 못하며, 학습 활동 과정에 대해 심층적으로 분석하지 못한다. 이러한 집단 인식 도구는 학습 결과의 모니터링과 평가를 하게 하는 것이 대표적이다.

그리고 협력적 논증의 설계와 지원에 대한 기존 연구 중 상당수는 대면환경에서 진행된 연구이며 CSCL 환경에서의 협력적 논증 활동의 방안 설계 및 세부지침에 대한 연구는 많지 않았다.

따라서 본 연구는 컴퓨터 기반 협력적 논증에서 집단 인식 도구 기반의 설계원리와 세부지침을 개발하였다. 본 연구의 연구 문제는 다음과 같다. 첫째, 컴퓨터 기반 협력적 논증에서 집단 인식 도구 기반의 설계원리와 세부지침은 무엇인가? 둘째, 설계원리와 세부지침을 반영한 집단 인식 도구에 대한 학습자의 반응은 어떠한가?

위의 두 가지 문제를 탐구하기 위해 본 연구는 설계개발 연구(유형 2)의 연구방법에 따라 진행하였다. 구체적으로 보면, 선행 연구의 검토를 통해 집단 인식 도구의 설계원리와 집단 인식 도구에 기반한 협력적 논증 활동을 촉진하기 위해 초기 세부지침을 도출하였다. 이후 3 명의 교육공학 전문가를 대상으로 집단 인식 도구의 설계원리와 초기 세부지침의 타당성에 대한 검토를 실시하였다. 전문가의

의견에 따라 초기 세부지침을 수정하고 수정된 세부지침을 45 명의 신입생에게 2 주 동안 적용하였다. 이외에 실제 협력적 논증 활동에 참여한 학생들에 대한 학습자 반응 조사도 실시하였다. 마지막으로 학습자의 설문조사(n=45)와 인터뷰(n=5) 결과를 분석하여 최종 세부지침을 도출하였다.

본 연구에서의 집단 인식 도구는 인지, 행위, 사회 인식 정보를 동시에 제공하며 온라인 학습 활동을 깊이 탐색하는 데 집중한다. 연구결과에 따르면, 집단 인식 도구 기반의 협력적 논증을 통해 일반적인 협력적 논증 활동이 동료학습자 및 현재 그룹 학습상황의 인지, 행위, 사회 인식 정보를 획득하지 못하는 문제를 해결함으로써 학습동기를 지속적으로 유지시킬 수 있는 것으로 나타났다. 또한, 학습자 간 상호작용을 촉진하여 CSCL 학습의 질을 향상시킬 수 있었다. 본 연구의 연구결과를 실제 교육활동에 활용하면 학생들의 논증 능력과 협력적 문제해결력을 향상시킬 수 있을 뿐만 아니라 수업 지식에 대한 이해와 습득을 촉진할 수 있을 것이다.

주요어: 컴퓨터 기반 협력적 논증, 집단 인식, 집단 인식 도구, 학습자 간 상호작용

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