Argumentative Knowledge Construction and Certainty Navigation: A Comparison between Individual and Group Work

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Abstract: This study investigated (the extent to which levels of certainty impacted the argumentative knowledge construction in individual work and group work. Argumentative knowledge construction has been characterized into simple claims, grounds, qualifiers, counterarguments, and integrated replies to illustrate the components of argumentation and nature of resolving conflicts in argumentation where certainty levels have been divided into uncertain, neutral, and certain. Findings showed that individual and group work differed significantly in terms of levels of certainty for simple arguments and counterarguments. Study implications were discussed.

Keywords: Knowledge construction, collaborative argumentation, individual writing, group work, argumentative writing

1. Introduction and Literature Review

In Computer-Supported Collaborative Argumentation (CSCA) research, the argumentative knowledge construction model seeks to understand how social interactions and argumentation processes contribute to knowledge construction and learning (Nguyen & Young, 2022). Through engaging in social interactions and argumentation with others, individuals actively navigate uncertainty by constructing their understanding of a topic, negotiating meaning, and refining their ideas. Existing research on the area of knowledge construction has thus far centered on facilitating knowledge construction through placing the individual in the context of the community around him or her and building on discourse moves and reasoning to construct arguments (Nguyen & Young, 2022). Usage of words indicating certainty has been an area of focus in social interactions as they navigate between advancing their own knowledge and resolving conflicts with others (Tabak & Baumgartner, 2004; Tan et al., 2016). Uncertainty in argumentation in navigating conflict resolution is also demonstrated by using more hedging words (“possibly”, "maybe", and “potentially” etc.) to question and evaluate each other’s claims and evidence (Martinez-Maldonado et al., 2013). However, hedges such as "may" or "perhaps" show a tentativeness to commit i.e., uncertainty. Word such as "actually", showed stronger commitment. Our study investigated the extent to which levels of certainty used would impact argumentative knowledge construction when comparing individual work and group work.

In individual writing, students engage with deep learning of the content, clarify their thoughts and ideas, identify gaps in understanding, develop soft skills, and explore new perspectives on a topic (Harney et al., 2017; Latifi et al., 2020, 2021; Noroozi et al., 2022; Storch, 2005; Valero Haro et al., 2020; Weinberger & Fischer, 2006). Collaborative writing happens when group members contribute their perspectives and ideas to the group's collective efforts, working together to achieve learning outcomes while honing technological literacy, problem-solving, critical thinking, innovation, shared responsibility, belongingness within the group, better mastery of the concepts, interrelationships among concepts, and integration of new concepts with prior knowledge (Asterhan & Schwarz, 2007; (Clark & Sampson, 2007; Mayweg-Paus et al., 2021; Roberts, 2004).

Argumentation fosters higher-order cognitive abilities as students dissent, evaluate, expand, and synergize claims, evidence, and counterarguments to reach conclusions (Harney et al., 2017; Latifi et al., 2020, 2021; Valero Haro et al., 2020). Such higher-order thinking skills involve knowledge construction, concept integration, critical thinking, and reflective judgments (Harney et al., 2017; King, 2002; Lu & Zhang, 2013). Students move from individual work/argumentation, preparing themselves from individually constructing their arguments to collaborative argumentation. Individuals move from personal viewpoints to resolving conflicts and converging at a joint and shared knowledge in argumentation. Through social interactions (Hou & Wu, 2011), students co-construct knowledge as interpersonal interactions connect academic discussions and argumentative task coordination (Hou & Wu, 2011).

The model for managing uncertainty developed by Chen et al., (2019) postulated that learners go through the first stage of (1) raising uncertainty, where they ask questions to clarify, critique, and challenge existing gaps in individual knowledge about a topic before moving on to the next stage of (2) maintaining uncertainty where learners seek to find solutions and evidence along with garnering varied perspectives (Nguyen & Young, 2022). Finally, learners reduce uncertainty by reconciling current knowledge with prior knowledge – integrating and resolving conflicts and gaps in knowledge. Although argumentation has been linked with uncertainty navigation in past studies, previous work has been focused on how uncertainty plays a tentative and suitable role in challenging and resolving conflicting arguments in argumentative discourse (Nguyen & Young, 2022).

Therefore, this study investigated the following research question and hypothesis:

> Research Question: To what extent does level of hedging indicating certainty levels impact argumentative knowledge construction in individual work and group work?
>
> Hypothesis: There was a significant difference in uncertainty using hedging for individual and group work in argumentative knowledge construction.

2. Method

2.1 Study Design and Participants

18 Singapore Secondary grade 3 students (15 years old; 10 males; 8 females) participated in this study. The teacher assigned students randomly to a total of 10 groups, with each group consisting of four students. They discussed collaboratively on an online collaborative argumentation platform known as AppleTree. The students in the class knew one another and experienced asynchronous group learning in other lessons. Students addressed the extent to which they agreed and provided evidence for their claims and rebuttals/counterarguments on a topic surrounding social issues: “Volunteering causes more harm than good. How far do you agree?” In the individual work/ideation phase (15 minutes), students individually constructed arguments on the given topic. When students moved into group synergy/work (20 minutes), they collaborate with one another to achieve a group consensus. Ethics approval and a signed written informed consent was obtained from all participants before data collection in April 2023.

2.2 Coding Argumentation of Artefacts

Content analysis was used to address our research questions and hypotheses to examine the certainty levels from students’ individual and group argumentative work. Argumentative knowledge construction is operationalized as the average scores of these following coded elements (see Table 1 below). Dichotomous coding was used. The presence of an element below was coded as 1 whereas 0 was given if the element was absent.

Table 1. *The Coding Scheme for Argumentation Knowledge Construction in Individual and Group Work* (Weinberger & Fischer, 2006; Weinberger et al., 2005)

Element	Description	Examples

Simple Claim	Learners' position	"I agree that volunteering causes more harm than good."
Ground (with warrants)	Supporting reason or evidence	"Yes, I agree **because** the person hosting this event wants to try their best to support the volunteers rather than those needing help."
Qualifier	Exceptions to claim's validity	"However, sometimes when you volunteer to help someone the help you give may not really benefit them."
Counter-argument	Challenges to existing claims	"Volunteering spreads kindness around our neighborhood, precinct or even to further people, which could be a potential for more people being helped by volunteers to being volunteers to help those in need. **However,** some people feel that volunteering also causes negative impacts, such as people volunteering for financial gains and volunteering for work resume experiences to be written on. Some volunteering services are ineffective in helping people which causes more harm to the people in need than good."
Integrated Replies	Integrations of previous points or extension of the argument	"Research also shows that short-term orphanage visits can cause damage to children's development and emotional well-being, creating unhealthy short-lived attachments and separation anxiety. **Children need constant sources of love and support.**"

Level of certainty is indicated by the number of uncertainty and certainty words used in an argument (Nguyen & Young, 2022). Certainty and uncertainty words used by the learner were coded as 1 and then tabulated to compute a total score. If the participant used the same number of certainty and uncertainty words, the level of certainty would be coded as neutral (Nguyen & Young, 2022). Examples of uncertainty words are hedges such as "can" and "may be". while certainty words include, "actually" and "definitely" (Nguyen & Young, 2022).

2.3 Procedure

Students went through individual work followed by group work and then back again, based on the Spiral Model of Collaborative Knowledge Improvement (SMCKI) (Chen et al., 2021): (1) Individual ideation: students work on their own to indicate the extent to which they agreed or disagreed with the given question with their supporting evidence; (2) Group synergy: individual claims are merged together in a single claim; (3) Refinement: students reflected on the feedback given to them by the other group, choosing to make changes if needed; and (4) Individual achievement: students write their own individual reflections after the whole argumentation activity (Chen et al., 2021). For this study, we examined students' Individual Ideation work, and compared their individual work with their group work (Group Synergy).

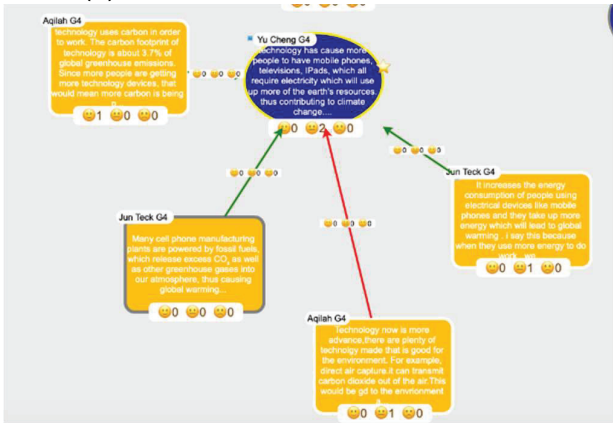

Figure 1. Sample of an argumentation diagram

The second and fourth authors coded students' individual writing work-sheets and argumentation graphs (see Figure 1) using the coding scheme (see Table 1). These findings indicated sub-stantial levels of agreement between the independent coders (Kappa: 82.5%). We used NVivo version 12 and Microsoft Excel for the manual qualitative content analyses coding before proceeding to analyze our quantitative data in IBM SPSS version 28.

3. Results. Discussion, and Conclusion

This study investigated the extent to which differences were observed in students' level of certainty as shown in hedging used in the context of individual and group social knowledge argumentation construction. The variables did not satisfy normality assumptions – potentially due to a small sample size. Using Spearman rho correlations (Table 2), significant associations ($p < .01$) were found between individual work qualifier and group work hedging used, group work ground and group work simple argument, group work ground and group work integrated replies, and group work ground and group work hedging used. It is expected that students' certainty levels would decrease significantly as they move from individual work to group work. This is in line with past research which encouraged students to use hedging to express an openness to consider conflicting arguments against their initial position (Nguyen & Young, 2022). Nevertheless, students' individual and group work were non-significant across other categories of argumentation. Thus, students' certainty navigation remained consistent throughout argumentative knowledge construction in individual or group contexts.

Findings from one-way ANOVA (Table 3) revealed significant differences ($p < .05$) in certainty levels when forming simple arguments during individual work and counterarguments at group work. Post-hoc Bonferroni's correction revealed significant differences between Certain and Neutral levels ($p < .05$, Mean Difference = .75; Standard Error = .26) when forming simple arguments during individual work, and between Uncertain and Neutral levels ($p < .05$, Mean Difference = .67; Standard Error = .18) when forming counterarguments at group work. Navigating uncertainty self-regulatory skills and attitudes requires time to hone and build (Xu et al., 2015). Although students are encouraged to express certainty, reconciling varied perspectives in argumentation required learners to take a tentative approach, hence, using uncertainty words (Nguyen & Young, 2022). It is possible that learners only become more aware of differences in synthesizing and expressing their arguments after moving on to group work from individual work. These findings added support that students did not merely copy and paste their individual work to group work, but rather, modified their work based on their learning experiences (Tsovaltzi et al., 2017). Future interventions may focus on supporting group interactions and scaffolding students' argumentative work to enable smooth online collaboration, familiarity with the challenges of communicating asynchronously (Oren et al., 2002), unshared knowledge in individual work translated into group work, levels of certainty impacted by vicarious learning via influence from other group members (Fischer & Mandl, 2001; Weinberger & Fischer, 2006), and emotional self-control (Nguyen & Young, 2022).

Table 2. *Spearman rho Findings on Certainty and Argumentative Knowledge Construction Reflected in Individual and Group Work; IW: Individual Work; GW: Group Work; SA: Simple Argument; Q: Qualifier; CA: Counterargument; IR: Integrated Replies; HU: Hedging Used (Uncertain = 1, Neutral = 2, and Certain = 3)*

Variables	1	2	3	4	5	6	7	8	9	10	11
IW-SA	-	-	-	-	-	-	-	-	-	-	-
IW-Q	.28	-	-	-	-	-	-	-	-	-	-
IW-CA	.22	.42	-	-	-	-	-	-	-	-	-
IW-IR	.90	.63	.81	-	-	-	-	-	-	-	-
GW-SA	.88	.59	.57	.69	-	-	-	-	-	-	-
GW-G	.73	.20	.44	.63	.01**	-	-	-	-	-	-
GW-Q	.49	.75	.88	.45	.49	.89	-	-	-	-	-
GW-CA	.50	.96	.07	.90	.06	.73	.49	-	-	-	-
GW-IR	.63	.47	.38	.21	.06	.01**	.39	.63	-	-	-
IW-HU	.85	.07	.64	1.00	.53	.91	.37	.39	.71	-	-
GW-HU	1.00	.01**	.83	.21	..08	.01**	.84	.26	.24	.61	-

Table 3. *ANOVA Findings on the Level of Certainty and Argumentative Knowledge Construction as Reflected in Individual and Group Work (Uncertain = 1, Neutral = 2, and Certain = 3; df1 = 2, df2 = 15)*

Variables	*Certainty*	*M*	*SD*	*F*	*p*

Individual Ideation	*Hedging Used: Uncertain = 9, Neutral = 5, and Certain = 4*				
Simple Argument	1	.78	.44	4.25	< .05*
	2	1.00	.00		
	3	.25	.50		
Qualifier	1	.33	.50	1.54	> .05
	2	.20	.45		
	3	.75	.50		
Counterargument	1	.56	.53	.49	> .05
	2	.40	.55		
	3	.25	.50		
Integrated Replies	1	.11	.33	.72	> .05
	2	.40	.55		
	3	.25	.50		
Group Work	*Hedging Used: Uncertain = 9, Neutral = 6, and Certain = 3*				
Simple Argument	1	2.11	1.54	.07	> .05
	2	1.83	1.47		
	3	2.00	1.00		
Ground	1	2.11	1.36	.53	> .05
	2	2.00	.89		
	3	1.33	.58		
Qualifier	1	.11	.33	.24	> .05
	2	.17	.41		
	3	.00	.00		
Counterargument	1	.00	.00	6.04	< .05*
	2	.67	.52		
	3	.33	.58		
Integrated Replies	1	.44	.73	.36	> .05
	2	.17	.41		
	3	.33	.58		

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