Evaluating Critical Thinking in Computer Mediated Communication Discussions

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ABSTRACT

This paper presents an investigation of whether computer mediated communication (CMC) can develop critical thinking in language classrooms. The research was conducted at a university branch campus in Malaysia over a period of 12 weeks. It involved three groups of learners in which each group was exposed to different discussion modes. The first group was exposed to a CMC discussion mode, the second group was exposed to a mixed mode of CMC and face-to-face (F2F) discussions and the third group had only the face-to-face mode of discussion. The critical thinking development in these three conditions was evaluated based on the content analysis method used by Newman, Johnson, Cochrane and Webb (1995). This research reports the findings which hopefully will give some insight to other teaching practitioners who are interested in incorporating IT in their classrooms.

Introduction

The Internet is a powerful means of communication and it has become an inexhaustible and ever-growing resource for English language teachers and learners. In recent years, its use in language classrooms (L2) has gained popularity as more teachers and learners have embraced it as a tool for developing language. The recent development of computer-mediated communication (CMC) as a feature of internet technology has created a new challenge in language learning experience. It has attracted many teachers and educators alike to incorporate it in second language classrooms to facilitate and mediate communication between learners or groups of

learners innovatively. The use of CMC in language classrooms is expected to extend learning opportunities as it has potential benefits as a pedagogical tool in developing language performance (Faizah, 2005; Dyson, 2001; Liu & Reed, 1995).

Nevertheless, an important question is whether the use of the Internet as a tool in the language classroom really has an impact on L2 learners' critical thinking development. Thus, the main purpose of this study is to answer this question by examining whether a CMC environment can help develop L2 learners' critical thinking skills. In Malaysia, learners' lack of critical thinking has been noted by a number of researchers (e.g. Moore, 1992; Galea, 1999; Martin, 1998). They suggest that the problem lies in the Malaysian educational system, which is too exam-oriented. The system has encouraged rote learning instead of critical thinking. Many learners have the tendency to depend on their teachers in making decisions. To rectify this problem, the Malaysian Education Ministry has introduced an examination format that emphases critical thinking. Datuk Dr Shukor Abdullah (cited in Lee & Kaur, 1998) has stated that 60% of the content in public examinations would require critical thinking from the year 2000. Another effort was the implementation of Smart Schools in 1999 with plans to integrate the use of computer technology into the teaching and learning process. This project, it was hoped, would produce Malaysians who are innovative in their thinking and adept with new technologies (Nojey, 1998). The latter effort by the government has inspired the present researcher to carry out this study. Based on her teaching experience at Universiti Teknologi MARA (UiTM) Dungun, Terengganu, she discovered that both diploma and undergraduate learners show major difficulties in expressing their ideas critically. Since a CMC environment is generally claimed to encourage learners to be involved in an active and constructive learning experience, the researcher investigated the effects of a CMC environment on the development of critical thinking among Malaysian learners, specifically those in the UiTM Terengganu.

There are many studies on the use of CMC in English as a Second Language/ English as a Foreign Language (ESL/EFL) classroom, ranging from the effectiveness of using e-mail, forum discussion and computer conferencing in language learning and teaching (Cononelos & Oliva, 1993; Gonzalez-Bueno, 1998; Leh, 1999; Sotillo, 1997; Goodfellow & Lamy, 1998; Tsui, 2001) to the perceptions of and motivation for using CMC (Song & Hunt, 2002; Gu & Xu, 1999; Dyson, 2001). Nevertheless, there are still few studies that investigate the role of CMC in promoting critical thinking skills and whether a CMC environment, specifically using synchronous communication, affects the development of such skills.

Purpose of the Study

The main purpose of this study is to examine the effects of a CMC environment on the development of learners' critical thinking skills. The study looks at the question of whether L2 learners in a full CMC environment have a higher critical thinking ratio in discussions than those in mixed-mode and non-CMC environments. The study will specifically determine if there is evidence of critical thinking development in all three environments, whether there is a significant difference in the critical thinking ratio in discussions across the three groups and whether there is a significant difference in the critical thinking ratio by indicator in the discussions across the three groups.

Participants

It was decided to select a sample of 60 learners enrolled in the second semester of a Diploma in Hotel Management (DHM) programme at UiTM Terengganu, Malaysia. All of them were familiar with the Internet as they had used it to complete their assignments. Nevertheless, they had not been in any classes that used CMC discussions. They were all Malays between 19 and 23 years old.

Methodology

In this study, the learners were divided into three different groups of 20 each. The first group was the full CMC environment group which meant that all the discussions conducted in this environment were via CMC. The second group was exposed to the mixed mode in which the learners had to conduct their discussions orally (for Discussion One and Four) and via CMC (for Discussion Two and Three). The third group did all discussions orally. The discussions were held at three week intervals and at the end of 12 weeks, the group had four discussions altogether. The learners were required to open a *YAHOO!* account and register themselves with *YAHOO!* MESSENGER since this web chat programme was used to conduct online discussions. The learners were given one and a half hours for the face-to-face discussions, but taking into consideration the typing time, an extra half hour was given for the learners to do the online discussions. The data collection was done one month

after the class was exposed to YAHOO Messenger in order to familiarise the learners with this programme.

Data Analysis

To find if the use of the Internet helped the learners to think more critically, learners' discussions online were printed out and those done face-to-face were taped and transcribed to be analysed. A total of 48 transcripts, 16 from each group, were analysed using the scoring criteria based on the content analysis method of Newman et al. (1995). The criteria had 10 indicators namely relevance, importance, novelty, outside knowledge, linking ideas, justification, criticism, resolving ambiguity, widening the discussion and practical grounding. The analysis of the data was based on the average scores of the three raters. The scores given by each rater for all discussions (Discussion One, Discussion Two, Discussion Three, and Discussion Four) were analysed using the Pearson correlation coefficient. It was found that there was a significant correlation in the scoring for all discussions ranging from 0.67 to 0.98.

Findings

To determine if CMC can influence on learners' critical thinking ability in the discussions, the researcher will discuss three parts: the evidence of critical thinking, the critical thinking (CT) ratio and the critical thinking (CT) ratio by indicator.

Evidence of Critical Thinking

The quantitative results of the study indicate that the Internet and, in this case, computer mediated discussion, play a great role in fostering L2 learners' critical thinking skills. The critical thinking (CT) ratios for each group were obtained by using the formula: x ratio = (x+ - x-)/(x+ + x-), converting the counts to a –1 to + 1. In this formula, x+ denoted the positive statements and x- denoted the negative statements. This formula measured only the quality of the messages and not the quantity of the participation. The CT ratios were later plotted to see the extent of the learners' critical thinking ability. The findings revealed that there was evidence of critical thinking skills in all language learning environments

for all discussions. However, the groups in the full CMC environment were found to have higher CT ratios.

Table 1 below shows the CT ratio for each environment for Discussion One. In this Discussion, all four groups in the full CMC environment had higher CT ratios as compared to those in the other two environments.

Table 1: Overall CT Ratio by Environments in Discussion One

Group	Topic	CT Ratio	CT Ratio Plot 0.0 0.2 0.4 0.6 0.8 1.0
Full CMC	1	(0.59)	fffffffffffffffffffffffff
(*CMC)	2	(0.60)	ffffffffffffffffffffffffff
	3	(0.70)	fffffffffffffffffffffffffff
	4	(0.64)	fffffffffffffffffffffffffff
Mixed-mode	1	(0.41)	ppppppppppp
(**F2F)	2	(0.42)	pppppppppppp
	3	(0.37)	ppppppppppp
	4	(0.33)	pppppppp
Non CMC	1	(0.38)	nnnnnnnnnnn
(**F2F)	2	(0.52)	nnnnnnnnnnnnn
	3	(0.41)	nnnnnnnnnnnnn
	4	(0.29)	nnnnnnnnn

* CMC = Computer mediated discussion
** F2F = Face-to-Face

Table 2 shows the CT ratio for each environment in the second discussion. Again, the groups in the full CMC environment had higher CT ratios. The CT ratio for the groups in the mixed-mode CMC environment improved in this discussion because they also conducted their discussion online.

Table 2: Overall CT Ratio by Environments in Discussion Two

Group	Topic	CT Ratio	CT Ratio Plot 0.0 0.2 0.4 0.6 0.8 1.0
Full	1	(0.89)	fffffffffffffffffffffffffffffffffff
(*CMC)	2	(0.90)	ffffffffffffffffffffffffffffffffffff
	3	(0.84)	fffffffffffffffffffffffffffffffff
	4	(0.85)	fffffffffffffffffffffffffffffffffff

Continued

Cont'd Table 2: Overall CT Ratio by Environments in Discussion Two

Group	Topic	CT Ratio	CT Ratio Plot 0.0 0.2 0.4 0.6 0.8 1.0
Mixed-mode	1	(0.66)	pppppppppppppppp
(*CMC)	2	(0.72)	pppppppppppppppppp
	3	(0.66)	pppppppppppppppp
	4	(0.76)	pppppppppppppppppp
Non	1	(0.48)	nnnnnnnnnnnnnn
(**F2F)	2	(0.29)	nnnnnnnn
	3	(0.54)	nnnnnnnnnnnnnnnn
	4	(0.43)	nnnnnnnnnnn

* CMC = Computer mediated discussion
** F2F = Face-to-Face

Table 3 below shows the CT ratio for each environment in Discussion Three. The groups in full CMC environment still maintained their high CT ratios. The CT ratio for the groups in the mixed-mode CMC environment was similar to that in Discussion Two. The mode of discussion, which was online, could be the reason for this.

Table 3: Overall CT Ratio by Environments in Discussion Three

Group	Topic	CT Ratio	CT Ratio Plot 0.0 0.2 0.4 0.6 0.8 1.0
Full	1	(0.92)	ffffffffffffffffffffffffffffffffffffff
(*CMC)	2	(0.80)	fffffffffffffffffffffffffffffff
	3	(0.84)	ffffffffffffffffffffffffffffffffff
	4	(0.82)	fffffffffffffffffffffffffffffff
Mixed-mode	1	(0.73)	pppppppppppppppppp
(*CMC)	2	(0.76)	pppppppppppppppppppp
	3	(0.60)	pppppppppppppppp
	4	(0.67)	pppppppppppppppppp
Non	1	(0.50)	nnnnnnnnnnnnnn
(**F2F)	2	(0.26)	nnnnnnnn
	3	(0.43)	nnnnnnnnnnnnnn
	4	(0.63)	nnnnnnnnnnnnnnnn

* CMC = Computer mediated discussion
** F2F = Face-to-Face

Table 4 shows the CT ratio for each environment in Discussion Four. The CT ratio of all the four groups in the full CMC environment remained the highest. The CT ratio of the groups in the mixed-mode CMC environment was again low in this discussion. This could be attributed to the traditional face-to-face method used in the class. The CT ratios of the groups in the non-*CMC* environment were low throughout the discussions.

Table 4: Overall CT Ratio by Environments in Discussion Four

Group	Topic	CT Ratio	CT Ratio Plot 0.0 0.2 0.4 0.6 0.8 1.0
Full	1	(0.88)	fffffffffffffffffffffffffffffffffffff
(*CMC)	2	(0.92)	fffffffffffffffffffffffffffffffffffffff
	3	(0.83)	fffffffffffffffffffffffffffffffff
	4	(0.85)	fffffffffffffffffffffffffffffffffff
Mixed-mode	1	(0.45)	ppppppppppppp
(**F2F)	2	(0.52)	pppppppppppppppp
	3	(0.50)	pppppppppppppp
	4	(0.21)	ppppppppppp
Non	1	(0.61)	nnnnnnnnnnnnnnnnnnn
(**F2F)	2	(0.24)	nnnnnnnn
	3	(0.61)	nnnnnnnnnnnnnnnnnnn
	4	(0.61)	nnnnnnnnnnnnnnnnnnn

* CMC = Computer mediated discussion
** F2F = Face-to-Face

These findings supported Newman et al's (1995) study, which reported that learners in a computer assisted learning environment engaged more in critical thinking than those in a non-computer environment. However, this present study went a step further by examining if there was a significant difference in the CT ratios in the three environments.

Critical Thinking Ratios in Argumentative Discussions

In order to ascertain whether there was a significant difference in the CT ratios, a one-way ANOVA was run to compare the CT ratio means of all the discussions held in the three environments. An examination of Levene's Test for homogeneity of variances suggested that this

assumption had not been violated ($p > 0.05$) and thus the interpretation of the ANOVA could proceed. The results in Table 5 show that there was a significant difference in the CT ratios among the three environments: $F(2, 45) = 27.52$, $p < 0.05$.

Table 5: A One-way ANOVA Comparing the Means of Critical Thinking Ratios in Argumentative Discussions Across All Environments

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.093	2	.546	27.523	.000
Within Groups	.893	45	1.985E-02		
Total	1.986	47			

The post-hoc Fisher's LSD indicated that learners in the full CMC environment (EG1) had a higher critical thinking ratio than those in the mixed-mode (EG2) and non-CMC (CG) environments: Fisher's = 0.260, $p < 0.05$ and Fisher's = .358, $p < 0.05$ respectively. However, no significant difference was found in the CT ratios between those in mixed-mode (EG2) and non-CMC (CG) environment: Fisher's = 0.0975, $p > 0.05$.

An examination of individual discussions across all environments was also made. A one-way ANOVA was run on all four discussions in all three environments. Table 6 below shows that there is a statistically significant mean difference in the CT ratios in all four discussions: Discussion One: $F(2,9) = 17.729$, $p < 0.05$, Discussion Two: $F(2,9) = 40.754$, $p < 0.05$, Discussion Three: $F(2,9) = 16.526$, $p < 0.05$, Discussion Four: $F(2,9) = 11.961$, $p < 0.05$.

Post-hoc multiple comparison tests were then run to see whether there were differences in the CT ratios. Post-hoc Fisher's LSD indicated that all the four discussions in the full CMC environment (EG1) had higher CT ratios than those in the other two environments. In the second and third discussions, learners in the mixed-mode CMC environment (EG2) had higher CT ratios than those in the non-CMC environment (CG). Since the discussions were held online for the EG2 group, it was possible for this group to think more critically in the discussions. Table 7 below summarises the results of the post-hoc multiple comparison tests.

Table 6: A One-way ANOVA Comparing the Means of CT Ratios in Individual Discussion Across All Environments

Discussion		Sum of Squares	df	Mean Square	F	Sig.
One	Between Groups	.156	2	7.791E-02	17.729	.001
	Within Groups	3.955E-02	9	4.394E-03		
	Total	.195	11			
Two	Between Groups	.386	2	.193	40.754	.000
	Within Groups	4.260E-02	9	4.733E-03		
	Total	.428	11			
Three	Between Groups	.339	2	.169	16.526	.001
	Within Groups	9.220E-02	9	1.024E-02		
	Total	.431	11			
Four	Between Groups	.448	2	.224	11.961	.003
	Within Groups	.169	9	1.874E-02		
	Total	.617	11			

Table 7: The Significant Values for Each Discussion

Discussion	Environment	Fisher's LSD	Significance
One	Full vs. Mixed-mode	.2500*	.000**
	Full vs. Non	.2325*	.001**
	Mixed-mode vs. Non	-0.0175	.718
Two	Full vs. Mixed-mode	.1650*	.008*
	Full vs. Non	.4350*	.000**
	Mixed-mode vs. Non	.2700*	.000*
Three	Full vs. Mixed-mode	.1750*	.037*
	Full vs. Non	.4100*	.000**
	Mixed-mode vs. Non	.2350*	.009*
Four	Full vs. Mixed-mode	.4500*	.001**
	Full vs. Non	.3525*	.005*
	Mixed-mode vs. Non	-0.0975	.340

* The mean difference is significant at the .05 level.
** The mean difference is significant at the .001 level.

Critical Thinking Ratios by Indicator in Argumentative Discussions

The critical thinking indicators used in this study are the same as those used by Newman et al. (1995). They are relevance, importance, novelty,

outside knowledge, linking ideas, justification, criticism, resolving ambiguity, widening the discussion, and practical grounding. In order to find the CT ratios for each indicator, the same formula: x ratio = (x+ - x-)/ (x+ + x-) was applied. Table 8 presents a summary analysis of the CT ratio by indicator for all three environments.

Table 8: Critical Thinking Ratio in Each Environment by Indicator

	Full CMC			Mixed-mode			Non-CMC		
Indicator	CTR	+	-	CTR	+	-	CTR	+	-
R+- Relevance	0.92	74	3	0.10	44	36	0.31	23	12
I+- Importance	0.64	37	8	0.00	21	21	-0.16	13	18
N+- Novelty, New information, ideas, solution	0.74	171	25	0.42	194	79	0.38	109	49
O+- Bringing outside knowledge/experience	0.84	91	8	0.72	68	11	0.29	27	15
A+- Ambiguity and clarity/confusion	0.34	39	19	-0.15	44	59	-0.52	31	98
L+- Linking ideas, interpretation	0.72	131	21	0.35	132	64	0.26	48	28
J+- Justification	0.92	489	21	0.88	447	29	0.85	320	26
C+- Critical assessment	0.78	40	5	0.80	64	7	0.44	18	7
P+- Practical utility (grounding)	0.71	36	6	0.37	28	13	0.38	22	10
W+- Width of understanding	1.00	15	0	1.00	8	0	1.00	7	0

In Table 9 below, the CT ratios for each indicator were plotted to see how different indicators of critical thinking were affected by the three environments. The plotted indicators revealed higher and positive CT ratios in the full CMC environment in which learners had all their discussions online. The negative CT ratios are also evident in the non-CMC environment for two of the indicators: important issues and ambiguity/clarity/confusion. In the mixed-mode CMC environment, a negative CT ratio is found for one of the indicators: ambiguity/clarity/confusion.

To see whether the difference in the CT ratios in the three environments was significant, a one-way ANOVA was run. The difference in the CT ratios by indicator was found to be statistically significant: $F(2,27) = 4.036$, $p < 0.05$ (Table 10).

Table 9: Pattern of CT Ratios by Indicator

Indicator	CMC Environment	CT Ratio	CT Ratio Plot -0.6 -0.4 -0.2 0.0 0.2 0.4 0.6 0.8 1.0
Relevance	Full	(0.92)	fffffffffffffffffffffffffff
	Mixed-mode	(0.10)	mm
	Non	(0.31)	nnnnnnnn
Import-ance	Full	(0.64)	ffffffffffffffff
	Mixed-mode	(0.00)	m
	Non	(-0.16)	nnnn
Novelty	Full	(0.74)	fffffffffffffffffff
	Mixed-mode	(0.42)	mmmmmmm
	Non	(0.38)	nnnnnnnn
Outside Know-ledge	Full	(0.84)	fffffffffffffffffffffffff
	Mixed-mode	(0.72)	mmmmmmmmmm
	Non	(0.29)	nnnnnn
Ambiguity	Full	(0.34)	fffffffff
	Mixed-mode	(-0.15)	mm
	Non	(-0.52)	nnnnnnnnnnn
Linking Ideas	Full	(0.72)	fffffffffffffffffff
	Mixed-mode	(0.35)	mmmmm
	Non	(0.26)	nnnnnn
Justifica-tion	Full	(0.92)	fffffffffffffffffffffffff
	Mixed-mode	(0.88)	mmmmmmmmmmm
	Non	(0.85)	nnnnnnnnnnnnnnn
Criticism	Full	(0.78)	fffffffffffffffffffff
	Mixed-mode	(0.80)	mmmmmmmmmmm
	Non	(0.44)	nnnnnnnnnn
Practical Grounding	Full	(0.71)	fffffffffffffffffff
	Mixed-mode	(0.37)	mmmmm
	Non	(0.38)	nnnnnnnnnn
Width of Discussion	Full	(1.00)	fffffffffffffffffffffffff
	Mixed-mode	(1.00)	mmmmmmmmmmm
	Non	(1.00)	nnnnnnnnnnnnnnnnn

Post hoc Fisher's revealed that there was a statistically significant means difference in the CT ratios by indicator in the full CMC environment (EG1) when compared to those in the non-CMC environment (CG), but not to those in the mixed-mode CMC environment (EG2). Thus, it could be concluded that the CT ratios of the learners in the full CMC environment (EG1) were higher than those of the learners in the non-

Table 10: A One-way ANOVA for CT Ratios by Indicator

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.017	2	.508	4.036	.029
Within Groups	3.401	27	.126		
Total	4.418	29			

CMC environment (CG) (Fisher's = .4380, $p < 0.05$), but they were the same as those in the mixed-mode CMC environment (EG2) (Fisher's = .3120,$p > 0.05$). The CT ratios between mixed-mode (EG2) and non-CMC (CG) environments were also the same (Fisher's = .1260, $p > 0.05$).

Discussion

In the argumentative discussions, students in the full CMC environment were more critical in their views throughout the semester than those in the other two environments. The statistical results show that their CT ratios were significantly higher than those of mixed-mode and non-CMC environments as early as in Discussion One. Students in the mixed-mode CMC environment had similar CT ratios to those in the non-CMC environment in Discussion One, but their CT ratios increased rapidly compared to students in the non-CMC environment in Discussion Two and Discussion Three. The CT ratio for students in the mixed-mode CMC environment decreased in Discussion Four and there was no significant difference between these CT ratios and those of the students in a non-CMC environment. As this discussion was done orally, this might be the reason for the decrease in the ratio. These statistical findings provide empirical evidence to support the study by Newman et al. (1996).

The indicators studied by Newman's et al. (1996) were also examined in this study. They were: relevance, importance, novelty, outside material, linking ideas, justification, criticism, resolving ambiguity, widening the discussion and practical grounding. Table 11 below summarises the CT ratios of the indicators under investigation.

Although Table 11 shows that the widening discussion indicator had a perfect CT ratio (1.00), it did not mean that the students did well in this

Table 11: Summary of the CT Ratio for Each Indicator in All Three Environments

Indicator	Full *CMC*	Mixed-mode *CMC*	Non-*CMC*
Relevance	0.92	0.10	0.31
Importance	0.64	0.00	-0.16
Novelty	0.74	0.42	0.38
Outside Material	0..84	0.72	0.29
Resolving Amb.	0.34	-0.15	-0.52
Linking Ideas	0.72	0.35	0.26
Justification	0.92	0.88	0.85
Criticism	0.78	0.80	0.44
Practical Gr.	0.71	0.37	0.38
Widening Dis.	1.00	1.00	1.00

area. This perfect CT ratio was due to the zero negative statements made in this category. This indicator also had the lowest positive statements as compared to the other indicators. This finding is in line with Newman et al. (1994) who also found few obvious statements in this indicator.

Table 11 also shows that the CT ratios in the justification indicator were higher than the other indicators in all three environments. This might be due to the students' tasks as they were required to justify their views in their discussions. It was also noted that students in the full CMC environment (EG1) had higher CT ratios for all indicators except criticism. This suggests that when students were discussing online, they were susceptible to more extensive, intense and quality discussions as they had the time to formulate and relate their ideas. These findings are not in line with those of Newman et al. (1996) in which students in the computer conferencing group had higher CT ratios only for six indicators: relevance, importance, outside material, linking ideas, justification and criticism. The fact that students in the non-CMC environment had the lowest CT ratio in contributing new ideas (novelty) as compared to the other two environments also contradicted the finding made by Newman et al. (1996). They found that students in face-to-face seminars came up more often with new ideas.

The CT ratios by indicators in the full CMC environment were also significantly higher than those in the non-CMC environment. The less spontaneous nature of online discussions might be the reason for this as the students had time to think. The findings also support DeLoach and Greenlaw's (1999) contention that online discussion serves as a catalyst

to accelerate students' critical thinking development. They claim that the visible nature of the arguments contributes to a natural structure for critical thinking development better than traditional writing assignments and oral discussions. Besides, online discussions provide a more lasting record than oral discussions. They allow students to reflect on what they have "said". McLoughlin and Luca (2000) add to this view by stating that when this occurs, the students could sustain interaction by arguing, negotiating, discussing and constructing ideas. This social, participatory and shared verbal activity in online environments can trigger critical thinking development.

The findings also show that the students perceived online discussion activity as the most helpful in the development of critical thinking. These perceptions support results from Jonassen's study (2001) which concluded that participants in his study believed that online discussions made them put in greater effort to work with the team members and this led to greater levels of personal reflection and critical thinking to facilitate decision making. They also became more thoughtful as they had to read, write and think to offer opinions and ideas in online discussions (Fox, 1998).

Conclusion

This study indicates that a full CMC environment can develop students' critical thinking skills. The findings of this study have corroborated other findings (Kroonenberg, 1995; Newman et al., 1995; Sotillo, 1997, 2002) that a CMC environment has the potential to foster critical thinking skills. These findings strengthen the claim that CMC can be a pedagogical tool in developing critical thinking in "speechless" communication skills.

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