

Effectiveness of Social Media Communication in Game Development Study using Team-Based Learning

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Abstract: Team-based learning helps students understand methods of usability enhancement by discussing problems and improvements during product development. In this paper, we examine the types of discussions and communication among the teams and their members that were the most important for progressively better results in terms of learning reflection. In this study, three teams from two different countries are compared: 1. Arabic team (consisted of 3 Arabic students); 2. Japanese team (consisted of 4 Japanese students); and, 3. International team (consisted of 3 Japanese students and 2 Arabic students). All the students were between 18 and 24 years old. Each team started with the same level of a basic html and javascript browser game, and this was provided by the experimenter. Teams were required to develop the game with user testing between versions. The game was developed using an online game editor provided by the experimenters. Code changes and updates were based on user testing by the other teams. The study lasted 3 weeks, with 3 development cycles. At the end of the study, the participants provided their social media communications, including Skype messenger, Facebook messenger, and other instant messaging applications. Based on their communications, we examined the relationships between team activities and their learning experiences with the project overall. The discussions and communications via social media of each group were categorized as: *Proposal*, *Permission*, *Encouragement*, and *Acknowledgment* using protocol analysis. The analysed results indicate that the learning satisfaction is influenced by the communication content. In addition, we concluded that *Proposal* was the most influential on the learning reflection in terms of self-efficacy, satisfaction, and achievement. This paper reports on our findings and implications for team-based learning using online media.

Keywords: Social Media Interaction, Team-Based Learning, Learning reflection, Usability, Human-Computer Interaction

1. Introduction

Social media communication helps students to interact with each other inside and outside of a class. Students use various social media applications as a communication tool and their familiarity with these applications is increasing. The use of social media technology such as Facebook messenger enhances “team-based learning (TBL)” and reflects students’ experiences and motivations (Rasiah, 2014). TBL is one of the instructional strategies that enhances the quality of student learning (Michaelsen et al, 2002). In addition, “computer-supported team-based learning (CS-TBL),” which extends learning to the hybrid classroom where students meet both face-to-face and online, influences students’ motivation, enjoyment and team contribution on learning outcomes (Gomez et al, 2010). Cross-cultural TBL has been investigated by comparing three different countries using a 3-D Collaborative Virtual Environment (Prasolova-Førland et al, 2007). Multicultural teamwork was studied between Australians, Norwegians, and Taiwanese members in previous work (Wyeld, 2010). These cross-cultural activities enhanced students’ knowledge and enriched their experiences. In the “computer-supported collaborative learning (CSCL)” environment, Erkens et al (2008) introduced the idea of coding dialogues using online communications.

Although previous studies examined TBL as an instructional strategy, and others have investigated online communication, TBL and social media communication have not combined yet together. To the best of our knowledge, this is the first study of describing effectiveness via social media communication using TBL. In this study, we focused on participants’ emotions, and investigated the learning effectiveness for self-efficacy, achievement, and satisfaction by analysing dialogues within and across teams, especially communication via social media.

The aim of this study was to examine:

- Categorization of social media communication through TBL using protocol analysis;
- Comparison of team activities using categorized social media communication; and,
- Relationship between Social Network Service (SNS) communications and learning reflections such as self-efficacy, achievement, and satisfaction (Nakayama et al, 2015).

2. Method

2.1 Study procedures

In this study, participants were asked to develop a game as a collaborative exercise with their teammates. All teams started with a basic html and javascript browser game, provided by the experimenter. Participants included 12 students (9 males and 3 females) from 2 different countries, United Arab Emirates (UAE) and Japan. Participants were divided into 3 teams based on their nationalities: 1. Arabic team (consisted of 3 Arabic students); 2. Japanese team (consisted of 4 Japanese students); and, 3. International team (consisted of 3 Japanese students and 2 Arabic students). Study duration was 3 weeks with 3 development cycles. Each cycle lasted 7 days: 6 development days and 1 usability testing day. The experimenter explained the overall project at the beginning of the study in both UAE and Japan.

All 12 participants signed to the Informed Consent Sheet, authorizing their social media communication as data for analysis. Participants who completed the team-based work received \$100 compensation. All the students were between 18 and 24 years old.

2.2 Game development

Each team started with a basic html and javascript browser game where three conceptually similar basic games were provided (see figure 1):

1. Globe Game (Arabic Team): The main character (green circle) scores points by catching the friends (yellow circles) and at the same time tries to avoid the enemies (orange squares) which randomly spawn off screen. Once the main character is hit by the enemies, the game is over.
2. Maze Game (Japanese Team): The main character (green square) scores points by catching the friends (blue squares) and at the same time tries to avoid the enemies (orange squares) which randomly spawn off screen. Once the main character is hit by the enemies, the game is over.
3. Catcher Game (International Team): The main character (green square) scores points by catching the friends (orange squares) which randomly spawn from the top of the screen. Once the main character misses three times (red squares on the top right) to catch the friends, the game is over.



Figure 1. Basic html and javascript browser games

Teams were required to develop their game using the online game editor by changing the code directly. Changes were based on user feedback from the other teams. In the first cycle, all teams needed to start with the basic game and develop it further based on the first usability testing result which was evaluated on the first day. Each development cycle lasted 6 days. At the end of a cycle, all participants evaluated another team's game. The results were collected and sent to each team towards the next cycle. In total, participants were asked to develop 3 cycles during the study.

2.3 Team characteristics

Participants were divided into 3 teams: 1. Arabic; 2. Japanese; and, 3. International (see Table 1). All teams were required to discuss and reflect their implementations via online/offline communications. The

experimenter didn't specify what type of communication and social media application they could use. All groups used social media applications to interact with teammates. Most of the social media applications had similar functions and features, but all 3 teams decided to use different social media applications. They used Skype messenger, Facebook messenger, and Line which is another SNS smartphone application. Both domestic teams (Japanese and Arabic) were able to communicate without social media, but they decided to use it regardless. All teams not only used the text messaging system, but also file attachments which were screenshots and word/excel documents. The Arabic team communicated via Facebook messenger on the 1st and 3rd cycle. In the 2nd cycle, they met on campus to discuss, so the data was not collected. The Japanese team used Line, which is the most commonly used in Japan SNS application. Line application has a similar functionality with other messengers, but it has some additional functions. The Japanese team tried to use the scheduler function for the time arrangement, but they decided not to use it (they switched to regular messaging) because they only had 4 people in the team. The International team decided to use Skype (video) and Skype text messenger. Skype messenger was used as more precise communication tool to exchange information. Having members from 2 different countries, with a 5-hour time difference, teams decided the weekly discussion meeting time at the beginning. Arabic teammates had met as classmates before, whereas the Japanese and International teammates had not met the other teammates before.

Table 1. Team characteristics and attributes

	Arabic Team	Japanese Team	International Team
Nationalities	Arabic	Japanese	Arabic and Japanese
Number of students	3	4	5 (2 Arabic and 3 Japanese)
SNS tool	Facebook messenger	Line application	Skype messenger
Used functions	Text and images	Text, images, attachment files (excel/word), and scheduler	Text, images, and attachment files(excel)
Members	Classmates	Unfamiliar members	Unfamiliar members

2.4 Learning reflection

At the conclusion of the project, individual participants were required to complete a questionnaire about their learning reflection. The survey consisted of 3 parts; 1. Self-efficacy (10 questions); 2. Satisfaction of learning; and, 3. Achievement of learning. The participants' efficacy and satisfaction were self-evaluated at the end of the course to measure learning reflection. In this study, the self-efficacy contains motivational efficacy which is based on the previous work (Nakayama et al, 2015), and technical efficacy to measure their understanding through the learning activities. The questions concerning self-efficacy are shown in Table 2. All participants were asked to answer using a 5-point Likert scale.

Table 2. Question items: motivational and technical efficacies

Motivational efficacy

- 1 I was dedicated in developing this project and put a lot of effort.
- 2 I fully understood the contents of this project.
- 3 I achieved all the goals of this project.
- 4 I enjoyed the collaboration with my teammates for this project.

Technical efficacy

- 5 I learned a lot of techniques/skills about game development.
- 6 I learned about user interface design and game contents.
- 7 I improved my programming skills through the project.
- 8 I made enough implementations by considering the feedback, and developed a more enjoyable game.
- 9 I tried to be creative through the entire study.
- 10 I will recommend this activity to my friends.

Additionally, the satisfaction and achievement of learning were surveyed to measure the participants' level of emotional experience. Their answers included both their expectations in the beginning of the study (defined as initial) and their actual experience (defined as final) about the learning reflection. We examined these differences between the initial and final, which was affected by SNS communications.

3. Results

3.1 Categorizing social media communications

The total number of social media communications across all teams was 392. The social media communications from all groups was divided into 2 categories: project related communications (PRC), and non-project related communications (“non PRC”). The purpose of this classification is to exclude first greetings, exchanging personal information, and time arrangements for the meetings. As a result, the summary of PRC is shown in Table 3. The percentage of PRC increased from the first development cycle (42%) to the third cycle (59%), because the participants were discussing more about project-related matters towards the last cycle. In addition, the Arabic team had the highest percentage of PRC (66%) because they knew each other as classmates, and it was not necessary for them to introduce themselves.

Table 3. Result of project related communication (PRC)

	Cycle 1		Cycle 2		Cycle 3		Average of PRC for each team (%)
	Total		Total		Total		
	PRC	non PRC	PRC	non PRC	PRC	non PRC	
Arabic	59		25		104		66
	53	6	-	25	44	60	
Japanese	35		44		52		52
	9	26	30	14	32	20	
International	35		19		19		39
	4	31	6	13	14	5	
Average of PRC for each cycle (%)	42		50		59		

The PRC were categorized into 4 different types of communication using protocol analysis. Protocol analysis is often carried out to classify communication and dialogue (Daly et al, 1989; Aleman et al, 1994). It is also used to evaluate social media communications (Erkens et al, 2008; Hara et al, 2000). In this study, the social media communications were categorized as: *Proposal*, *Permission*, *Encouragement*, and *Acknowledgment* with the following criteria:

-*Proposal*: Dialogues which include information about a new implementation idea.

-*Permission*: Acceptance against someone’s proposal such as ‘Okay’ and ‘I think so.’

-*Encouragement*: Communication where someone encourages other teammates, such as ‘We will do our best.’

-*Acknowledgment*: Notification and acknowledgement when students reply against teammates’ work such as ‘Thank you’ and ‘I changed’ Also it includes information what she/he did and thought based on their discussion.

The protocol analysis was conducted by 2 experimenters; 88.6% of the classifications were initially matched, and the rest of the unmatched items were decided after discussing. The numbers of each categorized communication are shown in Table 4. The frequencies of the categorized communications seem to be related to the team activities, therefore the SNS scores are calculated by using the weighting coefficients to investigate the relationships with the learning reflection. These are determined by the 2 experimenters based on the importance and the contents of the communications to reflect their qualities. For example, the *Proposal* communication is considered as the most important communication and also 10 times more significantly important than the *Acknowledgment* communication. As a result, the importance of the communications is resolved in this order: *Proposal*, *Permission*, *Encouragement*, and *Acknowledgment*. Additionally, the weighting coefficients for the SNS scores were determined as ‘*Proposal*: 10, *Permission*: 8, *Encouragement*: 5, *Acknowledgment*: 1’. The relationships between the SNS scores, including the types of SNS communication, and the learning reflection will be discussed in section 3.4 of this paper.

Table 4. Number of categorized social media communications and scores

	Arabic Team (N=3)			Japanese Team (N=4)			International Team (N=5)		
	Cycle 1	Cycle 2	Cycle 3	Cycle 1	Cycle 2	Cycle 3	Cycle 1	Cycle 2	Cycle 3
Proposal	17	-	11	4	7	10	1	1	3
Permission	2	-	1	0	3	0	0	0	0
Encouragement	2	-	0	2	4	5	0	0	1
Acknowledgement	32	-	32	3	16	17	3	5	10
Total N*	53	-	44	9	30	32	4	6	14
SNS Score**	228	-	150	53	130	142	13	15	45

*Total number of SNS communication

**SNS Scores are summed up as Proposal: 10, Permission: 8, Encouragement: 5, Acknowledgement: 1

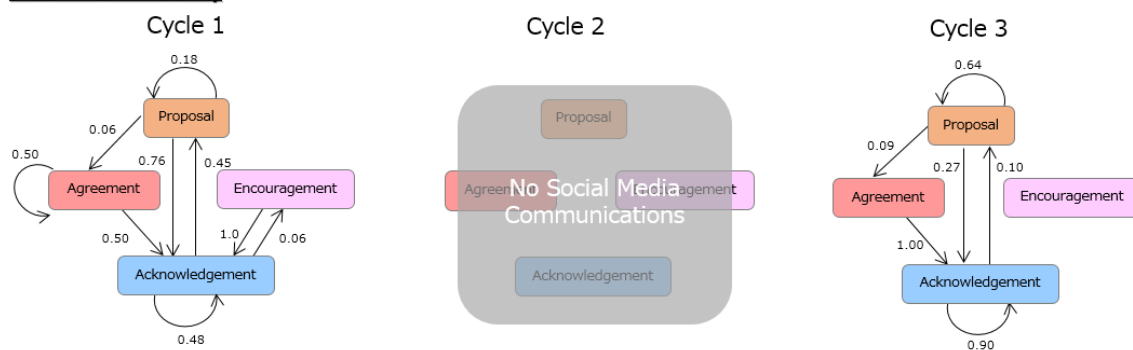
3.2 Communication activity using Markov model

The categorized communications shown in section 3.1 were analysed qualitatively per each cycle per team since the number of participants in this study was only 12. A Markov model was used to explain their activity precisely by using topic state transition, and illustrated as a stochastic model of communication/dialogues. In fact, the relationship between the categorized communication or dialogue and the effectiveness was investigated in a previous study (Minami et al, 2009; Boyer et al, 2009).

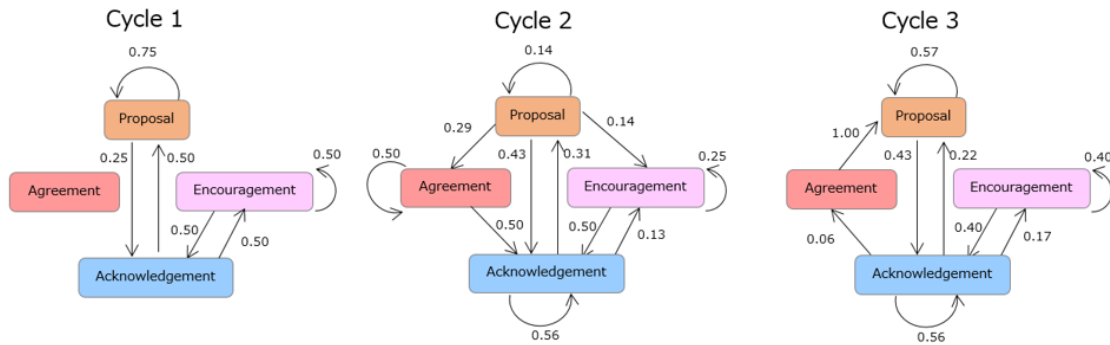
The calculated path for each team per cycle is shown in figure 2. Each team had different state transitions and probabilities to develop the games. As mentioned, social media communications did not occur in Arabic team's 2nd cycle; they decided to meet face-to-face instead of online communication. The summary of the results is:

- Acknowledgement was the most commonly observed communication in all teams.
- All teams had the transition between *Proposal* and *Acknowledgement* in most of the cycle.
- Only the Japanese team had the communication from *Encouragement* to *Encouragement*.
- None of the teams had any communication between *Permission* and *Encouragement*.
- The number of the state transitions increased in both Japanese team and International team but stayed about the same in the Arabic team from the 1st to 3rd cycle. This is considered to be affected by the team familiarities mentioned in section 2.3.

Arabic Team Activity



Japanese Team Activity



International Team Activity

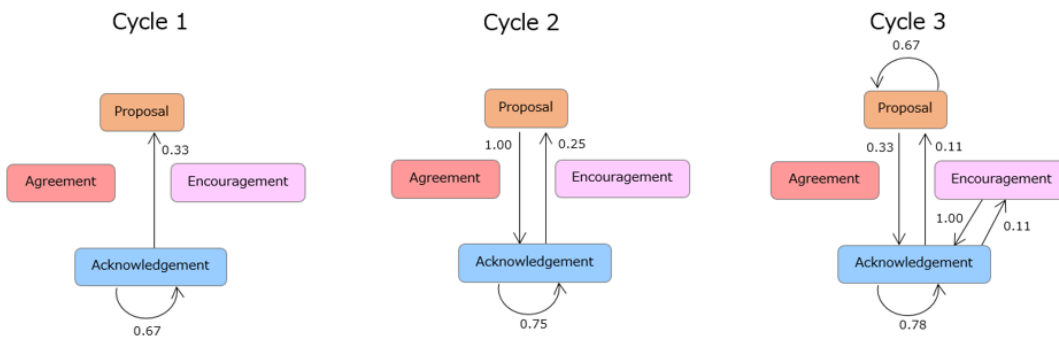


Figure 2. Communication activities using Markov model

3.3 Results of self-efficacy, satisfaction, and achievement

The summary of the 2 efficacies is shown in Table 5. The Arabic team self-evaluated the highest score (mean: 4.3) in motivational efficacy; The Japanese team evaluated the highest score (mean: 4.2) in technical efficacy. The relationship between such efficacies and SNS communications will be discussed in section 3.4.

Table 5. Result of motivational and technical efficacies

Team	Arabic (N=3) Mean (SD)	Japanese (N=4) Mean (SD)	International (N=5) Mean (SD)	Total (N=12) Mean (SD)
Motivational efficacy	4.3 (0.2)	4.2 (0.2)	3.9 (0.3)	4.1 (0.2)
Technical efficacy	3.8 (0.9)	4.2 (0.3)	3.8 (0.5)	3.9 (0.6)

The satisfaction and achievement through the whole learning activity were measured between 0-100 by self-evaluation (see Figure 3). To examine the differences among teams, the participants were asked to answer for the 'initial' stage, and 'final' stage in terms of learning satisfaction and learning achievement. All scores are mean for each team. Using the data, a paired t-test was carried out. Results from the t-test demonstrated that there were no statistical differences for both satisfaction (Arabic: $t(2)=-1.94$, n.s., Japanese: $t(4)=-1.76$, n.s., International: $t(3)=-1.18$ n.s.) and achievement (Arabic: $t(2)=2.50$, n.s., Japanese: $t(4)=-1.53$, n.s., International: $t(3)=1.41$, n.s.). Based on the achievement result, the Arabic and International teams accomplished less than expected. The Japanese team accomplished more than expected in the end.

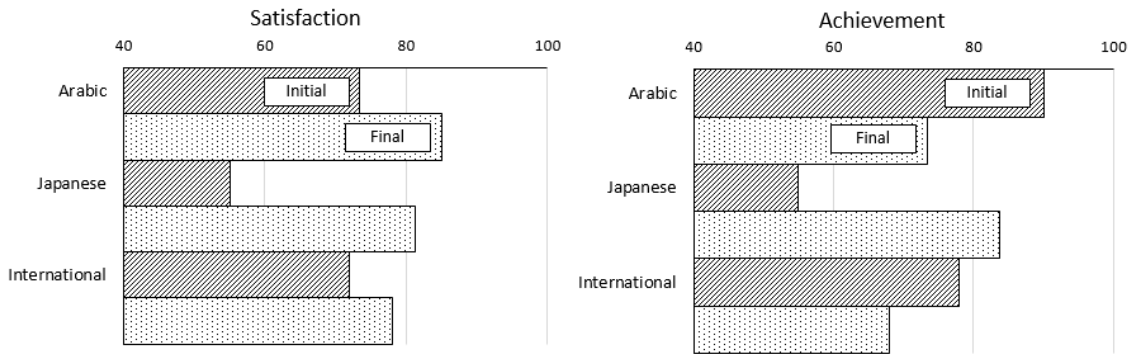


Figure 3. Satisfactions and achivement of learning

3.4 Effectiveness of social media communication

A correlation analysis was conducted to examine the relationships between SNS communication and the learning reflection. Self-evaluation was utilized as the learning reflection, which is 2 efficacies (motivational and techical efficacies explained in Table 2) and satisfaction and achievement differences (the differences between before and after, results indicated in Figure 3). The results are summarised in Table 6. The SNS score, which applies the weighted coefficient for each categorized communication correlated with the participants' learning reflection ($r=0.65$, $p<0.10$ in cycle 3). Although, it does not statistically correlate with the total number of SNS communication. This result shows that specific communications were able to influence their learning reflection.

Table 6. Correlation coefficient (r) between quality of learning and SNS communication

Cycle	SNS comm.	Motivational efficacy	Technical efficacy	Satisfaction differences	Achievement differences
1 (N=12)	Total N	(0.22)	(-.05)	(0.00)	(-.37)
	Score	(0.18)	(-.08)	(0.00)	(-.39)
2 (N=9)	Total N	0.70	0.73	(0.43)	(0.30)
	Score	0.66	0.71	(0.38)	(0.29)
3 (N=12)	Total N	(0.38)	(0.17)	(0.43)	(0.03)
	Score	(0.46)	(0.25)	0.65	(0.27)

(): not significant coefficient

To confirm the relationship between the learning reflection and categorized SNS communication, multiple regression analyses were performed. The summarized result is shown in Table 7. It shows the communication overall in cycle 3 was more significantly affected by the learning reflection than in cycle 1 and 2. This is because the 3rd cycle was the most active and the most influential to their learning reflection.

In the first cycle, where SNS communication was not active yet (especially in the 2 domestic teams), only technical efficacy was influenced by *Encouragement* ($r=3.51$, $p<0.10$). In addition, the Arabic team didn't have any social media communication in the 2nd cycle, hence the relationship between *Encouragement* and satisfaction differences are negatively examined ($r=-45$, $p<0.10$). Moreover, in the 3rd cycle, *Proposal* was the most important factor for the learning relection (achievement differences: $r=14.08$, $p<0.10$, satisfaction differences: $r=9.85$, $p<0.10$, technical efficacy: $r=0.98$, $p<0.10$, motivational efficacy: $r=0.74$, $p<0.10$) in cycle 3. On the other hand, *Permission* negatively impacted satisfaction ($r=-31.59$, $p<0.10$) and achievement($r=-72.47$, $p<0.10$). In the 3rd cycle, *Encouragement* positively influenced technical efficacy ($r=1.38$, $p<0.10$), and *Acknowledgement* also affected the Achievement differences ($r=-3.73$, $p<0.10$). This indicates that *Proposal* tends to help learning reflection, especially for the participants' achievement, but *Permission* and *Acknowledgement* influence learning reflection negatively.

Table 7. The result of partial regression coefficient in terms of learning reflection

Objectives	Cycles	Proposal	Permission	Encouragement	Acknowledgement	R ²	Adj R ²
Motivational efficacy	1	(-1.18)	(-2.41)	(2.14)	(0.77)	0.32	-0.06
	2	(-2.50)	(1.00)	(-1.00)	(1.75)	0.66	0.33
	3	0.74	(-2.50)	(0.81)	(-0.10)	0.46	0.15
Technical efficacy	1	(-1.88)	(-3.03)	3.51	(0.97)	0.43	0.11
	2	(-4.00)	(7.00)	(-3.00)	(1.75)	0.65	0.30
	3	0.98	(-5.04)	1.38	(-0.22)	0.58	0.35
Satisfaction differences	1	(-2.45)	(3.73)	(-5.37)	(1.19)	0.07	-0.46
	2	(-25.00)	(70.00)	-45.00	(10.00)	0.87	0.73
	3	9.85	-31.59	(3.16)	(-1.58)	0.79	0.68
Achievement differences	1	(-5.61)	(12.67)	(-1.99)	(-0.33)	0.20	-0.25
	2	(32.50)	(90.00)	(-60.00)	(-16.25)	0.76	0.51
	3	14.08	-72.47	(4.33)	-3.73	0.73	0.58

Mean of total messages: Cycle1=5.4, Cycle2=3.6, Cycle3=7.5

All intercepts significantly contribute to Objective variables.

(): not significant coefficient

4. Conclusion

In this project, we found that *Proposal*, such as constructive communication, contributes to learning reflection. This was especially so in cycle 3, where the project activities seemed to be the most active. However, *Permissio*n and *Acknowledgement* had negative coefficients. This suggests that these types of communications influenced negatively the learning reflection. Hence, *Proposal* communication may directly affect the project implementations when the participants concentrate on the project topics. To lead to better learning results, we need to encourage contribution, and instruct participants to agree on a proposal during the learning activity.

In future studies, we plan on investigating relationships with usability scores and cross-cultural difference across teams. In addition, social media communication was only one form to communicate for all teams. All teams used also either skype or face-to-face meeting during the project. These types of discussions also need to be investigated.

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