

# Investigating Student-Groups' Learning of Design & Technology in Computer-Mediated Learning Environment

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**Abstract:** Design & Technology (D&T) is a project-based subject taught in secondary schools. This study involved 15 students (aged 15) who formed three groups (five members) and they learnt to design collaboratively in a technology-mediated environment. We chose to focus on three stages of students' D&T learning: Situation, Ideation and Development. The technology mediation is by means of Knowledge Forum (KF), an asynchronous online discussion tool. The student-groups' online messages and participation were analyzed qualitatively and quantitatively using self-developed coding scheme. Findings showed that the discussions among student groups were not evident at the Situation stage but were more evident at the Ideation and Development stages. Participation levels also varied among the three groups during the three design stages. Generally, a relatively high level of in-depth information processing was observed among the three groups during the three design stages of D&T.

**Keywords:** Technology-mediated environment, asynchronous online discussion

## 1. Introduction

Technology makes knowledge construction process explicit and helps learners become more aware of the learning processes through interaction in a collaborative environment [1]. The social and cognitive processes involved in online interaction are significant in creating a community of learners [2]. Technology mediation acts as intermediary agent in effecting communication among learners in an online environment and makes the learning process more visible. Effective participation in discussion occurs where communication facilitates the development of a deep understanding of the material through sharing and critically evaluating ideas [3]. Analysis of online learning usually involves the evaluation of cognitive and social aspects of learning. Among the models highlighted [4], Henri's model [5] of analysis looks into the level of information processing such as surface or in-depth processing, as adopted from Entwistle and Waterston [6]. The students' learning of D&T is project-based and student-centred pedagogy is adopted by the teachers [7]. This study explored how students learnt D&T in a technology-mediated environment. The research questions were:

1. How do student-groups represent their ideas in the design situation?
2. How do student-groups generate and develop their design ideas?
3. To what extent do different student-groups learn through their online participation across the D&T design stages?

## 2. Method

The sample consisted of 15 D&T students (aged 15) of slightly above-average ability from a high school. They were introduced to the ground rules and a warm-up activity before the actual discussion took place. In this study, the students worked in three groups of five. Face-to-face discussions took place among the members in each group and online discussions involved every participant in the class.

There are four main stages of D&T design process that students experience in their learning - Situation, Ideation, Development and Realization [7]. The three stages of the design process discussed online in this study were Situation, Ideation and Development. At the Situation stage, students were expected to probe each other's understanding of the requirements of the design task and the needs of users. At the Ideation stage, students were to generate and evaluate design ideas leading to the most appropriate design solution. At the Development stage, students discussed and improved their design ideas such as choice of materials and technology. The product was finally made at the final stage named Realization that had no further online discussion in this study. The component named Research is linked to the entire design process and its tasks are information-gathering and decision-making. The teacher-facilitators design the online activities, group the students and teach just-in-time skills for the online discussions.

A self-developed coding scheme was used to analyze the content of the students' messages. Students' cognitive process in the discussion forums was analyzed using Henri's Levels of Information Processing [5] of cognitive dialogue. Students' participation in the discussion forum, defined as the number of their posted messages, was analyzed quantitatively.

## 3. Findings

Research question 1: How do student-groups represent the design situation?

Coding results of the 23 messages posted by the 15 participating students at the Situation stage are shown in Table 1.

Table 1: Coding Result of Students' Representation of Design Situation

Design Stage	Indicators	# of student messages (%)
Situation	• Students consider needs and values of intended users	11 (47.8)
	• Students consider design factors that affect design	1 (4.4)
	• Students gather relevant information to consider design factors that affect design	11 (47.8)
Total		23 (100)

There was an absence of interaction among students at the Situation stage. Most of the messages were consideration of user needs (47.8%) and gathering of relevant information (47.8%).

Research question 2: How do student-groups generate and develop their design ideas?

Coding results of the 57 messages at the Ideation stage and the 37 messages at the Development stage are shown in Table 2.

Table 2: Coding Results of Generation and Development of Design Ideas

Design Stage	Indicators	# of student messages (%)
Ideation	• Students use ideation techniques to generate ideas	7 (12.3)
	• Students use scaffolds to communicate	46 (80.7)
	• Students improve on previous idea	4 (7)
	Total	57 (100)
Development	• Develop ideas by considering design factors	19 (51.4)
	• Students use scaffolds to communicate	15 (40.5)
	• Students improve on previous idea	3 (8.1)
	Total	37 (100)

There was a marked increase in student interaction at the Ideation and Development stages. At Ideation, most of the messages (80.7%) were scaffolds that students have used to help others improve on their design ideas. At Development, students were more active in consideration of design factors (51.4%).

Research question 3: To what extent do different student-groups learn through their online participation across the D&T design stages?

*Group participation at each stage:* The quantitative measure of the overall participation level by each of the three project groups at each stage of the design process is summarized in Table 3.

Table 3: Group Participation Level at Each Design Stage

Student Group	Situation	# of Messages (%)	
		Ideation	Development
1	9 (7.7)	24 (20.6)	12 (10.3)
2	8 (6.8)	27 (23)	13 (11.1)
3	6 (5.1)	6 (5.1)	12 (10.3)
Overall	23 (19.6)	57 (48.7)	37 (31.7)

No. of students = 15

The graphical representation of the group participation level of each project group at each stage of the design process is shown in Figure 1. All the three groups started with low participation level at Situation. At Ideation, groups 1 and 2 increased their participation while group 3 remained unchanged. At Development, participation level of groups 1 and 2 decreased while group 3 increased.

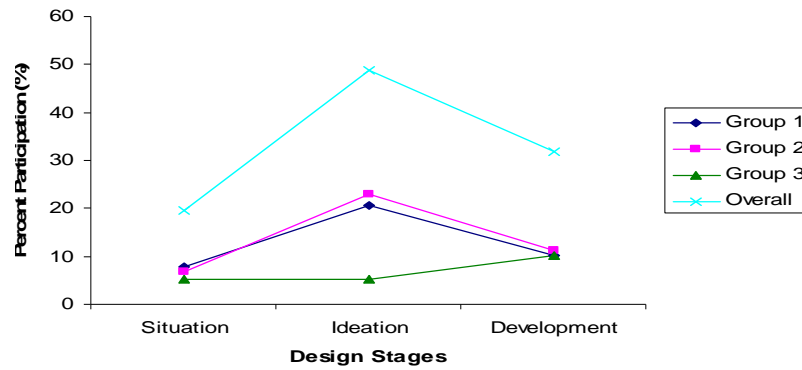


Figure 1: Graphical Representation of Group Participation

*Student groups' cognitive levels of information processing:* The quantitative measure of the cognitive levels of information processing by each of the three project groups at each stage of the design process is summarized in Table 4. The graphical representation of the overall cognitive levels of processing at each stage of the design process is shown in Fig. 2.

Table 4: Cognitive Levels of Processing

Student Group	# of Messages (%)					
	Situation		Ideation		Development	
	Surface	In-depth	Surface	In-depth	Surface	In-depth
1	3(2.5)	6(5.1)	12(10.2)	12(10.2)	5(4.3)	7(6.1)
2	0(0)	8(6.8)	7(6.1)	20(17.1)	5(4.3)	8(6.8)
3	2(1.7)	4(3.4)	2(1.7)	4(3.4)	8(6.8)	4(3.4)
Overall	5(4.2)	18(15.3)	21(18.0)	36(30.7)	18(15.4)	19(16.3)

In-depth level of processing was relatively higher than surface level at each of the three stages of the design process.

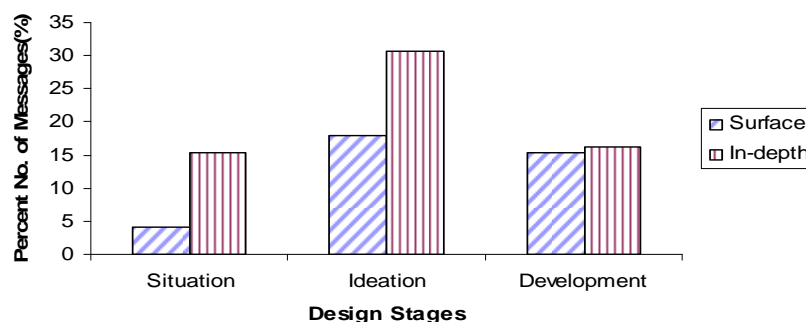


Figure 2: Graphical Representation of Cognitive Levels of Processing

#### 4. Conclusion

Students' contributions to the forum at Situation stage were mainly individual notes posted within each student-group. The teacher's simple and direct design situation presented to students at the beginning of the lesson could have resulted in little effort needed on the part of students to clarify and elaborate the design situation among the students. The scaffolds used by the students at Ideation have indeed helped them make a total of four

improvements (7%) to their design ideas. At Development stage, most of the messages were considerations of design factors. Again, this could be due to the simple design situation posted to students that only allowed them to consider design factors readily without much difficulty.

All the student-groups showed low participation at the initial Situation stage. It was also observed that an in-depth level of information processing was observed to be relatively high (15.3%) as student-groups were able to justify their statements without much difficulty. At the Ideation stage, participation by student-groups increased for groups 1 and 2 as students commented actively within their groups on their peers' generated design ideas and with their justifications made. However, group 3 students showed inactive participation in comparison to groups 1 and 2 and that warranted a close monitoring by the teacher-facilitator. At the Development stage, interruption from the school breaks could have changed the group dynamics along the way and altered the participation pattern of the three groups. The marginal difference observed between the in-depth and surface level of processing could be due to their lack of deep content knowledge, in particular, the appropriate materials and processes which in a way could have prevented them from making justified contributions to the discussions.

In this study, technology mediation has engaged students' learning in terms of their articulation of design ideas and application of thinking skills as shown from their message postings. Teachers' design of D&T learning task and facilitation are also important in bringing about active engagement of students in the discussions. This includes preparing more complex design situations and active monitoring of student participation. Although higher-order thinking through in-depth level of information processing was evident in student-group discussions, students still need to be scaffolded in this technology-mediated environment so that they can benefit cognitively and collaboratively.

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