



## Graphical representations and transfer of ideas between multi-draft pre-writing stages

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In this study, 36 engineering students who were taking a course on effective communication used graphic organizers to prepare their draft for a writing task. This was followed by a review by peers and the teacher. As students often have difficulties constructing knowledge across representations, this study aims to uncover the factors that influence students' cognitive decision-making when transferring information between pre-writing stages. The findings show that the factors were: the level of elaboration of the main ideas, the link between the writing goal of each pre-writing stage, and the level of importance of the main ideas. Furthermore, the redundant information in the pre-writing stages helped rather than hindered them from transferring ideas between the pre-writing stages. In addition, the students were more ready to accept feedback from the teacher than their peers. These findings highlight the importance of factoring in the function of the information in the representations in instructional design using multiple representations.

Keywords: graphical representations, transfer of ideas, redundant information, writing

### Introduction

The learning landscape nowadays is transforming more rapidly. As teachers, we can see that the future landscape is very much driven by our students rather than us. In a competitive educational environment, we want to design a learning environment to maximize the highest possible levels of outcome for our students. Our students who are often immersed in multimedia explorations/gaming however, want to charge ahead, with minimal structure and maximum freedom given. How do we as teachers engage our students effectively and yet meet their learning needs?

Jenkins, Purushotma, Clinton, Weigel, and Robison (2006) feel that students should be taught to be hunters rather than farmers as they grapple with complex learning environments. Traditional learning has taught students to focus on being farmers, focusing on one thing for an extended period of time (Hartman, 1999). The rise of digital media however, gives rise to the need to teach students to be hunters who are able to multi-task purposefully. Jenkins et al. (2006) define multi-tasking as the ability to scan one's environment and shift focus onto salient details on an ad hoc basis. The ability to pick out salient details (selective attention) as students multi-task is important because the capacity of our short-term memory is limited (Baddeley, 1999). Selective attention prevents information overload by controlling what information enters short-term memory.

This study examines the use of multiple graphic organizers coupled with peer and teacher feedback in a multi-draft pre-writing activity among engineering majors in an Asian university. The use of graphical organizers in lieu of text aims to help students see better the relationship between ideas so that they can revise their writing better. Using interviews and document analysis, we uncover the factors that influence students' cognitive decision-making when transferring information from one prewriting stage to the next.

The findings from this study hope to provide some insights on students' decision-making specifically what do they pay attention to as they multi-task (plan, give feedback and revise) in a multi-draft pre-writing activity using graphic organizers. In addition, research on students' coordination of information across representations has often regarded redundant information in the representations negatively (Gerjets, Scheiter, & Catrambone, 2006; Mayer, 2001). This study re-examines the role of redundant information in multiple representations, specifically representations where the information has complementary and constraining functions. The authors feel that in transforming learning to meet students' future needs in complex learning environments, teachers should empower students to make informed and critical decisions independently. The findings on students' decision-making process could help teachers empower their students to face the unknown future confidently.

## **Literature review**

In our study, the use of graphical representations, coupled with peer and teacher feedback, formed the main strategy to assist university students in writing. This strategy was informed by a review of the relevant literature. In this section, we first present a review of problems faced by unskilled writers, and some corresponding scaffolding strategies like peer review. This is followed by a review on graphic organizers, which explains the potential of the organizers in planning for writing. However, the use of multiple representations could also present some problems to the students. In the last section of this review, we discuss the potential benefits of using multiple representations for learning, as well as key issues such as redundancy of information across representations.

### **Scaffolding unskilled students in writing**

In the context of teaching students how to write, research has reported difficulties faced by unskilled writers in planning and revising their writing. Unskilled writers are not able to provide a strong support for their main ideas because they tend to focus so much on the accuracy of their language that it truncates the flow of their thoughts (Perl, 1979). In addition, as unskilled writers do not have a clear mental representation of their ideas, they often use the trial and error approach rather than goals to trigger more writing (Scardamalia & Bereiter, 1986) and have inflexible plans (Becker, 2006).

One of the most common forms of explicit cognitive support given to scaffold students' writing process is feedback from their peers and/or teacher. Feedback in general, has been shown to be effective in helping students to clarify their ideas and negotiate meaning with their peers or teacher (Ferris, 2004; Hyland & Hyland, 2006). There are however, a few criticisms about peer and teacher feedback. For example, students feel that their peers lack the knowledge and credibility to provide critical feedback (Linden-Martin, 1997). In addition, students often have problems detecting errors and often provide formulaic comments (Hyland & Hyland, 2006) that are too harsh (Villamil & de Guerrero, 1996) or focus on surface errors (McGroarty & Zhu, 1997). In terms of teacher feedback, students sometimes find written teacher feedback difficult to understand, vague, formulaic, and contradictory (Hyland, 1998).

This paper looks at an alternative form for giving feedback and revising that is, through the use of graphic organizers.

### **Scaffolding students with graphic organizers**

Graphic organizers consist of "spatial arrangements of words (or word groups) intended to represent the conceptual organization of text" (Stull & Mayer, 2007, p. 810). Examples of graphic organizers include concept maps, fishbones, matrices and flowcharts. In this study, we adopted a visual rather than textual form to help the students see better how their revisions affect the overall quality of their ideas in their planning stage. Although graphic organizers have not been used to scaffold students' revision, research has shown that graphic organizers can scaffold students' planning process.

Graphic organizers could help students to elaborate their ideas as they provide a basic framework for students to further develop their ideas. Guastello, Beasley, and Sinatra (2000) found that concept maps help students to form a cognitive schema to assimilate, tune, and restructure information. Graphic organizers also help students to be more flexible in processing their plans as the perceptual features of graphic organizers help to highlight any gaps in the students' knowledge (Reiser, 2004). Robinson and Kiewra (1995) found that graphic organizers (matrices and tree diagrams) help students to learn coordinate relations and write more contrasting premises. This is important because an organized and contrastive writing style is associated with writing maturity (Langer, 1984).

The use of multiple representations could assist the students in writing, but also present some problems, which is discussed in the next section.

### **Multiple representations and learning**

Ainsworth and vanLabeke (2003) held that using multiple representations in learning is beneficial because firstly, one representation can be used to constrain possible misinterpretations in the use of the other representation. For example, if students are given model essays to follow when they do their own writing, students are less likely to stray from the structure given in the model essays. Secondly, multiple representations can be used to facilitate deeper understanding of a learning task. This is because students are encouraged to construct and switch between multiple perspectives of a domain, thus helping students to build abstractions.

Research has found however, that students have difficulty in coordinating information across representations (Ainsworth, Bibby, & Wood, 2002). One reason for this difficulty is the level of students' declarative and procedural knowledge. Kozma, Chin, Russel, and Marx (2000) found that expert chemists are able to coordinate between representations because they are able to build abstractions with their wide repertoire of declarative and procedural knowledge. Their study shows that expert chemists have an integrated multi-representational understanding of chemical phenomena as opposed to novices who have a piecemeal (local) perspective of the same phenomena. Redundant or repetitive information in multiple representations also hinders students from coordinating information across representations successfully. Mayer's (2001) coherence principle states that extraneous and redundant elements should be excluded rather than included in learning materials as it increases students' extraneous cognitive load. Moreno and Mayer (2000) found that students who receive the narration, background music and sounds treatment fare the worst because there is too much auditory load for the students to process. The negative effect of redundant instructional support is also seen in the study by Gerjets et al. (2006). The students did not find instructional explanations helpful when learning using modular examples because they could engage in the self-explanation activities independently and thus, they did not need the explanations. Ainsworth et al. (2002) agreed that when students process redundant information, it increases their working memory cognitive load. She further added that this situation could be avoided if students were informed about how the information was distributed between the representations from the beginning of the intervention.

### **Purpose of this study**

The research question guiding this study is: using graphical representations with feedback for multi-stage pre-writing, what are the key factors that influence students' cognitive decision-making when transferring information from one prewriting stage to the next?

We are particularly interested in the complementary and constraining functions of multiple representations identified by Ainsworth (2006). The function of the information between the pre-writing stages is complementary if the information between the pre-writing stages is relevant to each other in terms of writing goal. On the other hand, the function of the information between the pre-writing stages is constraining if the information between the pre-writing stages is not relevant to each other in terms of writing goal. For example, if some of the ideas in the first pre-writing stage are not relevant to the writing goal of the second pre-writing stage, then these irrelevant ideas would be constrained (not transferred) to the second pre-writing stage. In addition, research has found that redundant information in multiple representations with the constructing function distract students from their focus of attention (Gerjets et al., 2006, Moreno & Mayer, 2000). We would like to re-examine the utility of redundant information in multiple representations where the information has complementary and constraining functions.

## Context

This study took place in an Asian university where *Effective Communication*, a core communication skills course, was offered to all engineering students. The key objective of the course was for the students to learn to communicate effectively in interpersonal, group and mass settings. Each two-hour tutorial consisted of two to three activities which included role plays, discussions, and/or written assignments based on scenarios given. There were three assignments for the course – one individual written assignment, one group written assignment and an oral presentation. The use of organizers as a feedback and revision tool was only used for the individual written assignment in the classes taught by the first author. Due to time constraints, the first author could not extend the intervention to include the other two assignments; doing so might compromise her ethical responsibility to complete the syllabus so as to adequately prepare the students for the end-of-semester examination.

## Participants

The participants were 36 first-year engineering students from two classes that the first author taught. As the first author assumed the dual roles of instructor and researcher, care was taken to conform to the ethical issues surrounding this relationship (Herr & Anderson, 2005). The students were invited to participate in the study. They were also informed that there was no monetary benefit or course credit in return for their participation. In addition, the writing assignment for all the students in the classes the first author was teaching was moderated at the course level by the Center to ensure fairness for all students.

The students were pre-registered into their classes randomly by their respective schools of engineering without any prerequisites. All the students were taking communication skills courses for the first time. In addition, all the students indicated that they did not know what graphic organizers were when answering the pre-questionnaire. There were 21 students from Singapore, 6 from Malaysia, 5 from Indonesia and 4 from China. Their ages ranged from 17 to 21 years old. There were 30 men and 6 women.

## Intervention

The intervention lasted over a period of 6 weeks and consisted of 3 stages: pre-session, in-session and post-session. In the pre-session stage, the teacher modeled the use of six organizers and how to give feedback in the organizers based on one tutorial activity on the white board. The teacher drew the organizers and then wrote their oral answers for the tutorial activity in the organizers. The organizers chosen reflected the three most common rhetorical patterns used in academic writing. The organizers were: the tree diagram and target to reflect main idea and sub-ideas, fishbone and clustering to reflect cause and effect, and matrix and Venn diagram to reflect the compare and contrast rhetorical patterns.

In week 4, the first author briefed the students about the writing assignment. A scenario was provided to the students for this writing assignment with the following goals: The goal of the first pre-writing stage was to identify the causes for Angela's (a student in the university) communication problem as given in the scenario; the goal of the second pre-writing stage was to identify the main causes for the communication problem as it relates to the general undergraduate student population to their audience (the Student Affairs Office); and the goal of the third pre-writing stage was to provide solutions to the problems identified in the second pre-writing stage. In addition, for each pre-writing stage, the students had to generate their ideas (*generating* sub-stage) and revise their ideas based on feedback from their peers and teacher (*revising-peer* and *revising-teacher* sub-stages). The first pre-writing stage was done in class. The students generated their organizers in the *generating* sub-stage based on ideas extracted from the scenario. Next, they gave their organizers to a classmate of their choice for comment. The students then revised their organizers based on their peers' feedback in the *revising-peer* sub-stage. The organizers were then given to the teacher for comment and the students revised their organizers based on the teacher's feedback in the *revising-teacher* sub-stage.

In week 5, the students were asked to do likewise for the second and third pre-writing stages outside class hours. They were also instructed to write their assignment after they had completed the three pre-writing stages. The second and third pre-writing stages were completed outside the class hours because the teacher had to cover the syllabus and the students did not want to come for any extra class sessions

to do the assignment. The students submitted all their organizers, and assignment to the first author in week 6. In week 7, the focus group discussion was carried out to probe for the students' reflections about the whole pre-writing stage.

## Data collection and analysis

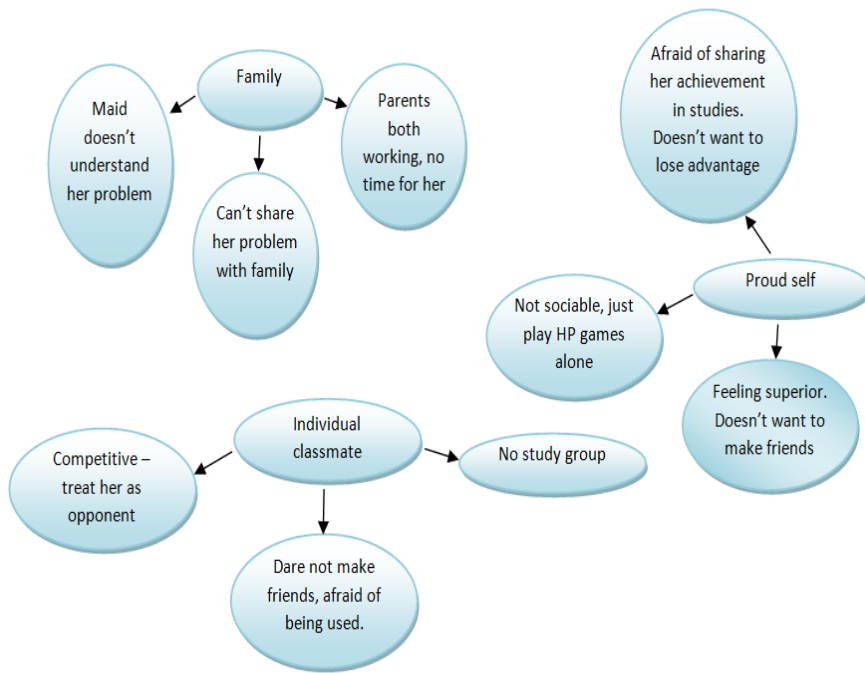
The data was collected using the students' organizers and focus group discussion. The students' organizers were analyzed qualitatively to find out what ideas were transferred or not transferred in one pre-writing stage to the subsequent pre-writing stage. The organizers provided a way for the researcher to confirm the factors the students mentioned in the focus group discussion.

In the focus group discussion, the students were asked what factors affected their transfer of ideas from one pre-writing stage to the subsequent pre-writing stage, what they looked for when commenting on their peers' organizers, and whether they accepted all their peers' and teacher's feedback. The planning for the focus group discussion followed Morgan's (1998) approach where the questions were drafted, piloted and revised based on feedback from two teachers teaching the course and one former student who took the course. The focus group discussion was moderated and analyzed as advised by Krueger (1998). The first author coded the students' responses and the coding was counter-checked by two postgraduate students with a 98% agreement.

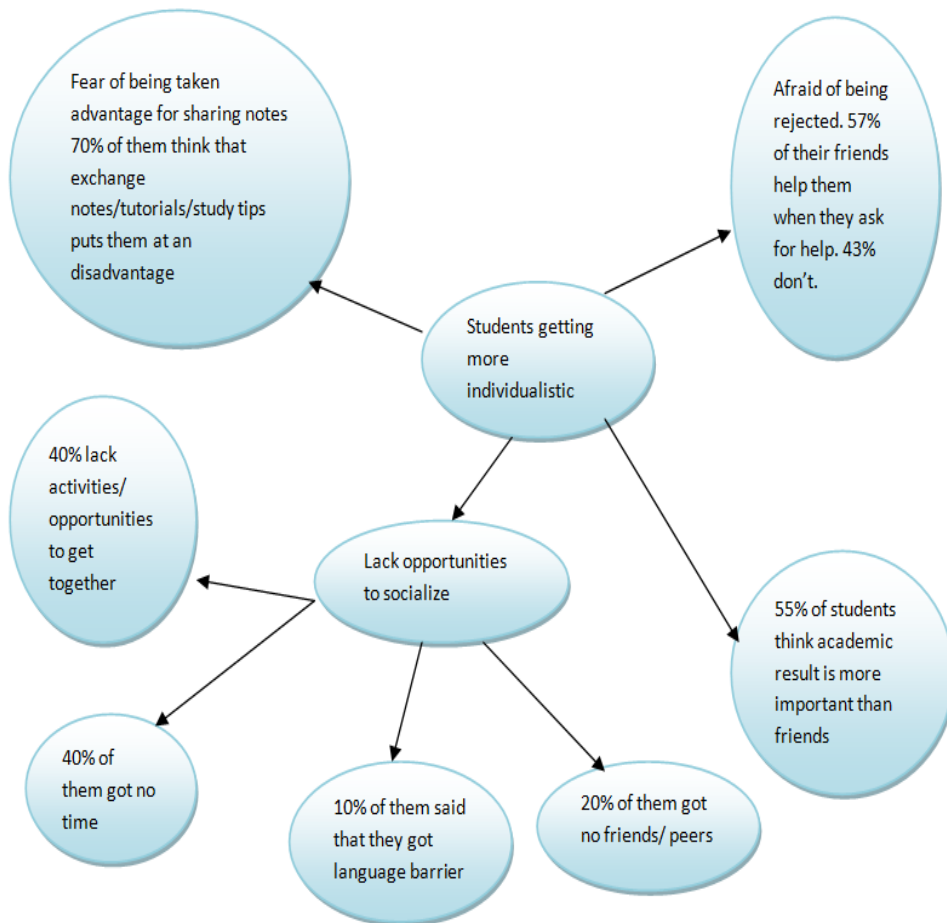
## Findings

The findings show that there were three main factors that influenced the students' cognitive decision-making process when transferring information between pre-writing stages: the level of elaboration of the main ideas, the link between the writing goal of each pre-writing stage, and the level of importance of the main ideas. There was a difference however in students' focus of attention when transferring ideas. In addition, the students were more ready to accept feedback from the teacher than their peers.

A consideration that the students had when deciding on what ideas to transfer was the level of elaboration of the main ideas. The students mentioned that main ideas that had the most sub-ideas were chosen for transfer. This was because the students felt that it was easier to write with main ideas that were strongly supported by sub-ideas. Another consideration the students mentioned was whether there was a link between the writing goals of the pre-writing stages. In other words, if the ideas in the pre-writing stages matched in terms of writing goals, the ideas were transferred and if the ideas in the pre-writing stages did not link or match, the ideas were not transferred. An example of this can be seen in Student 1's transfer of ideas from pre-writing stage 1 to 2 (Figures 1 and 2). The writing goal of pre-writing stage 1 was to identify the causes for the student's communication problem while the writing goal of pre-writing stage 2 was to identify what were the main causes of the communication problem (from a survey conducted by the students) that also affected the undergraduate population to the Student Affairs Office (their audience). Figure 1 shows that Student 1 had three main ideas in pre-writing stage 1 – "individual classmates", "proud self" and "family". However, in pre-writing stage 2 (Figure 2), he dropped the main ideas "proud self" and "family" (and their corresponding sub-ideas). In addition, he elaborated on the main idea "individual classmates" because he felt that it was more relevant to his writing goal for the subsequent pre-writing stage.



**Figure 1: Student 1's organizer for pre-writing stage 1**



**Figure 2: Student 1's organizer for pre-writing stage 2**

In transferring ideas from pre-writing stage 2 to 3, many students mentioned that main ideas that were transferred had to have a high percentage (as gathered from the survey they conducted) as the high percentage would denote that the problem should be given priority for resolution. In addition, these ideas with the high percentage must be ideas that they have a practical solution to and can write about. If the main ideas had a high percentage but they could not solve them, they would not transfer those ideas to pre-writing stage 3. An example of this can be seen in Student 34's transfer of ideas from pre-writing stage 2 to 3 (Figures 3 and 4). Figure 3 shows that Student 34 felt that the main causes of the communication problem were the competitive environment (60%), personal reasons (20%), and family problems (20%). In addition, he only elaborated on the main idea "competitive environment" and not on "personal reasons" or "family problems" in pre-writing stage 2 because it was the reason with the highest percentage. In pre-writing stage 3 (Figure 4), he provided solutions on how to reduce the competitive environment in the university. His solution was to get schools to recognize that grades were not a holistic reflection of a student's ability. Instead, schools should encourage students to improve their communication skills and to develop friendships in the university.

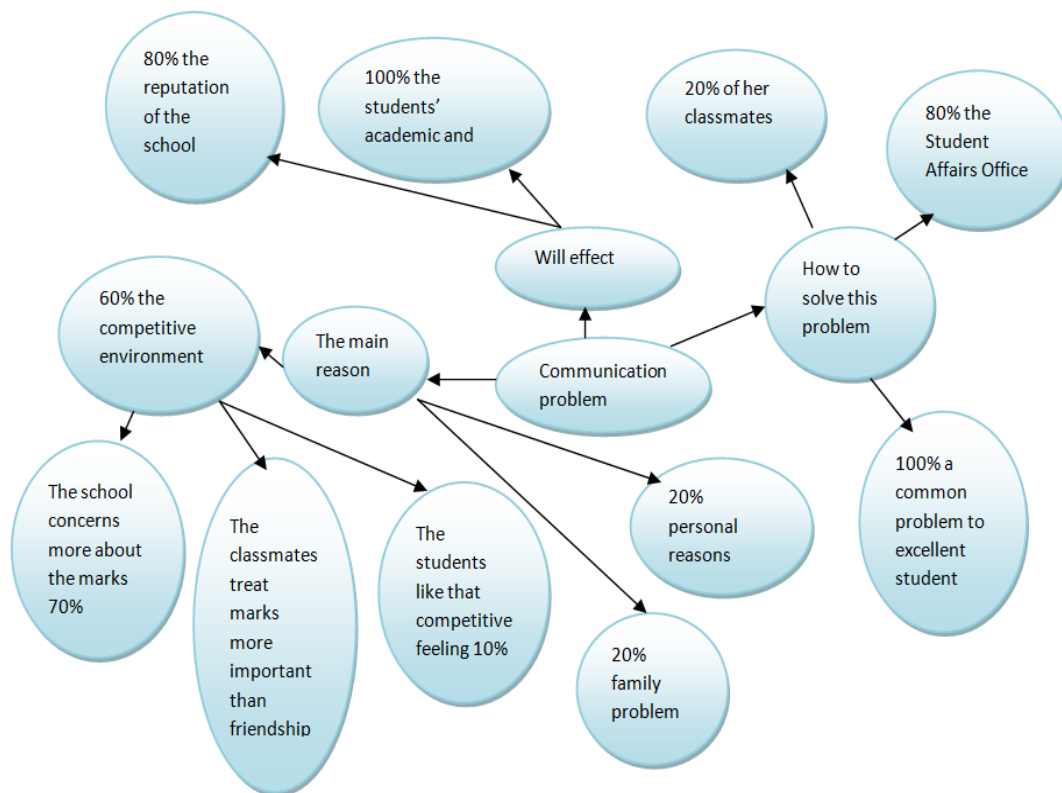
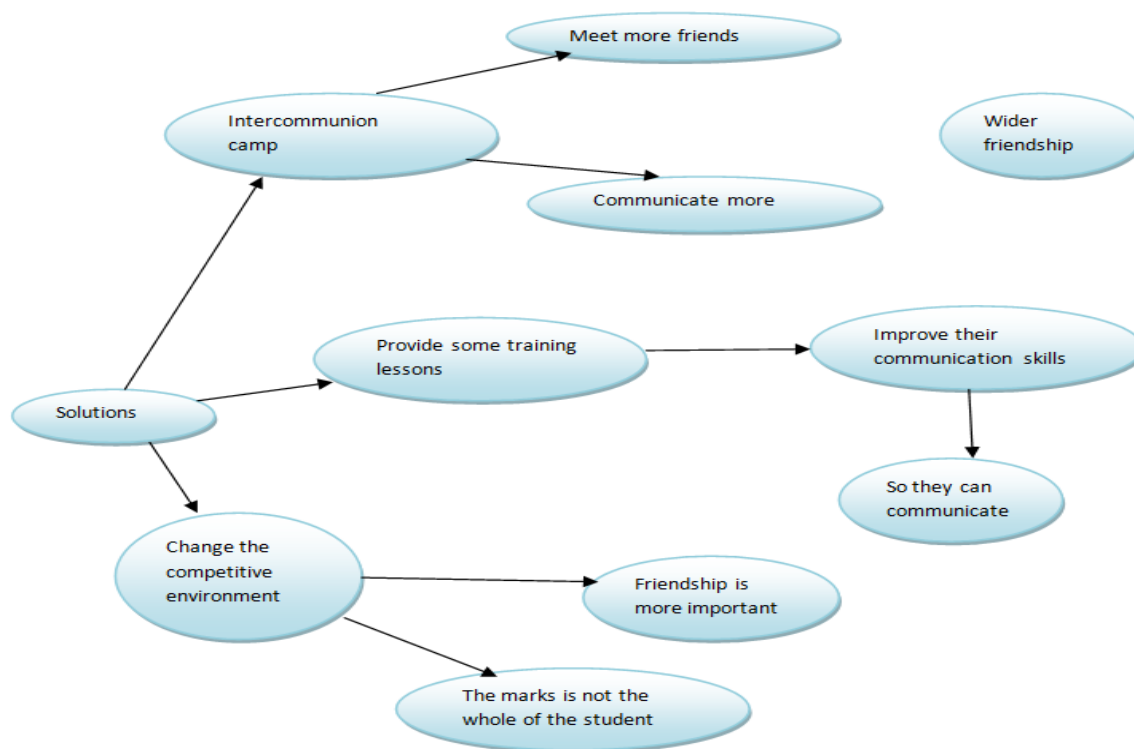


Figure 3: Student 34's organizer for pre-writing stage 2





**Figure 4: Student 34's organizer for pre-writing stage 3**

A noticeable difference in the students' responses during the focus group discussion was their focus of attention when transferring ideas. Some students mentioned that they matched the survey results in pre-writing stage 2 with the causes of the communication problem they identified in pre-writing stage 1 (local focus). However, others mentioned that they not only looked at the link between the causes of the problem in pre-writing stage 1 and the survey results in pre-writing stage 2 but also how the survey results affected the solutions that they were going to propose in pre-writing stage 3 (global focus). An analysis of the students' organizers shows that many ideas were not transferred from one pre-writing stage to the subsequent pre-writing stage in the organizers of students who had a more local focus of attention. On the other hand, most ideas were transferred from one pre-writing stage to the subsequent pre-writing stage in the organizers of students who had a more global focus. The writing proficiency of these students was then traced to their writing assignment to find out whether there was a relationship between their writing skill and focus of attention. Their writing proficiency level was member checked by two other lecturers teaching the course, following Raimes (1985). The results show that the students who had a local focus of attention were unskilled writers while students with a global focus of attention were skilled writers. These findings are in line with research on skilled and unskilled writers' composing process (Raimes, 1985; Zamel, 1983). Skilled writers have a clear direction in their writing and thus adopt a global focus when transferring ideas between the pre-writing stages. Thus, the ideas they included in their organizers even from the first pre-writing stage were mostly relevant to the writing goals of the three pre-writing stages. However, as the unskilled writers did not have a clear direction in their writing, they had a local focus of attention where they looked at the link between the pre-writing stages one pre-writing stage at a time. Thus, they included many ideas in one pre-writing stage which they later found were not relevant to the writing goal of the subsequent pre-writing stage and thus had to be dropped.

Another point of interest is the feedback given by their peers and teacher (Table 1). Responses from the focus group discussion (Table 1) show that when commenting on their peers' organizers, they checked primarily for relevance of the ideas to the writing goal of each pre-writing stage. This response is promising as it suggests that the graphic organizers helped the students to focus on the writing goal of each pre-writing stage when giving feedback. Surprisingly however, 16 students mentioned that they did not accept all the feedback their peers made in their organizers. A primary reason given was that



they felt that their peers' feedback were not relevant to their writing goal or "what they were trying to say" (12 students). They also mentioned that they could not understand the feedback (3 students).

**Table 1: What students look for when commenting**

What students look for when commenting in their peers' organizers	Number of students
Checking the relevance of the ideas to the writing goal	17
Adding examples or ideas to the organizers	10
Correcting mistakes	8
Comparing their answer with their peers'	4
Checking for clarity	2
Checking for flow	1

On the other hand, most of the students (13 students) mentioned that they accepted all of their teacher's feedback (Table 2). Table 2 shows that the main reason students mentioned for accepting the teacher's feedback was that the teacher was a credible source of feedback and the feedback was relevant to their writing goal. Two students mentioned that they did not accept all the teachers' feedback because they could not understand the comment (1 student) and the comment was too general (1 student).

**Table 2: Reasons for students accepting the teacher's feedback**

Reasons for accepting the teacher's feedback	Number of students
Credible source of feedback	7
Feedback was relevant to their writing goal	3
The student felt that he lacked the knowledge and skill to do the assignment	1
Feedback provided her with more ideas	1
Feedback was accepted subject to further changes that might be made	1

## Discussion

The aim of this study was to uncover the factors that influence students' cognitive decision-making when transferring information from one prewriting stage to the next. The findings show that the factors were: the level of elaboration of the main ideas, the link between the writing goals of the pre-writing stages, and the level of importance of the main ideas. Furthermore, the redundant information in the pre-writing stages which arose because the writing goals of the pre-writing stages were related to each other helped rather than hindered them from transferring ideas across the pre-writing stages. This is contrary to Mayer's (2001) finding that redundant information should be reduced when working with multiple representations. This finding suggests that the utility of redundant information needs to be seen in relation to the function of the information in the representations they reside. In deciding what ideas to transfer, the level of elaboration and importance of the main ideas in each pre-writing stage served the complementary function as main ideas which were more elaborated were also regarded as more important compared to the other main ideas and thus were transferred to the subsequent pre-writing stage. Similarly, the link between the writing goals of each pre-writing stage formed the constraining function. This is because ideas that were not relevant to the writing goal of the subsequent pre-writing stage were not transferred.

It is interesting to note that many of the students did not accept their peers' feedback even though the feedback was regarding their writing goal. Furthermore, the main complaint that students had was that the feedback was not relevant to their writing goal. Most of the students however accepted the teacher's feedback. This finding concurs with students' preference for teacher feedback compared to peer feedback (Nelson & Carson, 1998; Paulus, 1999). However, more study needs to be conducted to find out the reasons for the low acceptance rate for peer feedback using graphic organizers.

The implications from this study suggest that in helping students to pay attention to salient details when multi-tasking, teachers should state explicitly the goals of the task in their task sheet. The students and peers were able to focus on aligning their ideas to the writing goal of each pre-writing stage because they were informed explicitly about how the writing goals related to each other. In addition, students' ability to pay attention to salient details while multi-tasking depends on their proficiency level in the subject. Novices for example, should be encouraged to use the matching strategy to help them focus

their attention when dealing with information in representations with complementary and constraining functions.

In addition, visuals tend to be subjective to interpretation depending on a person's perspective. Hence, students could be asked to write a short summary of the main points in their organizer to enhance their peers' understanding of the flow of their thoughts when giving feedback in their organizer. Liu and Sadler (2003) mention that students tend to provide more superficial feedback online. The use of the organizers might encourage students to provide more idea-related feedback online due to their perceptual features. Furthermore, as mentioned by Hyland and Hyland (2006), online feedback should be supplemented with face-to-face feedback rather than seen as a replacement of face-to-face feedback. Negotiation of meaning between students and their peers could be further facilitated if their discussions are localized in an organizer rather than different threads.

## Conclusion

This study provides insights from a case study on students' decision-making process when coordinating information across representations. The findings show that students are better equipped to multi-task and pay attention to salient details if tasks are adapted according to students' proficiency level and students are informed explicitly about the function of the information in the representations. Empowering students is one of the greatest gifts teachers can give to students. We hope that the findings could be integrated into lessons that involve the use of multiple representations in complex learning environments for the benefit of our students.

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