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Using Group Brainstorming in Industrial Design Context: Factors Inhibit and Exhibit

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Abstract

Brainstorming is a series of procedures designed to maximize the productivity of groups. This study examines two main factors, production loss and ownership of the topic that influence the performance in group brainstorming. 115 groups from 6 different universities have participated in this experiment study. The data is analyzed at group-level. Results reveal that production blocking is negatively related to the group brainstorming performance whereas evaluation apprehension is positively related to the performance of group brainstorming. Ownership of the topic is related to the performance too. The results are of potential interest to industrial design context, educators, and researchers.

Keywords: Industrial design; brainstorming; production loss; ownership of the topic; group level analysis

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1. Introduction

Industrial design is the area that contributes the services in terms of creating and developing concepts and specifications for both user and manufacturer (The industrial Design Society of America (IDSA), 2004). The term of Industrial design that is always used interchangeably with product design involves both engineering and aesthetic design (Ekberg, 2005) but it emphasizes more on users' consideration (Roozenburg & Eekels, 1995). Therefore, Industrial Designers are not the people who handle the things that are involved with engineering directly, but they deliver the idea to an engineer (Hannah, 2004). For instance, Alexander Graham Bell was the person who was responsible to invent the telephone, but Henry Dreyfuss as an Industrial designer was the person who is responsible to give the modern form to the phone (Hannah, 2004). Hence, in industrial design context, creativity is needed and it plays an important role to come up with the ideas and solutions (Takala, Keinonen, & Mantere, 2006). In Malaysian industrial design context, Rahman (2005) has revealed that Malaysian designers are preferred to have a strong attitude in dynamic team such as brainstorming practice in terms of explicit knowledge in the organizations.

In an organizational setting, the essential of group creativity cannot be denied (Paulus, Larey, Putman, Leggett, & Roland, 1996; Paulus, 2000) because organizations use it to overcome the problem or invent a new product (Paulus & Brown, 2007). This group creativity can be enhanced through brainstorming. For instance, in IDEO, Kelly (2001) has emphasized that creativity in design firm is not coincidental or mysterious, but it could be gained. Moreover, brainstorming is one of the most well-known tools for creative thinking (Isaksen, 1998). Therefore, small group always contribute a good result for many practitioners in the field of Creative Problem Solving (Dorval, 1999) and imaginative tasks (Nickerson, 2003).

Malaysian designers are known to have a strong attitude in dynamic team such as brainstorming practice in terms of explicit knowledge and creation in the organizations (Rahman, 2005). He states that "…. management practices such as metaphor and analogy application, work with expert, design manager power, and brainstorming are the high preferences by designers that contribute towards explicit knowledge" (Rahman, 2005 p. 31). Moreover, brainstorming is the technique that emphasizes on the thinking activities. Nevertheless, most of literatures as discussed above are lack of intention in industrial design context. Even though Rahman (2005) has stressed on brainstorming technique to gain new ideas, there is no empirical evidence to support Rahman's (2005) finding of brainstorming especially in industrial design education in Malaysia. Moreover, there is lack of group-level of analysis in personality and group performance (Bolin & Neuman, 2006) which lead to the perfect finding to be concluded in the study. Therefore, the objective of this study is to examine the influence of process on group brainstorming performance at group level among industrial design students.

2. Literature Review and Hypotheses Development

2.1. Group Brainstorming

Brainstorming is a series of procedures (rules) designed to maximize the productivity of groups engaged in idea generation by reducing production loss, popularized by Osborn an advertising executive. The main concern of the development this tool is to increase creativity in organization (Osborn, 1963). Brainstorming is also identified as a technique of a variety tools for generating ideas (Isaksen, 1998) and that many people could produce many ideas compared to working alone (Osborn, 1963). The study on brainstorming has begun when Taylor, Berry, and Block (1958) examined the empirical study to prove the effectiveness of brainstorming as claimed by Osborn in his influential book, Applied Imagination

(1957). Since the study by Taylor et al. (1958), the further studies tremendously increased such as by Bouchard and Hare (1970), Diehl and Stroebe (1987), Barki and Pinsonneault (2001), Nijstad, van Vianen, Stroebe, and Lodewijkx, (2004) and Nijstad, Stroebe, and Lodewijkx (2006). Most of the studies on group brainstorming emphasize on group process.

2.2. Group Process

In brainstorming, group process plays an important role towards group performance through the interaction between individuals in the group which introduces factors into brainstorming process that acts to improve performance. In other words, it is called process gains (Dennis & William, 2003). Meanwhile, the factors that act to impair performance are called production loss (Dennis & William, 2003) or production loss (Diehl & Stroebe, 1987). In production loss, Production Blocking is defined as competition for speaking time in interactive group (Diehl & Stroebe, 1987), while Barki and Pinsonneault (2001) defined evaluation apprehension as individuals in group feel fear that their creative ideas would be evaluated and can be retaliated in the group and Social loafing can be defined as a decrease in an effort when individuals perform in group (Latane', William, & Harkins, 1979).

There has been a strong trend in the study of brainstorming as idea generation (Paulus, 2000; Paulus, Dzindolet, Poletes, and Camacho, 1993; Dennis, and Valacich, 1993). In other words, idea generation should be the important determinant of the group brainstorming performance. Therefore, Osborn (1963) and the other practitioners such as Rawlinson (1981) emphasize on idea generation. Although there are several process as mentioned above, most brainstorming researchers such as Diehl and Stroebe (1987) Shepherd, Briggs, Reinig, Yen, and Nunamaker Jr. (1996), Bolin and Neuman (2006), and Coskun (2005) agree that the three prominent factors always disturb the brainstorming performance; Production Blocking, Social loafing, and Evaluation Apprehension. Moreover production blocking represents cognitive process, social loafing represents motivational factor, and evaluation represents social psychological factor (Mullen, Johnson, & Salas, 1991).

2.2.1. Production Blocking

Production blocking can be defined as a competition for speaking time in interactive group (Diehl & Stroebe, 1987). While Furnham and Yazdanpanahi (1995) define production blocking as a state where there is only one person who can speak at a time, and other group members should waiting for their turn, and that the waiting time would cost loss of productivity in a brainstorming group. Production blocking occurs when individuals in the group cannot express their ideas because the other group member is talking at the same time (Gallupe, Dennis, Cooper, Valacich, Bastianutti, & Nunamaker Jr., 1992) and it subsequently, would reduce the effectiveness of brainstorming sessions (Gallupe, Bastianutti, & Cooper, 1991).

2.2.2. Social Loafing

Social loafing can be defined as a decrease an effort when individuals perform in group. (Latane', William, & Harkins, 1979) and it occurs only when their ideas are not identified or attended by other group members (Paulus & Brown, 2007). According to Karau and Williams (1993), social loafing is when the individuals tend to spend less effort when they are working in groups than when they are working individually. The term of social loafing is the same meaning with free-riding whereby, individuals in group try to limit their effort to produce creative ideas (Barki & Pinsonneault, 2001).

2.2.3. Evaluation Apprehension

Diehl and Stroebe (1987) define evaluation apprehension as individuals may be feared to a negative reaction from group members and they withhold their ideas in brainstorming. Barki and Pinsonneault (2001) define evaluation apprehension as individuals in group who fear that their creative ideas would be evaluated and can be retaliated in the group. According to Gallupe et al. (1992), evaluation apprehension occurs when individuals in group withhold their ideas and feel that their ideas would not be approved by other members in the group. Therefore, the researcher's prediction regarding the process of brainstorming includes:

- H1: There are relationships between group process (Production blocking, Social loafing, and evaluation apprehension) and the quantity of ideas among industrial design students in brainstorming session.

The following exploratory sub-hypotheses are shown:

- H1a: There is a relationship between Production blocking and the quantity of ideas among industrial design students.
- H1b: There is a relationship between Social loafing and the quantity of ideas among industrial design students.
- H1c: There is a relationship between Evaluation apprehension and the quantity of ideas among industrial design students.

2.3. Ownership of the Topic

There are certain external factors that could also influence the group brainstorming performance. One of the factors is ownership of the topic. The topic that is given in brainstorming is quite general to the subjects of study such as 'Thumbs problem' (Dennis & Valacich, 1993; Gallupe, Bastianutti, & Cooper, 1991; Bolin & Neuman, 2006; Paulus et al., 1993), and role play of school and education (Shepherd et al., 1996; Coskun, 2005; Nijstad et al., 2004) are always preferable to be given in the study of brainstorming. In addition, the issue of unsuitable topic that is given in the study of brainstorming especially in Industrial Design context has been raised by Zainol & Yusof (2008). They suggest that the topic should be parallel with the subjects' interests in brainstorming session so that the participants could be more energetic to contribute creative ideas.

As mentioned earlier, the topics of brainstorming also play an important role in brainstorming study. As suggested by Isaksen (1998), researchers in brainstorming should pay attention on the topic given to the participants in the study in brainstorming sessions. Subsequently, the participants of study would be more responsive to the kind of tasks, problem and challenges given to them if they feel the sense of ownership of the topic. The researcher also suggests that future research should focus more on the ownership because in brainstorming session, the task or topic given is more on open-ended or creative task. Therefore, the ownership of the topic in brainstorming should be parallel with team members' field. This is supported by the result by Barki and Pinsonneault (2001) and Nijstad et al. (2006) that demonstrate that the sensitive topic would reduce the quality of ideas rather than simple topic. Understanding the degree of ownership of the topic in brainstorming study may help in determining the accuracy of this issue. The following hypothesis is proposed:

- H2: There is a relationship between ownership of the topic and the quantity of ideas among industrial design students in brainstorming session.

2.4. Conceptual Framework

Based on the discussion above, we propose the following conceptual framework, as shown in Fig. 1. First, there is a direct relationship between production loss and quantity of ideas. Second, there is also a direct relationship between ownership of the topic and quantity of ideas.

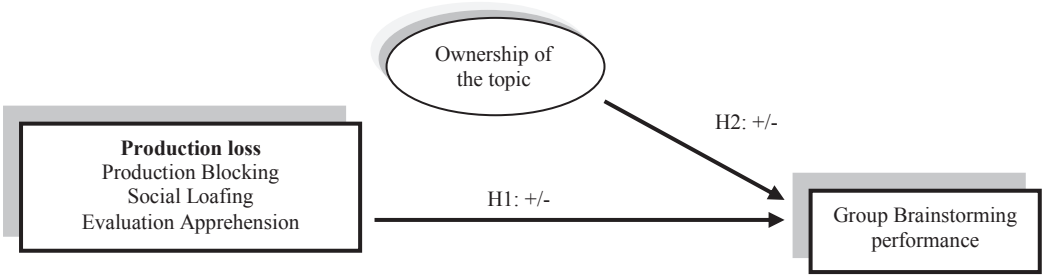

Fig. 1. Conceptual Framework of Group Brainstorming Performance

3. Methodology of the Study

3.1. Research Design

The researcher has gone to every university that has been chosen for brainstorming session to be conducted. Firstly, the participants were gathered in the hall to be given the briefing and instruction of the study (hypothesis of study were not given). There were 460 industrial design students at degree-level across six universities in Malaysia. The participants were divided into small groups. Four-person group was formed by using simple random technique. Therefore, the number of groups formed was 115. The instruction of rules of brainstorming: a. focus on quantity of ideas b. no criticism c. the wilder ideas are encouraged and d. combination and improvement of the ideas. To get the participants familiar with brainstorming session, warm-up topic was given and discussed for 5 minutes. Osborn (1963) also recommended to people who has no knowledge about brainstorming should be exposed to orientation on this technique to encourage ideation. Then, the actual topic on Malaysian furniture was given. The participants then brainstormed for 20 minutes. All ideas were written on the flip-chart. After 20 minutes of brainstorming session, the participants were given the instruments to measure production blocking, social loafing, evaluation apprehension and ownership of the topic.

3.2. Sample Size

Based on six IPTA in this study, stratified random sampling was used to choose the subjects. Stratified random sampling is a good strategy to determine the subjects in the study. Stratified random sampling would screen member of population and it also reduces the variability of the sample (Tuckman, 1994). This type of sampling facilitated a study of any differences that may exist within subgroups of the population. It also guaranteed that the various subgroups in the population were represented (Sekaran, 2000). After stratified random sampling technique was implemented, simple random sampling was applied. From 579, after Stratified random sampling is applied become 460 undergraduates Industrial Design students at degree-level across six universities in Malaysia.

3.2.1. Group-level Analysis

In group performance study, the suitability of operationalization depends on the nature of the task that will be completed by the group, the research question being asked, and the specific traits being analyzed. A task, according to Steiner (1972) is a 'job assignment' that would be achieved by the group. Steiner (1972) classified the task into four categories: The first category is a disjunctive task. It is referred to task that is determined by the best group members. The second category is a conjunctive task. It is referred to task that is determined by the worst group members. An additive task is the third category. It is referred to task that is determined by the sum of all member contributions. The last category is a compensatory task. It is referred to task that is determined by the range and distribution of responses within the group (one man, one vote). Steiner (1972) also said that "In real life, many tasks are additive." (pp.33). Therefore, in the case of brainstorming, Bolin and Neuman (2006) emphasized that group-level analysis is appropriate method to be used. This is because, the idea contributed is not owned by the individual but the group. Therefore, analysis at group-level is appropriate.

3.3. Instrument

3.3.1. Measurement

Production Blocking - The Process instrument (Bolin, 2002; Bolin & Neuman, 2006) was used to measure the process of Production Blocking, Social Loafing, and Evaluation Apprehension. In this study, an adapted version of Production blocking (Bolin, 2002; Bolin & Neuman, 2006) was used. This instrument was aimed at measuring of Production blocking. Originally, this instrument is consisted of 12 items (Bolin, 2002). These items were measured based on five-point Likert's scale that ranges from "strongly agree" to "strongly disagree". Production blocking included items such as the following: "It was hard to know when it was my turn to talk", "It was hard to concentrate on my ideas while others in the group were talking" and the reverse item such as "I felt I could speak up whenever I had something to say". The internal consistency coefficient of five items was also high (Cronbach's alpha = .84). This indicates that this instrument was very good and suitable to measure production blocking in group brainstorming.

Social Loafing - This instrument was aimed at measuring of Social Loafing. Originally, this instrument contained of 13 items (Bolin, 2002). These items were measured based on five-point Likert's scale that range from "strongly agree" to "strongly disagree". Social loafing had an item such as "I didn't try very hard to help complete the group task" and "I really didn't take this task seriously". The reverse item such as "working in a group helps me fell motivated" and "I was very motivated to generate quality ideas" were provided. The internal consistency coefficient of six items is high (Cronbach's alpha = .80). This indicates that this instrument was very good and suitable to measure social loafing in group brainstorming.

Evaluation apprehension - In this study, evaluation apprehension is referred to subject's responses to instrument of evaluation apprehension (Bolin, 2002; Bolin & Neuman, 2006). These items were measured based on five-point Likert's scale that range from "strongly agree" to "strongly disagree". Sample items include "I felt apprehensive about sharing my ideas with the group" and "I didn't express all of my ideas because I didn't want the members of my group to think I was weird or crazy". The internal consistency coefficient of seven items is also high (Cronbach's alpha = .77). This indicates that this instrument was very good and suitable to measure evaluation apprehension in group brainstorming.

Ownership of the topic - The Ownership of the topic instrument developed by the researcher was used to measure the Ownership of The Topic. This instrument was aimed at measuring of Ownership of The Topic. Originally, this instrument contained of 15 items. These items were measured based on five-point Likert's scale ranging from "strongly agree" to "strongly disagree". Ownership of The Topic had an item

such as "The problem in the brainstorming should suit with my area", "I feel that the brainstorming problem was related with my field" and: "If such problem is going to be held in the future, I will be willing to participate". The internal consistency coefficient of fourteen items is also high (Cronbach's alpha = .93).

Quantity of ideas - Quantity of ideas was based on the result of ideas produced during brainstorming session. It was defined as non-redundant ideas. Once the number of quantity of ideas from Rater 1 was determined, the number of ideas from Rater 2 was also determined. The value was calculated by using the formula of:

(Calculated as 1 - number of disagreement)
Number of ideas

$$1 - \frac{12}{1384} = 0.9913$$

That is adapted from Dennis, Valacich, Connolly, & Wynne (1996). The value of two raters' counts was .99. It shows that the high interrater reliability and satisfactory for quantity of ideas. Hence, the number of Rater 1 was used.

3.3.2. Interrater reliability-group-level Analysis

Before the data is computed to the group-level analysis, interrater reliability should be examined. It is determined by using the formula from James, Demaree, and Wolf (1984). The purpose of the interrater reliability is to examine the degree of differences of individual score in the group could be changeable (James et al., 1984). The formula is shown as below:

$$R_{WG(J)} = \frac{J[1-(S_{Xj^2}/\sigma EU^2)]}{J[1-(S_{Xj^2}/\sigma EU^2)]+(S_{Xj^2}/\sigma EU^2)}$$

$$= \frac{J[1-(S_{Xj^2}/(A^2-1)/12)]}{J[1-S_{Xj^2}/(A^2-1)/12]+S_{Xj^2}/(A^2-1)/12}$$

where J = *the number of item*

S_{Xj^2} = *variance*

$$\sigma EU = \frac{(A^2-1)}{12} \text{ and}$$

A^2 = *scale (e.g. 1-5, 1-7)*

Mean interater reliability for Production Blocking ($R_{WG(J)}$ = .70), Social Loafing ($R_{WG(J)}$ = .93), Evaluation Apprehension ($R_{WG(J)}$ = .80), and Ownership of the Topic ($R_{WG(J)}$ = .89) respectively. These results justified that the data be aggregated to the group-level.

4. Data Analysis

Table 1 shows the relationship between Production blocking and the quantity of ideas among industrial design students is significant (r = -.38, p< .01). The relationship between Social loafing and the quantity

of ideas among industrial design students is significant (r = -.21, p< .05). The relationship between Evaluation apprehension and the quantity of ideas among industrial design students is also significant (r = -.22, p< .05). The positive association between Ownership of the topic and quantity of ideas is also significant (r = .26, p< .01).

Table 1. Correlation analysis (N=115)

Variables	(1)	(2)	(3)	(4)
Production blocking	1.00	---	---	---
Social loafing	.75**	1.00	---	---
Evaluation apprehension	.71**	.79**	1.00	---
Ownership of the topic	-.47**	-.58**	-.67**	1.00
Quantity of ideas	-.37**	-.21*	-.22*	.26**

Note: ** Correlation is significant at the 0.01 level (2-tailed),* Correlation is significant at the 0.05 level (2-tailed), † Correlation is significant at the 0.10 level (2-tailed).

4.1. Hypothesis Testing

Data in this study is analyzed by using Partial Least Squares (PLS). PLS is a second generation multivariate technique in data analysis (Haenlein & Kaplan, 2004). PLS has the advantages to handle some problems such as:

- multicollinearity among independent variable
- data that is not normally distributed
- could be able to analyze whether the scale is nominal, ordinal, interval or ratio (scale-robust)
- able to analyze the models with either reflective, formative, or both, reflective and formative
- small sample size
- missing value
- analyzes the model simultaneously and
- analyzes the complex model such as independent, mediating, moderating, and dependent variable.

5. Finding and analysis

5.1. Assessment of the Model

Using Structural Equation Modeling (SEM) with Partial Least Squares (PLS) requires the researcher to perform two major steps: (1) assessing the measurement model in order to examine both convergent and discriminant validity and (2) assessing the structural model in order to examine the path coefficient (Hulland, 1999).

5.2. Convergent and Discriminant Validity

In PLS, firstly, the loading in the same block should be higher than the other blocks. This means that there is high convergent validity. A standardized loading that is recommended in measurement model is .70 (Chin, 1998). Nevertheless, loading of .50 and .60 are also still acceptable when the construct is the

new construct and the model is still new (Imam Ghozali, 2006). In this study, the researcher applied loading of 0.60 whereas the model using PLS is still new in group performance research. Table 2 shows the loadings within the same construct and the other constructs.

For discriminant validity, in PLS, it is assessed by three criteria: (1) factor loadings for all items should be .60 and above (2) composite reliability should be .70 and above and (3) AVE must show the cut-off .50 which indicating at least 50% of the measurement variance (Fornell & Larcker, 1981).

Table 3 shows the composite for constructs are greater than .70. Fornell and Larcker (1981) argued that composite reliability is powerful than Cronbach's alpha because it is determined by the relative loadings of the items and is not influenced by the number of items. Fornell and Larcker (1981) suggested the composite reliability cut-off value .70 to be satisfactory for the constructs. The table also shows the value of Cronbach's alpha for all constructs. The results indicate that all constructs have satisfactory to be measured (quantity of ideas has Composite reliability and Cronbach's alpha value of 1, this should not be interpreted as perfect indicators because it has absolute performance and not measured by the number of items).

Table 2. Crossloading between Constructs

	PRODUCTION BLOCKING	SOCIAL LOAFING	EVALUATION APPREHENSION	OWNERSHIP OF THE TOPIC	QUANTITY OF IDEAS
pb1	0.866	0.662	0.584	-0.357	-0.377
pb11	0.769	0.762	0.754	-0.403	-0.219
pb2	0.872	0.643	0.643	-0.408	-0.381
pb4	0.847	0.764	0.679	-0.389	-0.235
pb6	0.831	0.657	0.599	-0.364	-0.342
sl 1	0.611	0.775	0.684	-0.367	-0.181
sl 4	0.764	0.908	0.732	-0.476	-0.268
sl 5	0.744	0.927	0.707	-0.484	-0.345
ea 5	0.73	0.788	0.953	-0.499	-0.234
ea 7	0.714	0.736	0.949	-0.525	-0.225
top 1	-0.316	-0.374	-0.346	0.727	0.101
top 11	-0.343	-0.411	-0.381	0.826	0.273
top 12	-0.409	-0.446	-0.45	0.782	0.297
top 14	-0.415	-0.45	-0.418	0.739	0.276
top 15	-0.457	-0.453	-0.641	0.665	0.093
top 2	-0.322	-0.403	-0.412	0.782	0.139
top 3	-0.196	-0.268	-0.291	0.758	0.259
top 4	-0.345	-0.377	-0.419	0.838	0.278
top 5	-0.465	-0.49	-0.54	0.759	0.247
top 6	-0.356	-0.439	-0.5	0.774	0.13
top 7	-0.326	-0.406	-0.446	0.865	0.252
top 8	-0.416	-0.476	-0.498	0.802	0.184
top 9	-0.282	-0.275	-0.288	0.742	0.256

QUANTITY	-0.387	-0.318	-0.241	0.304	1.000

Note: pb= production blocking, sl = social loafing, ea = evaluation apprehension, top= ownership of the topic

In the case of discriminate validity, Table 2 also reflects the loadings of items on their own constructs. It shows that the loadings of all constructs within the same construct are expected to be high on this construct, whereby indicates that high convergent validity. Meanwhile, low on the other constructs indicates that high discriminate validity. Table 2 also shows a clear convergent and discriminate validity for all construct. The items in all the respective construct show higher loadings than the other constructs.

Table 3. Composite reliability and Cronbach's alpha

	Composite Reliability	Cronbachs Alpha
Production Blocking	0.92	0.9
Social Loafing	0.91	0.85
Evaluation Apprension	0.95	0.9
Ownership Of The Topic	0.95	0.95
Quantity Of Ideas	1	1

In the case of discriminate validity, Table 2 also reflects the loadings of items on their own constructs. It shows that the loadings of all constructs within the same construct are expected to be high on this construct, whereby indicates that high convergent validity. Meanwhile, low on the other constructs indicates that high discriminate validity. Table 2 also shows a clear convergent and discriminate validity for all construct. The items in all the respective construct show higher loadings than the other constructs.

Table 4 shows that AVE for Production blocking is .70, Social loafing is .76, Evaluation apprehension is .91, and ownership of the topic is .60. All the constructs have value above .50.

Table 4. Average Variance Extracted (AVE)

	AVE
Production Blocking	0.7
Social Loafing	0.76
Evaluation Apprension	0.91
Ownership Of The Topic	0.6
Quantity Of Ideas	1

5.3. Assessing the Structural Model

In order to estimate the statistical significance of the parameter estimates, a bootstrapping procedure with replacement using 500 subsamples was used in this study. A bootstrapping was used for the purposes to eliminate the assumption of normality. Since all hypotheses are not directional, this study used two-tailed t-test. This means that 90% level of confidence or $p< .10$ level of significant need t-value >1.645, 95% level of confidence or $p< .05$ level of significant need t-value >1.960, and 99% level of confidence or $p< .01$ level of significant need t-value >2.576.

5.4. Direct Effects of Process and Ownership of the Topic on Group Brainstorming Performance

This study hypothesized that Production loss is related to quantity of ideas among Industrial design students. Table 5 shows the direct effects of production loss on quantity of ideas. The results revealed that production blocking had negative effects on quantity of ideas ($\beta = - .43$, $p< .01$)., therefore supporting H1a. However, results showed that Social loafing ($\beta = - .05$, $p> .10$) was not significant. Hence, H2b was not supported. Evaluation apprehension had significant effects on quantity of ideas ($\beta = .24$, $p< .10$), indicated that H1c was supported.

This study also hypothesized that Ownership of the topic is related to quantity of ideas among Industrial design students. Table 5 shows that the direct effect of Ownership of the topic is related to quantity of ideas among Industrial design students. Result showed that Ownership of the topic had significant effect on quantity of ideas ($\beta = .21$, $p< .05$), therefore supporting H2.

Table 5. Direct Effects of Process and Ownership of the topic on Group Brainstorming Performance

	β	T-statistics	Hypothesis Supported
production blocking -> quantity of ideas	-0.43	3.250	Yes
Social loafing -> quantity of ideas	-0.05	0.405	No
Evaluation apprehension -> quantity of ideas	0.24	1.683	Yes
Ownership of the topic -> quantity of ideas	0.21	2.329	Yes

Overall, as shown in Figure 2, this research model explained 19 percent of the variance in group brainstorming performance ($R^2 = .19$). This indicates that Production loss of production blocking and evaluation apprehension is powerful predictors of the group brainstorming performance. Ownership of the topic also contributes to the group brainstorming performance.

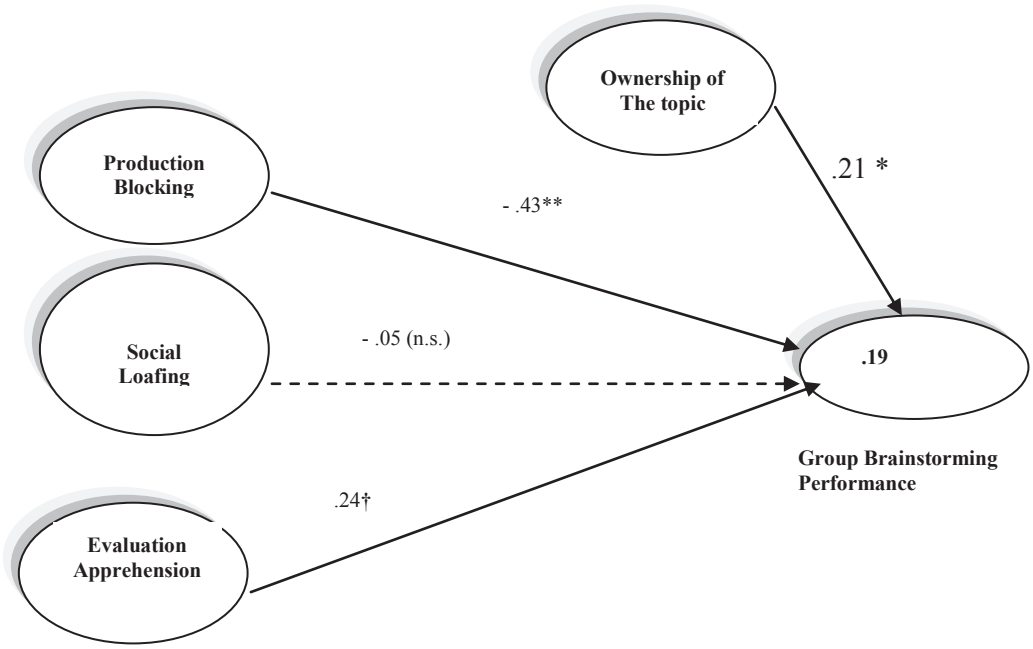

Fig. 2. Model of Process in Group Brainstorming

6. Discussions and Conclusions

The results of this study support the hypotheses that production loss as a unique predictor of group brainstorming performance. For each specific process, production blocking and evaluation apprehension are the strongest predictors whereas social loafing is not a predictor to group brainstorming performance. These findings are congruent with past research on brainstorming (Diehl & Stroebe, 1987; Diehl & Stroebe, 1991).

For evaluation apprehension, the positive relationship with group brainstorming performance is not in line with the previous researches such as by Barki and Pinsonneault (2001) and (Mullen et al., 1991). The results of this study on the production loss suggest that group that has high production blocking would produce less ideas rather than the group that has evaluation apprehension among industrial design students. Whereas the higher evaluation of apprehension the higher ideas would be contributed by industrial design students in the group brainstorming session. The findings also revealed that ownership of the topic is a good predictor to the group brainstorming performance. This result is consistent with the finding by Barki and Pinsonneault (2001) and Nijstad et al. (2006). The results also suggest that in order to enhance the group brainstorming performance, the topic which is parallel with the participants' interests should be considered as mentioned by Zainol and Yusof (2008). The positive relation between ownership of the topic and quantity of ideas for current sample is similar to the findings from previous research that had established that, the topic the participant owns would produce better performance (Paulus & Brown, 2003).

This study gives some theoretical and practical implication. Firstly, the topic that was given in the brainstorming session should be emphasized by the future researcher because it will influence the result in brainstorming research. Secondly, the topic given also should come from the experts in the area of study. Surprisingly, even though almost all studies agree that evaluation apprehension is prominent loss, but this

study is against their findings because it will give more positive group brainstorming performance in industrial design context. This circumstances is seen when the participants in group brainstorming feel that they are evaluated by the other members, they would more contribute the ideas.

This study also has a few limitation of study. Firstly, this study is limited to undergraduates who take the programme of Industrial Design in some public university in Malaysia. Any attempt to generalize this study to any other area and private colleges must be proceeded with caution. Second, even though most of the hypotheses are supported, 19 percent of the variance explained in this study should be taken an account by future researcher.

All in all, the result of this study supports the magnitude of three production loss especially production blocking and evaluation apprehension. The ownership of the topic given also is one of the factors that contribute to group brainstorming performance especially in industrial design context. Therefore, industrial designers can work in any situation even with the issue of transportation, electrical appliances etc. being conferred.

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