Design Exploration and Collaboration within Groups in Learning-By-Making (LBM) Approach

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Abstract. Using a case study of the 3rd instalment of Bamboo Nation (BN) 2018, an international learning workshop for bamboo structure and construction, this research explores Learning-By-Making (LBM) implementation with a focus on design exploration tools and collaboration within a group tasked with designing cores. As commonly found in LBM practices, the participants involved in the 3rd BN were assigned to design and, eventually, build a 1:1 scale model within two weeks. In that process, there were tendencies for groups that relied on a particular design tool, the physical models, as a more relatable to each other. The study inquires specifically on the Design Explorations aspect, using particular design tools and Collaboration aspects within groups in the 3rd BN. The result will provide a basis for further development to improve design performance in LBM as a design learning approach. Data collection regarding design processes and products was from first-hand documentation and interviews with data for collaboration assessments were obtained by peer-assessment and self-assessment from every participant in the 3rd BN. Both types of data were then further analysed according to the Design Exploration Aspect and Collaboration Aspect of a typical LBM practice. A comparison of these aspects concludes the analysis. The study is a focus on finding a relation between a group’s productivity on delivering design alternatives and its collaboration aspects within groups. It also investigated the design tools that the groups used, whether by physical models or any other tools, on their contributions in the whole aspects of Learning-By-Making (LBM) processes. Contribution of the research will involve mainly evaluation of the LBM characteristics as an alternative for design and technical-based studies and suggestions for further applications of the approach.

1. Introduction
The 3rd Bamboo Nation (uapsugbuarchitects.wixsite.com/bamboonation) is an international learning workshop for bamboo structure and construction using Learning-By-Making (LBM), a design learning approach within-group(s) that involves designing and making the design to a 1:1 or real-scale model [1]. Held at Students’ Center of School of Architecture and Fine Arts (SAFAD), University of San Carlos (USC), Talamban Campus, Cebu City, the Philippines in August 2018, the participants were given two weeks for an assignment that consists of design and built activities in groups, following a given design brief.

In the design process of BN 3, based on observations, the groups that relied more on physical models as design tools produced design alternatives that are more related to each other compare with the groups that relied more on other design tools. This tendency raised a presumption of a particular
Design Exploration that may affect the process and the outcome of the design. Other resurfacing remarks from Design Exploration in a group setting are a collaboration of groups that are the primary subjects of the design learning process and result. In order to test these presumptions, the research will investigate the relationships between these Design Exploration and Collaboration within groups during BN 3.

The findings of this research aimed to explain the relationship between Design Exploration and Collaboration within groups during BN 3. The research will contribute to the knowledge and understanding of Design Exploration and Collaboration aspects within a group, related to the LBM approach. For research purposes, the definition of the Design Exploration aspect is as a learning aspect which refers to whether the participants have experimented with design and construction, and made relations between them with their solutions. At the same time, collaboration is a learning aspect which describes the participants’ level of engagement and commitment to their team’s project [2].

The scope of the investigation is the relationship between Design Exploration and Collaboration within groups consisting of 28 participants, during the design process of BN 3. The participants in this research are the individuals given the responsibility to complete the whole process in BN 3: students that are registered officially and the official committee. The design process of BN 3 was conducted from 22nd to 24th August 2018, daily from 09.00 AM to 05.00 PM (UTC + 08:00). This research began one week after the conclusion of BN 3 (Figure 1).

2. Methodology

2.1. Research Type and Data Collection
This research is a mixed-method descriptive research which involves qualitative data types: design results and process from every group, and collaboration assessments from every participant to understand their engagements [3]. Ordering information from interviews of each participant provides analysis for the design process and result. In contrast, quantification of results from peer and self-assessment [4] provides the collaboration assessments, which refers to a specific rubric in Table 1. The
research then continued with a comparison of results for analysis. All research data were collected 2 months after the conclusion of BN 3, all from first-hand sources that are all the participants.

2.1.1. Data Collection for Design Results and Process. Photographic documentation and interviews with every participant, respectively, formed the primary data for the Design Results and Process stage. The data for analysis from Design Results and Process aspects are (1) each group’s proposed design alternative(s) during the design process of BN 3, (2) participant(s) who proposed each of the design alternative(s), (3) design tool(s) used to find the design each of the design alternatives, (4) the relationships between each of the design alternatives proposed within the group, and (5) the final design alternative(s) chosen for the final design presentation.

2.1.2. Data Collection for Collaboration Assessments. The research utilised data from questionnaires from each participant of BN 3 for the Collaboration assessments. The questions for the collaboration assessments refer to the Collaborative Assessment Rubric in table 1, taken from Peer Assessment Collaboration Rubric taken from peer and self-assessment developed by Deakin University [5]. The rubric is compatible with higher education institutions hence suited for the task at hand.

| Table 1. Collaboration Assessment Rubric |
|-----------------------------------------|
| **Category (Factor)** | **Score** | **Score** | **Score** | **Score** |
| | | | | |
| **Participation** | Group member participated fully and was always on a task in class. | Group member participated most of the time and was on task most of the time. | Group member participated but wasted time regularly or was rarely on task. | Group member did not participate, wasted time, or worked on irrelevant material. |
| **Leadership** | Group member properly assumed leadership when necessary by helping the group stay on track, encouraging group participation, posing solutions to problems, and having a positive attitude. | Group member sometimes appropriately assumed leadership. | Group member usually allowed others to assume leadership or often dominated the group. | Group member did not assume leadership or assumed it in a non-productive manner. |
| **Listening** | Group member listened carefully to others’ ideas. | Group member usually listened to others’ ideas. | Group member sometimes did not listen to others’ ideas. | Group member did not listen to others and often interrupted them. |
| **Feedback** | Group member offered detailed, constructive feedback when appropriate. | Group member offered constructive feedback when appropriate. | Group member occasionally offered constructive feedback, but sometimes the comments were inappropriate or not useful. | Group member did not offer constructive or useful feedback. |
| **Cooperation** | Group member treated others respectfully and shared the workload | Group member usually treated others respectfully and | Group member sometimes treated others disrespectfully or | Group member often treated others disrespectfully |
The collaborative assessment encompasses both self-assessment and peer-assessment. Assessments were given to participants to assess all individual performances in the respective group. Assessments’ responses are varied and scored with a value from 1 to 4 based on the following criteria from Table 1:

A. Participation
How did the group member participate in the assigned work, during the design process of BN 3?
1. The group member did not participate, wasted time, or worked on unrelated material
2. The group member participated but wasted time regularly or was rarely on task
3. The group member participated most of the time and was on task most of the time
4. The group member participated fully and was always on the task in class

B. Leadership
How did the group member apply leadership within the participant’s group, during the design process of BN 3?
1. The group member did not assume leadership or assumed it in a non-productive manner
2. The group member usually allowed others to assume leadership or often dominated the group
3. The group member sometimes assumed leadership in an appropriate way
4. The group member appropriately assumed leadership when necessary by helping the group stay on track, encouraging group participation, posing solutions to problems, and having a positive attitude

C. Listening
How did the group member listen to the other members within the participant’s group, during the design process of BN 3?
1. The group member did not listen to others and often interrupted them
2. The group member sometimes did not listen to others’ ideas
3. The group member usually listened to others’ ideas
4. The group member listened carefully to others’ ideas

D. Feedback
How did the group member give feedback to the other members within the participant’s group, during the design process of BN 3?
1. The group member did not offer constructive or useful feedback
2. The group member occasionally offered constructive feedback, but sometimes the comments were inappropriate or not useful
3. The group member offered constructive feedback when appropriate
4. The group member offered detailed, constructive feedback when appropriate
E. Cooperation
How did the group member work cooperatively with the other members within the participant’s group, during the design process of BN 3?

1. The group member often treated others disrespectfully or did not share the workload fairly
2. The group member sometimes treated others disrespectfully or did not share the workload fairly
3. The group member usually treated others respectfully and shared the workload fairly
4. The group member treated others respectfully and shared the workload fairly

F. Time Management
How did the group member manage participant’s time during the design process of BN 3?

1. The group member did not complete most of the assigned tasks on time and often forced the group to make last-minute adjustments and changes to accommodate missing work
2. The group member often did not complete assigned tasks on time, and often held up completion of the newspaper
3. The group member usually completed assigned tasks on time and did not hold up progress on the newspaper because of incomplete work
4. On-time completion of the group task

Subsequently, all individual responses are presented and organised in their entirety in a table.

2.2. Analysis of Learning Aspects
By ordering the development of design alternatives, Design Exploration Aspect can be elaborated from each group on tree-shaped Horst Rattle Diagrams [6] as in figure 2. A circle presents each design alternative with a colour code as in figure 3. Each circle represents participant(s) who were actively proposing the design alternative and their respective design tool(s).

Finally, asterisks (*) mark each presented or final design alternatives, while red-dotted sections highlight the process from the first design alternative to the final design alternative within every group. For example, the red-dotted section in Figure 2 traces the process from Alternative 1, which is the first design alternative to Alternative 6, the final design alternative of the group.

![Figure 2. Example of Horst Rittel Diagram](image)

![Figure 3. Design Tools Color Code](image)

The Collaboration Aspect was achieved through the quantification of collaboration assessments collected in the table. It was done by converting each participant’s response from a score value according to the Collaboration Assessment Rubric in table 1. All individual scores within each group
are then averaged to gain the group score according to criteria found in the rubric and also cumulatively. A comparison of scores of each group with another then follows.

3. Results and discussions
Figure 4 describes the Design Exploration by diagrams that present the design tools. These participants actively proposed the design alternative, and the relationships the design results and process of BN 3 from every group. At the same time, table 2 and table 3 present the results of data collection, and the relationships of Design Exploration and Collaboration within the design process of BN 3.

![Figure 4. Results of the Design Exploration](image)
Initially, there were five groups involved in the data collection. However, in the groups’ score comparison, the scores of Group 4 tend to defy the trends and therefore present an anomaly. The tracing of Group 4’s design process showed that the group decided to extend the design process over the allocated design time and place, as previously mentioned. The exclusion of Group 4 from the analysis of results has resulted from its unequal allocation of time and place setting.
Based on the tables, Group 3 and Group 5, who proposed two-stage developments within their design process gained the highest Cumulative scores of (3,39) and (3,59) respectively. Meanwhile, Group 1 and Group 2 that only proposed one-stage developments gained the lowest Cumulative scores of (3,35) and (3,32) respectively. A similar trend is also visible in Listening criteria. Group 3 and Group 5 acquired (3,56) and (3,72) respectively, while Group 1 and Group 2 acquired (3,40) and (3,33). This trend continues in Feedback criteria, where Group 3 and Group 5 scored (3,36) and (3,50) respectively, while Group 1 and Group 2 scored (3,16) and (3,31) respectively. Hence, the groups that proposed two-stage developments tend to obtain higher scores on Cumulative, Listening criteria, and Feedback criteria than the groups that only proposed one-stage developments.

On the other hand, the groups that are more consistent in conducting design developments by physical models as design tools tend to score higher in Cumulative and Listening criteria than the groups that relied on other design tools. Among the groups that have ever proposed two-stage developments, Group 5, which is more consistent in using physical models as design tools scored higher than Group 3, which is less consistent. Group 5 obtained (3,59) and (3,72) respectively, while Group 3 only obtained (3,44) and (3,56), respectively. The similar trend occurred among the groups that only have ever proposed one-stage developments. Group 1 which is more consistent gained (3,35) and (3,40) respectively, while Group 2, which is less consistent gained (3,32) and (3,33) respectively.

4. Conclusions

During the design process of BN 3, physical models are the most involved design tools in the development of the design alternatives, and design alternatives that were found by physical models are the most developable ones. Figure 4 visualised this tendency. From the whole 15 developments of design alternatives that occurred (yellow or purple-coloured arrows in figure 4), all of them involved the design alternatives that were found by physical models as a design tool. Furthermore, 13 out of the 15 developments occurred from the design alternatives that were found by physical models (yellow-dotted section in figure 4), while 12 out of the 15 developments produced the design alternatives that were found by physical models (red-dotted section in figure 4).

Physical models as design tools also played an essential role in the occurrences of two-stage development which is correlated with higher Cumulative, Listening, and Feedback criteria scores. All the design alternatives iterated through the two-stage developments (purple arrows in figure 4) were developed with physical models as design tools. Moreover, all the one-stage-developed (yellow arrows in figure 4) design alternatives, with potentials for the two-stage-developed ones, were found only on groups implementing physical models as design tools.

Overall, the Design Exploration, which utilises physical models as design tools, results in better collaboration within groups. The proportional relationship between Cumulative shows this trend, Listening, and Feedback criteria scores within the groups, and their number of development(s) of design alternative(s), especially the two-stage development(s). Meanwhile, physical models are responsible or at least involved for almost every development that occurred during the design process of BN 3.

Therefore, during any Design Exploration sessions of LBM, participants need to be encouraged to develop previously iterated design alternatives instead of ’starting again from scratch’. The groups that conducted their design process toward the development of design alternatives tend to perform better collaboration in their learning process. On the other hand, as commonly recommended in LBM [7], participants also need to be encouraged to utilise the physical model as the design tool, which is the most capable of developing design alternatives. In conclusion, in order to enhance the collaborative performance in LBM approach, participants should be encouraged to understand and use a physical model as a design tool to develop design alternative(s) during the design process.
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