Re-clarifying Design Problems through Questions for Secondary School Children
An Example Based on Design Problem Identification in Singapore Pre-Tertiary Design Education

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Abstract

It is believed that secondary school students often define design problems in the design coursework superficially due to various reasons such as lack of exposure, inexperience and the lack of research skills. Questioning techniques have long been associated with the development of critical thinking. Based on this context and assumption, the current study aimed to explore the use of questioning techniques to enable pre-tertiary students to improve their understanding of design problems by using questions to critique their thinking and decision-making processes and in turn, generate more effective design solutions. A qualitative approach is adopted in this study to identify the trajectories of students during design problem identification and clarification process. Using student design journals as a form of record for action and thoughts, they are analysed and supplemented by hearing survey with the teacher-in-charge. From the study, the following points can be concluded: 1) questions can be a useful tool to facilitate a better understanding of the design problem. 2) The process of identification and clarification of design problem is important in the development of critical thinking skills and social-emotional skills of the students. 3) It is important that students are given time and opportunity to find out the problems by themselves. 4) Teachers can be important role models as students may pick up questioning techniques from teacher-student discussions. 5) Departmental reviews and built-in professional development time for weekly reviews on teaching and learning strategies are necessary for the continual improvement D&T education.

Keywords: Design Education; Questioning Techniques; Design and Technology; Critical Thinking

The process of design, on one hand may be understood as a process of rational problem solving (Simon, 1973; Coyne, Rosenman, Radford, Balachandran & Gero, 1990; Liikkanen & Perttula, 2009) and on the other, a process of reflective practice (Schön, 1983, 1987). Design and Technology (D&T), studied as a general education subject in Singapore secondary schools, engaged students with the full range of design activities that span from identifying design problems to the production of solutions in the form of working prototypes. One of the challenges for students towards proposing an effective solution was to clearly understand the design problem before moving into ideation and development of the solutions.

A common technique used to clarify design problems include mind mapping,
conducting field research and interviewing potential stakeholders. General feedback from teachers is that students are looking for the wrong type of information that is not related to the design problem. Also, due to the lack of research skills, students are passive and often dependent on teachers to provide instructions in clarifying design problems. In some cases, in the name of students’ inexperience, teachers resort to telling students what the design problems should be instead of allowing students to explore and understand the problem by themselves.

Questioning techniques have long been associated with the development of critical thinking skills. Using Bloom’s Taxonomy as a basis, asking higher order questions will require higher order thinking in the form of analysis, synthesis and evaluation. In addition, the skilful use of convergent and divergent questions may facilitate decision making, expansion, exploration and creativity (Elliot, Kratochwill, Cook & Travers, 2000).

It is in this context and assumption that the current study aimed to explore the use of questioning techniques to enable pre-tertiary students in improving their understanding of the design problems by using questions to critique their thinking and decision-making processes and in turn, generate more effective design solution.

**Design Problems in the Design & Technology Coursework**

It is widely agreeable that nature of design problems are complex, ill-structured with ambiguous goals, without a determined solution path and required the integration of multiple knowledge domains (Reitman, 1965; Simon, 1973; Jonasson, 2000). According to Goel and Pirolli (1989), problems involved in design contain many degrees of freedom, required substantial information collection, problem structuring and negotiation. Much of the information required comes from external sources or prior experience of the designer (Goel & Pirolli, 1989). In addition to the understanding of design problems, a design problem may evolve throughout the design process thus making it hard to identify (Dorst & Cross, 2001; Dorst, 2006). In the design coursework, students usually engaged in design problems with little ‘design experience’. Although students are trained in problem solving skills in other subjects, most of the commonly encountered problems are well-structured. In handling design problems, students required a different set of problem solving skills to explore into the ill-defined and ambiguous design situations and eventually proposed the most effective and plausible design solution within their own defined constraints.

**Questions and Critical Thinking**

Critical thinking and the Process of Design

Critical thinking is thinking about one’s thinking process; it occurs when a person evaluates reasoning used in coming to a conclusion (Moore & Parker, 2015). According to Butterworth and Thwaites (2013), critical thinking is about making informed evaluative judgements about claims and arguments. As a process, critical thinking may involve three main activities, namely, analysis, evaluation and further argument (Butterworth & Thwaites, 2013). As an ability, critical thinking involves the
capacity to assess and apply evidence to support or evaluate an argument (Watson & Glaser, 2008). In addition, critical thinking can be considered as a rigorous process of inquiring, learning and acquiring knowledge for the critical analysis and evaluation of evidence to justify one’s belief (Ikuenobe, 2001). As a critical thinker, several skills are believed to be necessary, such as, interpretation, analysis, evaluation, inference, ability to clarify, decision-making and problem solving.

In the process of designing, critical thinking is very much involved right from the process of identifying and clarifying design problems to the conceptualisation of a suitable solution to the production of the prototype. Whether design is treated as a rational problem solving process or a reflective practice requires the designer to interpret the information related to the design problem so as to propose and evaluate all possible and effective solutions.

Questioning in Thinking Process

According to Chin and Langsford (2004), questions can to some extent influence the level of thinking operations that students engage in. Questions may be classified into various categories as such:

- Lower and higher order questions according to different levels of thinking (Bloom, 1956)
- Open and closed questions (Blosser, 1995)
- Productive questions (Elstgeest, 1985)
- Operational questions (Alfke, 1974)

In associating questions with critical thinking, it is believed that questions that require higher order of thinking, such as a) inference from patterns, trends or underlying relationships in data, b) predict outcomes and c) evaluate and use criteria based on given information to make judgement, are pitched at critical thinking level (Chin & Langsford, 2004). While questions that involve, a) formulating alternative hypothesis from same observations, b) planning and designing experiments for investigation using tests and c) proposing and generating solution to a problem, invoke creative thinking skills (Chin & Langsford, 2004).

The relationship between questioning and thinking can be understood according to Ikuenobe’s (2001) analysis on how the process of questioning, for the purpose of eliciting information and justifying one’s belief, is necessary for critical thinking. To think critically involves the ability to question and evaluate beliefs, so as to justify and approximate the ‘truth’ (Ikuenobe, 2001). It is through the process of critically evaluating and questioning a number of evidence that one would then move on to make the judgement that there is adequate evidence to consider it reasonable (Ikuenobe, 2001). Similarly, Siegel (1988) argued that critical thinking involves the acceptance of a belief, based on reasons, after a rigorous process of questioning.

Questioning creates understanding

Ikuenobe (2001) explained that the process of questioning is very much a sequence of
open-ended question and answer, where in this open-ended process, one question may lead to another. It is through this process that issues can continuously be opened-up about the reasonableness of a belief and requires the providence of better evidence and counter evidence. This attitude of critically engaging in inquiry though the process of questioning can be learned if one is taught to appreciate the logic, functions and significance of questioning with respect to knowledge acquisition. Hintikka (1984) argued that questioning offers a useful model for different types of knowledge seeking. These types of knowledge-seeking may include learning, inquiry, eliciting information, reasoning, evaluating evidence and determining reasonableness of a belief (Ikuenobe, 2001).

It appeared that questioning already has a strong research base across disciplines (Duke & Pearson, 2002; Sternberg, 1998). Questioning as a form of thinking, according to Wilson and Smetana (2011) can be a framework for comprehension of expository text and content across content areas. In the process of learning, through questions, a person may make use of questions to independently monitor and regulate his/her thinking. Questioning in turn guide the use metacognitive actions and the answers to the questions may inform the person of the metacognitive task necessary for learning.

**Research Methods**

**Scope of Study**

The current study looks into a typical secondary two D&T coursework in a Singapore secondary school. As D&T is only an elective subject at the secondary three and four level, the D&T programme at secondary two level may provide a better reflection on the types of design activities that most of the secondary school students would have gone through in their secondary school education. As the current study aimed to focus on the design problem clarification aspect in the design process, the process of design problem identification and clarification of design problems will be identified and analysed.

**Participants**

The participants in this study came from a class of 41 secondary two students in an autonomous secondary school in Singapore. The D&T programme in this autonomous secondary school is widely recognised by the local D&T fraternity to be well established among the secondary schools in Singapore. At secondary two level, the students are generally around the age of 14 and will have prior D&T knowledge based on the initial study of D&T in secondary one. Throughout the design coursework, students were grouped to work in pairs although most of the processes were to be done as an individual work. During a discussion with the teacher teaching the class for D&T, it was understood that not all of the work done by students present a good representation of D&T learning in the class. Some of the works done by students were lacking in documentation on the processes which provided a challenge for accurate analysis. Some students were not able to produce good quality work due to heavy commitments in other school activities. Out of the 41 students, work done by nine students were selected as representatives of the typical D&T work done in the class. The grouping were as follow: Group 1, Group 2, Group 3, Group 4 and Group 5. It should be noted that Group 5 consisted of only one student. The grouping of students is as shown in Table 1.
Table 1: Grouping of Students in Each Group.

<table>
<thead>
<tr>
<th>Group</th>
<th>Student</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>S1A</td>
</tr>
<tr>
<td></td>
<td>S1B</td>
</tr>
<tr>
<td>Group 2</td>
<td>S2A</td>
</tr>
<tr>
<td></td>
<td>S2B</td>
</tr>
<tr>
<td>Group 3</td>
<td>S3A</td>
</tr>
<tr>
<td></td>
<td>S3B</td>
</tr>
<tr>
<td>Group 4</td>
<td>S4A</td>
</tr>
<tr>
<td></td>
<td>S4B</td>
</tr>
<tr>
<td>Group 5</td>
<td>S5A</td>
</tr>
</tbody>
</table>

Procedures

During the design coursework, students record their course of action and thoughts into the design journal. Besides, students often have individual consultation sessions with the teacher-in-charge so as to allow the teacher to understand the challenges that the students are facing and also to guide the students.

As such, the current study is based on a qualitative approach that aims to analyse and understand the design problem identification and clarification trajectories that the students have taken during the design coursework. The main piece of data that is analysed in this study is based on the design journals done by the students. From the journals, the analysis mainly focuses on the process of design problem identification, and particular attention is placed to review how the usage of questions may enable students to clarify their understanding of the design problems.

Although it is understood that the design journal may not be able to provide a 100% record of the design problem identification process; verbal feedback and discussions with the teacher-in-charge provide essential supplementation to the information that may not be recorded in the journals. As such, interviews with the teacher-in-charge are conducted throughout the data analysis process.

Research Findings

Overall View of Coursework Tasks

The secondary two D&T design coursework spread over 14 weeks with a 2-hour lesson each week. The students engage the design coursework in pairs but due to the odd number of students in the class, one of the students worked as an individual. The main stages in the design coursework include:
1. Identification of Design Problems
2. Idea Conceptualization
3. Design Development
4. Prototyping
5. Evaluation

Although students are grouped to work in pairs, they are required to work on stages 1, 2 and 5 individually. They submit their work related to the three mentioned stages as individual work.

The Flow in Identification of Design Problems

In the stage of design problem identification, given a theme, students start off with brainstorming to scan and identify possible design problems. There is no restriction on the type of strategies that students can use during the brainstorming process. The underlying rationale is that there is no single approach towards the identification of design problems. As such, students can make use of any strategies they know during the brainstorming session.

From the brainstorming process, students then move on to select a few prospective design problems for further clarifications. It is after this clarification that the members of each group come together to decide and select a design problem to engage further as a group. Just before moving into the Idea Conceptualization stage, students work as a pair to conduct further research to facilitate idea conceptualisation. This flow of the process is presented in Figure 1.

![Flow Chart](image)

Figure 1: The Flow during the Identification of Design Problem.

At this point, some details should be mentioned during the further clarification stage
for selected design problems. In this process, a critical thinking template is created by the D&T department to help students critically assess their perceptions and understanding of the chosen design problems. The critical thinking template is created due to the observations and experience from D&T teachers in supervising design coursework in the previous years. From those observations, the D&T teachers observed that in general, students’ understanding of design problems are superficial. As students are low on exposure and life experience, perspective and understanding of the design problems are mainly based on their prior knowledge or experience. In addition, there is also no habit of critical inquiry and research to find out and understand more about design problems.

Based on the concept of Paul and Elder (1996, 2002) on strategies for critical thinking, the critical thinking template is a template that requires students to clarify three main questions,

1) Is the problem or needs clear?

2) Is my thinking accurate?

3) Is my thinking only from my point of perspective?

The critical thinking template adopted some of the universal standards, as suggested by Paul and Elder (1996, 2002), that can be applied to check the quality of reasoning about a problem, issue or situation. The universal standards used in the template are related to, Clarity, Accuracy and Breadth. It must be noted that the first use of the template was in 2012 and the original template contained more standards than the current version. However, according to the teacher-in-charge, students are not able to handle and work on so many universal standards at one go. As such, only three of the standards that are deemed to be most achievable and useful for students to critically assess their thinking in the current context are used.

Within each of the main questions in the template, students are required to come out with sub-questions to guide themselves during the clarification process. In the end, students are required to redefine the problem or needs identified. Figure 2 shows a sample of the critical thinking template used in the design coursework.

Moving on to the next part of the finding, the design problem identification and clarification trajectories of the students is presented. The main focus is to highlight the use of questions to clarify and understand selected design problems and lead to the decision-making process in selecting the design problem for further engagement. The presentation will be divided into two main parts, 1) Brainstorming session and 2) Selecting and further clarification of design problems.
Brainstorming Session

In the brainstorming session, students started off to explore possible design problems. It is observed that students employ two to three main approaches in general. These methods are mind mapping, problem-solution analysis and a hybrid of mind mapping cum problem-solution analysis.

In the use of mindmaps, it is observed that the quality of exploration differed among students. For example, referring to Figure 3 and 4, in the exploration done by student S1A, the areas of interest are listed followed by short notes. Whereas for student S1B, she made use of questions that start with How, What, Why, Who and Where, to guide the exploration process.

Figure 2: Critical thinking template used during the design coursework.
It can be observed from the mindmap that student S1B jotted down deeper thoughts into the journal as compared to her partner where the exploration of design problems are more superficial. At this point, it is necessary to highlight that, through the questions, student S1B tried to provide the rationale behind the various aspect of the design problem which may bring about better understanding of the design problem.

For students who approach the brainstorming session using problem-solutions, students mainly identified possible problems and tried to suggest certain solutions to the problems. Some examples of such approach are presented from Figure 5 to 8. A common observation found in these three examples is that the design problems, which is the main aim for exploration, are quite briefly analysed by the students. All students tried to state the main perceived problems, but all failed to provide at least some basic
underlying reasons to justify the problems that they perceived are in fact problems.

Figure 5: Exploring possible design problems through problem-solution by student S3A.

Figure 6: Exploring possible design problems through problem-solution by student S3B.
Figure 7: Exploring possible design problems through problem-solution by student S5A.

Figure 8: Exploring possible design problems through problem-solution by student S4A.

Figure 9: Exploring possible design problems through problem-solution by student S2A.
It seems that the lack of depth in understanding the main cause of the design problems and providing reasonable justifications to support their claims are common among students. In fact, such similar observations can also be observed for students who tried to brainstorm and explore problems using the hybrid between a mindmap and problem-solution analysis, refer to Figure 9. Such observations may suggest that the depth of understanding of design problems does not hinge on the types of approach but may be related to the ‘way of thinking’, in other words, the habit of the mind to critically assess one’s thought and believe.

Selecting and Further Clarifying Design Problems

As it is expected that students might not be able to critically assess and evaluate their perception and belief about a certain design problem, the critical thinking template was introduced as an intervention to ‘facilitate’ students to look into the ‘matter’ more critically. It appears that the critical thinking template does have some effects on students who have initially explored the design problems very superficially. As the whole, when students re-define and re-write their design problems, improvements in clarity and depth can be observed across all the students. While the level of improvements varied among the students, this study did not go into a more specific analysis to detail the specific level of improvements in each student. An example of the critical thinking template, when done by students, is shown in Figure 10.

Figure 10: Exploring possible design problems through problem-solution by student S1A.
Though improvements can be observed in general, the critical thinking template seems to have a magnifying effect on students who are already ‘good’. For example, for student S1B, who is already able to explore the design problem with quite some detail, the template seems to help the student to elicit more information and inquire more critically into her own reasoning process. At the same time, expanding the breadth of her critical thinking process as she seeks other perspectives through research related to the problem. An example of the critical thinking template and research done by student S1B is shown from Figure 11 to 15.

Figure 14, shows an extremely long redefinition of the design problem or needs. In fact, student S1B wrote about her findings and analysis of the design problem instead of describing the design problem concisely. While students are required to redefine their design problem concisely, nonetheless, this information provided a form of documentation and evidence towards the quality of her findings.

![Problem/Needs identified]

<table>
<thead>
<tr>
<th>Sub-questions</th>
<th>Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>why people throw inside the house?</td>
<td>we have never seen a pamphlet giver walking timely slow, have we? they usually are giving a appearance as it in a rush to catch a train. this is why they usually throw the pamphlets inside our houses as they find it as a faster and easier way, and also that we should definitely see and read it.</td>
</tr>
<tr>
<td>why cannot open the door or why does it appear messy?</td>
<td>no, the pamphlets are usually thrown inside the house by the door step or door itself, after a while if the pamphlets are not cleared when opening the door, they may cause difficulties.</td>
</tr>
<tr>
<td>why do they receive such pamphlets or newspapers?</td>
<td>visibly advertisements, come in form or electronic form advertisements. and it easier to convey the advertisements through print form as, why may find it as a direct message to the public.</td>
</tr>
<tr>
<td>what do the residents usually do?</td>
<td>residents usually throw away the pamphlets, or sometimes read it (according to a survey done).</td>
</tr>
<tr>
<td>who is in the wrong?</td>
<td>in this problem, where many will blame the pamphlet giver, we should also open our eyes. this problem would only be a big problem if we do not clear the pamphlets soon enough.</td>
</tr>
</tbody>
</table>

Figure 11: The original design problem statement and the aspect of clarity about the problem by S1B.
Figure 12: The aspect of refining accuracy and validity of the problem by S1B.

Figure 13: The aspect of seeking other perspectives about the problem. Done by S1B.
Residents have a problem of pamphlets being stuffed between the door gaps. This is basically because there is no holder for the pamphlets. As pamphlet givers are usually very fast trying to distribute the pamphlets to all the houses, they usually find the door gaps a best area to place the pamphlets as they think that residents can definitely see their pamphlets if it is in the door gaps. Whereas, most residents find it irritating as for the pamphlets. If it is in the door gaps, whereas, most residents find it irritating as for the pamphlets, if it is in the door gaps, whereas, most residents find it irritating as for the pamphlets, if it is in the door gaps. In that case, this problem would be solved if there were pamphlet holders given by the government. I got to know that it would be better if the pamphlet holder is more innovative and attractive design wise. My evidence prefer it to be a single compartment as it would be too complicated to have many compartments. She also does not want it to be too big as it may give an unpleasant look. Looking at the information they are trying to tell us, both parties would get benefited as the residents would not get irritated looking at brochures, or pamphlets being stuffed in their door gaps. And pamphlet givers also do not need to roll or fold their pamphlets just to stuff it between door gaps, and it would also be easier and faster for them to distribute the pamphlets as they do not need to waste time folding or rolling the brochures.

Figure 14: Redefining the problem. Done by S1B.
For students who had explored the design problem very superficially, the critical thinking template ‘force’ them to look into the problem in more details. An example may be shown from Figure 16 to 18. This is attributed to the sub-questions that they need to ask themselves and at the same time, find out the ‘answers’ to their own questions. In addition, teachers also provide comments and guiding questions when checking students’ journal. Besides, students are also given the opportunity to comment and feedback on their partner’s analysis and understand of the design problem.

Figure 16. A very superficial design problem exploration. Done by S3B.
Figure 17. Assessing different elements of reasoning through Clarity, Accuracy and Breadth. Done by S3B.
Through the sub-questions, students, in general, get to explore the different aspects related to their design problems. It is unsure if students have thought about these questions during the brainstorming and exploration process. However, through the initial design problem statements, where most of the design problems are in a way superficially written by most students, it may be assumed that it is during this stage of critical thinking process that students started to think deeper about the design problem. Perhaps this perspective can also be supported by some of the students’ reflections where they mentioned that the overall design problem identification process had helped them to consider deeper and gain new insights towards the actual needs of stakeholders. In addition, through critically assessing and justifying their perception and beliefs about a certain problem, students are required to be more observant. Part of the extract of student reflections are shown in Figure 19, 20 and 21.

Figure 18. Redefining the problem. Done by S3B.

Figure 19. Extract of the reflection by S1A.
According to the teacher-in-charge, before the use of the critical thinking template, the teacher had gone through a discussion session with the students by giving them some examples of superficial design problems and using questions to guide students in providing more clarity and understanding towards the problems. After the discussion session, students moved on to engage into clarifying their design problems using the critical thinking template. From the sub-questions that students had come up with, it can also be observed that most of the sub-questions are of higher order thinking or open-ended. It is an interesting observation as students have not been specifically trained to ask lower and higher order thinking questions. In a way, students have plenty of opportunities to sharpen their critical thinking skills through higher order thinking questions.

**Discussion**

**Questioning as Tool Towards Design Problem Clarification**

When presented with a design problem, the previous experience and prior knowledge about the problem will naturally be activated to provide an immediate understanding, perception and belief about the cause of the problem. In most cases, students often showed a lack of experience and prior knowledge about the design problems that are identified. In order to bridge the gap between students’ level of understanding about the problem and the reality, the current study has presented evidence to show that questioning can be an effective scaffold to help the students critically assess their
thinking and evidence on hand about a design problem. Subsequently, it leads to the eliciting of information for new knowledge acquisition for the critical analysis and evaluation of evidence to justify their beliefs about the problem. During this critical analysis and evaluation process, students are required to be more observant during their research, and truly understand the issues and needs of the stakeholders. As such, learning takes place.

While the critical thinking template is created to facilitate the process of critical thinking, this template does not aim to get the students to follow a set of procedures or format in doing things. However, more importantly, by going through the process of critical assessment of thinking and reasoning, it is the internalisation of the attitude and ability in using questions in the critical thinking process that is the underlying aim for the use of the critical thinking template. Internalisation, in a sense, is to become part of the thinking habits in the student as a person. In this case, such attitude and ability may be applied across subject domains and may facilitate the development of the student as a life-long learner which is critical in the 21st century. As a general subject, D&T has an enormous potential in this aspect of critical thinking development.

The Importance of Design Problem Identification Process

If it is justified that the process of questioning facilitates and strengthen the development of critical thinking skills, then it may be assumed that the design problem identification process is as important to any other parts of the design process, such as idea conceptualisation and prototyping in the learning of design in D&T. As questions influence the level of thinking operation, the design problem identification process provides a rich ground for the development of higher order thinking skills due to the open and ill-defined nature of design problems.

As it can be observed in the students’ trajectories in identifying and clarifying the design problems, there is no definite answer to the design problems, in other words, no one answer is correct. The answer towards the design problem may evolve as students clarify the design problem is further. As such, the process of critical assessment of thinking and reasoning about the design problem allows students to understand the true nature of the world around them which they may have taken for granted. Additional to developing the cognitive aspect of the students, the process of identifying and clarifying design problems also develop the social-emotional aspect of the student. By developing a better understanding of the problems and needs of people, students may get to have more empathy and heart for people.

Thus, it is imperative that D&T teachers continue to provide opportunities and time for students to critically explore, scrutinise and define their understanding and beliefs about design problems during the D&T coursework. Sometimes, teachers may have the tendency to tell the students what the design problem should be, in the name of helping the students and time saving; such actions may take away their opportunities to learn about our world through design activities.
Teacher as a Role Model

While students are not taught on the theoretical aspect of lower and higher order type of questions, students ability to ask mainly higher order questions when using the critical template suggested that they may have picked up this skill during the discussion session. As mentioned in the findings, the teacher-in-charge provided some examples of superficial design problems and tried to get the students to think about the actual cause of the problem by asking them questions. In a way, the teacher is setting herself as a role model in using questions for critical assessment, reasoning and evaluating the understanding of the design problems. As such, role modelling, a traditional teaching and learning strategy, can be a fundamental strategy in teaching students how to question during the design problem identification and clarifying process.

The Importance of Teacher Professional Development Time

While the professional development of D&T teachers in secondary school is not the focus of this study, but during this study, the authors believe that the current study may be a good example to highlight the fruits of teacher professional development time in the school. In order to keep the design education relevant, the D&T department holds annual year-end review sessions for the D&T programmes and teaching pedagogies. It is during this type of review sessions that the D&T department teachers, based on their teaching encounters and experience, surfaced issues in the design problem identification process and the challenges that students faced. Through discussions and review of relevant theoretical references, the critical thinking template was conceived and implemented. While an implemented teaching and learning (T&L) framework and strategies required constant reviews, the D&T teachers make use of their weekly professional development ‘white space’ to review the critical thinking template and continue to sharpen the T&L framework and strategies. In other words, design educational programmes, T&L framework and strategies need regular reviews to keep them relevant to the needs of the students. In this sense, professional development time and regular ‘white space’ for educational reviews will continue to be a vital clog for the development of design education at pre-tertiary level. Perhaps, this may also be true for other subject areas.

Limitations to current study

The findings in the current study are based on the design coursework journals and feedback from the teacher-in-charge. Most of the observations and assumptions in the findings are based on the documentation done by the students in the journal. As such, it is also believed that not everything is measurable or observable based on the journals. Language and writing competencies of students may play a part in the ability to document detail findings and evaluations. In addition, some students may not be able to articulate their thoughts that well during the discussion session with the teacher-in-charge. Thus, the journals may only be able to provide a certain resolution towards the understanding of the students’ trajectories towards the identification and clarification of design problems. Besides, the attitude of students also played a part in the quality of the work. Thus, when it is assumed that a superficially identified problem may be due to competencies, in fact, it may be due to the effort of the students.
Another point to note is that journals from previous years are shown to the students for reference. This may also have a certain impact on the quality of work done by students as they are aware of the expectations of the output for their design journals.

Last but not least, during the brainstorming session in exploring possible design problems, the current study allowed students to make use of divergent processes that they are familiar. Perhaps, interventions should be done during the design problem exploration process so that multiple divergent processes may be explored to exploit the effective use of questions to sharpen students’ exploration of design problems during the brainstorming session.

Conclusion

In conclusion, the current study suggests that questions can be a useful tool in leading students to elicit information for new knowledge acquisition for the critical analysis and evaluation of evidence to justify their beliefs about the problem. This in turn provides them with a better understanding of the design problem. On top of that, this study further indicates that the process of identification and clarification of design problem is important in the development of critical thinking skills and social-emotional skills of the students. As such, D&T teachers need to provide students with the time and opportunity to find out the problems by themselves. In addition, teachers are also important role models for students as students may pick up questioning techniques from teacher-student discussions. Lastly, departmental reviews and built-in professional development time for weekly reviews on teaching and learning strategies are necessary for the continual improvement and development of D&T education.

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References


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