




Exploring the impact of design thinking tool among design undergraduates: a study on creative skills and motivation to think creatively

Balamuralithara Balakrishnan¹ 

Accepted: 4 January 2021 / Published online: 9 January 2021

© The Author(s), under exclusive licence to Springer Nature B.V. part of Springer Nature 2021

Abstract

This paper exploring the impact of the utilization of Design Thinking tool in facilitating the development of a group of design undergraduates' creativity skills and motivation to think creatively. This study used a qualitative approach based on open-ended face-to-face interviews. A group of 55 design undergraduates from a Malaysian university was recruited, who were equally divided into 11 design teams, with each team having to solve the problems faced by a local community. A stratified sampling method was employed to choose two members from each group, totaling 22 students as the interviewees. In the interviews, open-ended questions were asked to probe their experience on how Design Thinking had facilitated their creative thinking and motivation to be creative. The qualitative analysis of the interview data revealed that the Design Thinking approach helped the design students to be both creative and highly motivated, thus enabling them to propose and develop practical, innovative designs. Clearly, such findings suggest that both factors are intimately linked with one another. The study shows that it is important for design educators to utilize the Design Thinking learning strategy to synergize the creative skills and motivation to be creative especially in design education in developing competent, responsible future designers who are able to serve the society more effectively.

Keywords Design education · Design thinking · Creativity · Motivation

Introduction

In this twenty-first Century, Design Education has progressed rapidly in line with the paradigm of Industrial Revolution 4.0 whereby in Malaysia, this revolution brings in a digital lifestyle which is based on cyber-physical systems such as Internet of Things (IoT) (Ooi et al. 2018). Such a progress is inevitable as designers need to face and successfully overcome the challenges of this new era, the success of which would help them sustain their competitiveness and relevancy in this highly challenging sector. In this respect,

✉ Balamuralithara Balakrishnan
bmathara@gmail.com

¹ Faculty of Art, Computing and Creative Industry, Sultan Idris Education University, 35900 Tanjung Malim, Perak, Malaysia

Wang (2010) asserts that a change in design education is needed in which design educators should adapt their teaching approach to a new model that emphasizes creative experience. Such an emphasis is hardly surprising given that the main outcome of design is to produce new solutions to a design problem, which surely entail some form of creativity ingenerating such solutions (Mulet et al. 2017).

In the early 2000s, design thinking (DT) emerged as an approach for innovation for decision-makers in the field of business (Carlgen 2013). Over the years, DT has gradually emerged as a multi-disciplinary, human-centered innovation approach to help designers think and work (Kimbell 2011). Essentially, the core component of DT helps nurture creative confidence of anyone involved in any disciplines such that he or she will ultimately be able to develop a sound solution to a complex problem (Johansson-Sköldberg et al. 2013). Embedded in the design-based techniques, DT helps design students to generate creative ideas and produce innovative solutions (Fischer 2015).

The synergy of design and creativity helps produce designs that are high in quality, novelty, and usefulness. In this regard, Mulet et al. (2017) argue that there is a strong correlation between creativity and a design outcome, thus necessitating designers to be given ample opportunity and appropriate mechanism to induce creativity. Premised on this argument, it is, therefore, important to expose design students—the future designers—with proper creativity techniques that provide a conducive space for idea generation processes to obtain creative design solutions. More importantly, according to Crilly and Cardoso (2017), creativity inspires designers to explore a wide range of design solutions within the context of a design.

It has been acknowledged that an individual's motivation helps develop his or her creativity. For example, Shalley et al. (2004) posited that the effects of an individual's motivation may have a profound impact on his or her creative process. To lend credence to this proposition, Runco (2014) found that there was a strong relationship between motivation and creativity, suggesting that motivation drives a person's creative process in creating original, innovative ideas.

In today's era, creativity is an essential element of education as creative thinking plays an integral part in design education in particular and design in general, as societal problems are becoming more complex, global, and interdependent (Henriksen et al. 2016; Mohammed 2018; Halili 2019). Creativity and innovative mindset among the educators and students is important to support the overall concept of education in higher education and it is pivotal in design education context.

Design education needs a sound framework to assist design educators to develop and nurture creative thinking skills and motivation to think creatively among their students. In this respect, it is important for design educators to identify an effective tool to help build creativity among design students facing the challenges ahead of them.

To date, a number of studies focusing on the relationship between motivation and creativity have been carried out in many areas, all of which emphasize that there is a need in identifying the proper tools such as DT to facilitate idea generation process—creativity—among undergraduates (Serrano 2020; Tran 2019; Cha 2019).

Given that DT could provide a space for creative thinking and motivation to think creatively, design educators should utilize such an approach in their respective design classrooms to inculcate creativity among their students. Admittedly, the use of DT in design classrooms in the context of developing students' creativity and motivation to think creatively is not a well-researched area, as Henriksen et al. (2016) assert that the majority of the current research in the area of creativity in education is primarily concerned with individual creative processes. In fact, studies on the impact of DT on

creativity among design undergraduates in higher education institutions in Asia, such as Malaysia, are scarce.

In view of the scarcity of research, this study was carried out with the main aim being to examine how DT could facilitate the development of a group of design undergraduates' creativity skills and motivation to think creatively. In this study, a group of design undergraduates from a Malaysian university, who enrolled in the Research in Design course, were recruited as the study sample.

The findings of this study could serve as a cornerstone in design education to help educators in utilizing DT in classrooms efficiently to improve the creative thinking process of their design students. Furthermore, the findings of such a study would provide a greater insight into the understanding of the impact of motivation on the development of design students' creativity in design education.

Design thinking

DT emerged in the year 1987 in a book on architecture and urban planning written by Peter Rowe, who introduced such a concept. Later, the concept of DT was further expanded by the IDEO founder, David Kelley, who asserted that the process of DT is not only confined to product design and development but also to other disciplines, including education. As a case in point, Dorst (2011) states that DT is an exciting paradigm in dealing with problems in many diverse areas.

In essence, DT involves five major steps, namely (i) Empathy, (ii) Define, (iii) Ideation, (iv) Prototype, and (v) Test, which emphasize four key components, namely (i) empathy, (ii) collaborative, (iii) optimistic, and (iv) experiment. Such components make DT useful in solving open and complex problems involving human-centric approaches. In addition, DT helps develop creative confidence among individuals to help them develop new and better artifacts. Every designer should attain such confidence to help them engage successfully in the creative process of designing (Fig. 1).

Furthermore, Kröper et al. (2011) contend that motivation promotes the creativity of an individual engaged in the creative process. More revealingly, DT has been found to have a profound positive impact on an individual's motivation when involved in the creative process. Arguably, the confidence accorded by DT through the creative process helps motivate students to go beyond the normal boundary of their creativity and innovation capability (von Thienen et al. 2018). In fact, Scheer et al. (2012) found that design educators who applied DT in education were able to promote innovation, creativity, problem-solving skills, and strong collaboration among their students. To support such a claim, Goldman et al. (2012) also asserted that DT is a constructive learning methodology that motivates students to explore and solve problems and become more open to ideas, creative and innovative. Without doubts, such elements are deemed crucial to developing successful and highly competent designers.



Fig. 1 Process of design thinking

Creativity and motivation

In this twenty-first century, many design issues and problems that need to be solved are becoming more intertwined, global, and complex. Thus, the success of translating an idea into a design entails creative thinking (Henriksen et al. 2016). To date, creativity has been defined in several different ways, but basically, all such definitions share a common notion that creativity is something that is original and useful (Sarkar and Chakrabarti 2011). Such a notion is supported by Robinson's (2011) assertion that creativity is a process of generating novel ideas that have value.

In essence, creativity is a process of generating new, novel ideas that could solve problems or address issues. More importantly, novel creations developed through such a creative process can have immense benefits for society. In the context of designing, designers apply appropriate creative methods to generate new solutions to problems. In particular, designers have to rely on creative strategies to explore and generate new useful solutions (Mulet et al. 2017). As such, it is imperative that designers be given ample opportunities and appropriate mechanisms to induce their creativity to help them develop better designs (Carlgren 2013). Given such an imperative, institutions of higher learning, especially those involving design education, must promote effective learning practices that foster students' creative thinking and motivate them to actively engage in the creative process.

As in the design education which holds the responsibility in producing future designers who possess innovative and creative skills, DT plays an important role to develop those skills among the design undergraduates. Vanada (2014) found that DT develop the capacity to think creatively among the students while Carroll et al. (2010) revealed that DT supports the development of students' creative problem solving skills. Moreover, DT also found to be an effective tool that provide the learners with the strategies for creative task while evoking their creative skills (McCarthy 2020).

Surely, motivation to think and be creative is the driving force that encourages an individual to harness his or her potential to produce great ideas. In the context of motivation to think creatively, there are three main mechanisms involved, namely intrinsic motivation, creative self-efficacy, and pro-social motivation (Liu et al. 2016), each of which plays a vital role in developing the creativity of an individual. For example, Amabile (1996) asserts that intrinsic motivation is the primary motivation reinforcing the relationship between an individual's personality and creativity. In addition, Amabile and Pillemer (2012) state that intrinsic motivation refers to the degree to which a person engages in an activity primarily because he or she finds the activity itself to be interesting, enjoyable, and challenging.

Ohly (2018) mentioned that intrinsic motivation generates from the activity itself while extrinsic motivation refers to motivation that exist due to external reward. At the same time, Ohly (2018) also cited that creativity interlinked with reward, job scope, platform for creativity and organization environment. Baer et al. (2003) asserted that complexity of jobs and the individual's cognitive style determine the impact of external reward on the creativity level whereby the author found that an employee who having adaptive cognitive style had a positive relation between extrinsic reward and creativity while weak relationship for employee who having innovative cognitive style. Designers in nature are basically having innovative cognitive style due to the environment of the work and job scope of the designers who deal with creative process (Beefink et al. 2012). Thus, extrinsic motivation due to external rewards is not suitable for designers who are working in highly creative working environment. In view of this importance, design educators need to focus on how to improve students' intrinsic motivation through activities in their classrooms or design studios.

Creative mindset requires motivation that could help the designers to overcome constraints in the innovation process (von Thienen et al. 2018). Royalty and Roth (2016) found that DT provides strong belief and confidence in an individual's creative ability. DT also proven to be influential in developing creative confidence—positive belief on individual's innovation capacities and creative work—that highly motivates an individual to engage in creative process (Edelman et al. 2020). Moreover, Kröper et al. (2011) mentioned that the steps in the DT process encourage an individual's creative behavior through mitigating the elements that restrict creativity. Thus, imparting the fundamental aspects of DT among the design undergraduates is crucial in order to motivate the students to be creative.

Design educators involved in design education need to emphasize the development of creative thinking of their students and instill motivation in them that may lead to creative design solutions. As such, an effective tool that galvanizes both components—creativity and motivation to think creatively—in the design classroom is much needed to assist design educators to create efficacious learning and teaching activities and to provide a proper space for students to unleash their creative potential.

Utilization of design thinking tool in the course

The design undergraduates of University A, Malaysia have to enroll to a course called Research in Design where the students had to use the DT tool to facilitate in creating their design solutions for their assignment. These students were in their fourth semester of their study. In the assignment which is part of the coursework of the subject, they had to solve the problems faced by the local community living in an area near their campus. The assignment was assigned to each team in the second week of the semester, and the final design had to be submitted in the twelfth week. As such, the design assignment spanned 10 weeks. The students were divided into 11 teams consisting of 5 students—total of 55 students, with each having to choose one of the problems and propose a solution in their design. Furthermore, the DT process had to be modified to suit with the scope and learning outcome of the course.

In the empathy process—Step 1-, the students have to gather the information on the problems that faced by the stakeholders—community members—of their assignment project. In this step, the students would be able to understand on the feelings and experiences of the stakeholders due to the problems. The students should include various dimensions of the issues that faced by the stakeholders in order to solve the problem via their designs. The dimensions should cover on the problems faced, impact of the problems, feelings, needs and expectations of the stakeholders. The students may carry out interview sessions and/or survey with the community members to understand more about the problems which lead the students to get better insights through the analysis of the data collected in Step 2—Define. These insights will facilitate the students to build a better and useful designs that could solve the problems of the stakeholders effectively.

Such modifications were made to Step 4 and Step 5 of the DT process as illustrated in Fig. 2. In original DT process, Step 4 is Prototype whereby the user of the DT tool need to build the prototype of the design that identified in Step 3—Ideation. Since the students do not have enough fund to build the prototype, the Step 4 has been changed to Feedback, whereby the students will be seeking for the comments from the stakeholders on the designed solution that generated in Step 3 through an appropriate research method. In the original Step 5 of DT—Test—the user of DT tool has to test the developed prototype.

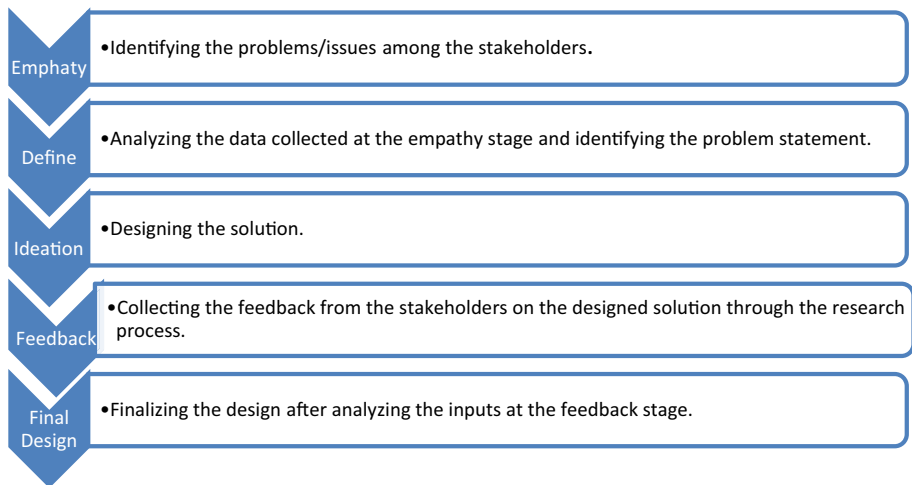


Fig. 2 Modified design thinking process of the research in design course

While in the modified Step 5, it has been changed to Final Design where the students need to finalize the design after analyzing the feedbacks from the stakeholders.

Methodology

This study was conducted based on a qualitative methodology to collect relevant data pertaining to how a Design Thinking tool could facilitate students' creative process and motivation to think creatively. In this study, selected students of University A, Malaysia pursuing Bachelor of Design were interviewed after they have completed their assignment for the course Research in Design. The interview sessions were conducted in Week 13 of their study week. A stratified sampling method was employed to choose two members from each group totaling 22 students for the open-ended face-to-face interviews—total groups were 11. The criteria for the inclusion of the group members who to be interviewed are as followings: (i) leader of the group and (ii) one member who was nominated by the other group members. These two members from each group able to represent their respective team members since both selected respondents of each group went through the process of using DT together as a team. The leader could provide all the information of the creative process experiences experienced by the team members to the researcher since the leader need to report the progress and issues faced by the team members to the subject instructor. The other nominated member could add more information of the experience utilization DT in accomplishing their assignment.

All the respondents were in their 4th semester with age of the participants ranged from 21 to 24 years old. There were 12 female and 10 male students involved in the interview sessions. The recruitment process was facilitated with full cooperation given by the administrator of the university.

The study considered small number of respondents—22—from the same institution and class whereby the study could be considered as a typical case study (Mabry 2008).

This study regarded as typical case study since there are likely other higher education institutions that utilizing DT in their design related classes.

In line with the aim of this investigation, the research design was framed to explore the students' experiences in relation to the scope that being studied. From this lens, focus was put to understand the impact of DT approach in carrying out their assignment specifically in the context of creative process and motivation to think creatively.

The study employed open ended interview questions to allow participants respond in depth. This will allow the researcher to fully comprehend the experiences of the respondents using DT. In the interview sessions, the participants were asked about the effects of DT on their creative process to complete their tasks. In particular, the questions probed their opinions on how DT had facilitated their creative thinking and motivation to think creatively such as to develop a design that could solve the problem faced by the society in their neighborhood. The interview questions were validated by three design educators and by one design industry expert, all of whom had more than 10 years of experience. The interviewees were given ample time to express their opinions freely without any due pressure throughout the interview sessions.

Questions of the open ended interview are as follows:

- (a) How was your overall creativity process experience when using the DT tool to accomplish your design work? Please explain.
- (b) How was your motivation to think creatively using the DT tool in completing your assignment? Please elaborate.

The validation process was carried out in-line with the requirements that outlined by Meriam (1998). Followings are the steps taken for the validation process:

- (i). Went through the interview transcript with the respondents to get their verification.
- (ii). Re-assess the interview transcript with two design educators who have more than 10 years experiences in design education.
- (iii). Make sure the interview results in-line with the scope of the research and consistent with the study research questions.

Thematic analysis strategy was employed for the data analysis. In this thematic analysis, the researcher looking for patterns and meaning of the responses from the participants. Iterative process analysis phases that guided by Braun and Clarke (2006) was employed in this investigation. The phases are as followings:

- (i). Familiarization of interview data that has been transcribed and read through a number of times.
- (ii). Initial set of codes were developed with initial notes were constructed within each interview transcript. Specific comments that relevant and important to the research aim were identified.
- (iii). Group the codes into themes to build a thematic map that connecting to the codes that developed in earlier phase.
- (iv). The thematic map that has been created was examined in order to establish a smaller number of main clusters within the core theme and a set of sub-themes for the creation of a thematic network. When this network emerged, all previous phases were

re-assessed to ensure that the themes that resulted accurately mirrored the original data.

- (v). The themes were analysed to get the meaning of the captured data.

Results and discussion

The reliability of the collected data was verified from the saturation that reached at the seventh interviewee for question (a) and by the sixth interviewee for question (b). The saturation of data was confirmed when there is no new information obtained from the interview transcript after seventh respondent for question (a) and sixth respondent for question (b).

Question (a): How was your overall creativity process experience when using the DT tool to accomplish your design work? Please explain.

For question (a), the coding of the interview yields three themes—referring to Table 1—related with the creative process experience of the respondents using DT. The results showed that DT could provide a conducive space for the participants to think and apply their creativity efficiently. A majority of the respondents responded positively by stating that the DT tool had facilitated their creative thinking.

- (i). Creative confidence through empathy

For example, one of the participants (A11) mentioned the following: “Design thinking gives me the confidence to think creatively due to its systematic approach that emphasizes the step-by-step process. I feel confident that our design is good enough to solve the problem faced by the local society”. It is worth noting that from the interview findings, the first step of Design Thinking, the empathy process, assisted the participants to acquire the confidence to design the appropriate solution, which was exemplified by the response given by one of the interviewees (A5) as follows: “The empathy process gives me the confidence that my design is going to be useful to the stakeholder. With such confidence, it drives me to create better creative solutions, and all of us in the team have the full satisfaction that our designs would be beneficial for the stakeholder”. Such a finding is consistent with Rauth et al. (2010) contention that DT is a structured approach to help generate and evolve ideas as its systematic process gives creative confidence to the designers.

Table 1 Initial codes and themes for Question (a)

Initial codes	Theme
a. Confidence to think creatively b. Confidence to build for stakeholders c. Empathy process gives confidence d. Creative Confidence using first step of DT	Creative confidence through empathy
a. Working with team members b. DT facilitate team work c. Effective team work in creative process d. Team spirit	Collaboration between team members
a. Ideas without limitations b. Proposed ideas come with critical judgment c. DT helped to refine ideas d. Creative ideas comes with critical thinking	Idea creation and critical thinking

This particular finding is aligned with the overall focus of DT where the design process starts with the empathy process that emphasizes the human-centric approach, which gives designers the opportunity to observe and generate ideas deemed useful for the society. At the same time, such a tool prevents the designers from projecting only their own preferences and perspectives in their creative process, thus allowing them to dedicate their attention to the real problems faced by the stakeholders.

(ii). Collaboration between team members

This study also found that DT helped promote strong collaboration among the team members in each group. Arguably, such strong collaboration encouraged the design students to celebrate the diversity of creative ideas of the team members in the group. An indication of such acceptance of diversity could be gleaned by the response of a participant (A1) who said: "Working with the team members allows us to get more and better ideas, and it promotes better creative spirit in me as DT allows us to work collaboratively from the start to the end of the design process". At the same time, one of the respondent (A9) also said: "The DT tool has facilitated the team work between us and it map out for a better collaboration between us in the team".

The finding supported by Scheer et al. (2012) who found that DT encourages team based learning which bolsters the practice oriented and holistic modes of constructivist learning in any project assignments. Elias (2012) in Scheer et al. (2012) also stressed that teamwork is one of the key elements of DT whereby cooperation and different individual perspectives enhance learning in teamwork. The finding of this study shows that team work that nurtured in DT process developed the courage to think creatively among the design students. Both individual and group effect the creative process because interactions and work in a group among team members play an essential role in stimulating individual creativity (Zhu et al. 2018).

(iii). Idea creations and critical thinking

Interestingly, one of the interviewees (A2) provided an insightful information when the respondent said the following: "We are able to give ideas without any limitations, especially in Step 3 (Ideation process), and all the proposed ideas seem practical. We have never experienced that all our ideas would be practical, and certainly, DT had helped realize such a feat".

While another student (A19) highlighted another valuable insight on the idea creations when the respondent said: "All our ideas that had been generated in step 3 were carefully scrutinized, and Step 1 and Step 2 of DT (Empathy and Define) helped us to gain a deep understanding of the problems faced by the society, which we had studied using the research methods taught to us by the lecturer. More importantly, Step 4 (Feedback) and Step 5 (Final Solution) helped us refine our ideas, which led to a sound final solution". It shows that DT not only gives a platform for idea development but also the steps encourage the design undergraduates to engage in critical thinking process.

The statement shows that DT helped facilitate the students' creative process to enable them to think creatively. More importantly, the ideas that were generated through the critical thinking process and the refinement process helped them to propose a sound final design. Callahan (2019) said that the utilization of DT in the design classroom reveals to undergraduates the importance of idea creation and critical thinking. Effectively, idea creation and critical thinking assisted the design students to develop novel design ideas from the real problem statement that they had to address. Moreover, the same process helped the

students to focus on the practical design needed to overcome the problem faced by society. The above findings highlight the effectiveness of the steps of DT in guiding design students to propose creative, meaningful designs.

(b) *How was your motivation to think creatively using the DT tool in completing your assignment? Please elaborate.*

For question (b), the coding produces three themes—referring to Table 2—related with the motivation to think creatively. The analysis of the interview data showed that the DT approach engendered a conducive environment that helped motivate the participants of this study to be engaged in the creative process of designing solutions for the society.

(i). Create interest to think

DT strategy was able to enhance the design students' interest that led them to propose better design solutions to the stakeholder because DT tool facilitate them through the 5 steps to design solution that the stakeholders really need. At the same time, such a strategy brought some form of interest for the students in the creative process of developing novel design solutions, which is evidently made clear by one of the participants' feedback (A20) as follows: "The overall journey of this assignment was very interesting because DT made us become interested to design better, more creative solutions. I had never experienced such an enjoyment in any other design assignments. DT has made me to think creatively and develop creativity in myself".

(ii). Motivate to think more creatively

Likewise, similar feedback was elicited from another participant (A5) who said: "This assignment motivated me and my team members to think more creatively... because of DT, we were happy that all of us could come with a good design. We also were able to cultivate our creativity via this useful tool—DT".

The same positive opinion of DT was registered when another interviewee (A7) said: "I felt very motivated to think more creative than usual as the DT gave me the confidence to believe in myself and our ideas, which is going to be useful to the society".

In a similar vein, another participant (A8) enthusiastically said: "The DT method used to design the solution has motivated us to think better thus, the idea is more creative, as it comes with a systematic structure that allows me to generate ideas beyond our capability".

With the use of DT tool in a constructivist approach, design students would have the appropriate design platform to explore the problem space with a level of motivation, to be

Table 2 Initial codes and themes for Question (b)

Initial codes	Theme
a. Interested to be creative b. Come with better creative ideas c. Always think for a better solution	Create interest to think
a. Motivate the team to think more creatively b. Motivate me and the team to come with creative solutions	Motivate to think more creatively
a. More responsible to the society b. Design that proposed to be useful to society c. Become a good designer d. Being responsible and accountable	Passion to be a good designer

more accommodative of other competing ideas, and to become more innovative (Renard 2014; Panke and Harth 2019). Evidently, the above findings indicate that the DT mechanism could help instill motivation to think creatively into design students that makes them become highly motivated in the design process. Definitely, all these elements related to motivation, openness, and innovation are essential for designers to design better solutions to help overcome the problems faced by the stakeholders.

(iii). Passion to be a good designer

From a broader perspective, another participant (A6) expressed the satisfaction with the use of the DT approach when he stated: “DT has driven me to think for better, more creative designs. More importantly, DT has instilled in me the passion to be a good designer for the society in the future through its useful steps”. While another respondent (A4) mentioned: “While using DT to design our solution, the steps especially the first step—Empathy—has motivate us to be a designer who is more responsible to the society and the design that we are going create in future should be beneficial to them”.

This finding underscores the impact of DT not only on making design students become more creative but also on encouraging them to be good designers who could design useful solutions for the society. This has bring in a new perspective into the use DT which it is not only for creative process but it is also instill the sense of responsibility towards society among the undergraduates.

Summary of the findings

This study found that DT helped foster the design students in their creative thinking process and serve as a catalyst to motivate them to be more creative by actively engaging in such a process. The impact of DT on design students’ creative thinking and motivation is positive, as evidenced by the research findings that indicated the participants had a positive experience as they were engaging in their creative thinking process in designing solutions to the problems faced by the related stakeholders. Such a finding is promising given that many design educators have found developing creative thinking skills among design students is a challenging task (Crilly and Cardoso 2017).

As demonstrated in this study, the utilization of DT would help overcome the main problem in cultivating creativity among future designers. DT has facilitate critical thinking and engage the future designers in meta-cognitive awareness through its key phases (5 steps) that foster creativity. Creativity is closely related to thinking (Amabile 1996) in which from this study, it is clear that DT has strengthened the thinking skills—creativity—among the design students. Tu et al. (2018) mentioned that the spirit of DT not only focusing on the design/solution but also strengthening the thinking of an individual who use DT tool.

This study revealed that DT has triggered students’ thinking and develop their creativity. It also motivates them to create design—solutions—creatively.

By experiencing the process of DT, the students could develop creative skills and develop creative confidence to solve problems successfully in various situations (Rauth et al. 2010). Therefore, setting up a platform for creative thinking for design students with an appropriate strategy, such as the DT approach, could enhance their confidence to be creative as well as to develop their creative skills.

In the context of motivation (in getting involved in the creative process), the research findings are highly promising as the participants indicated that they completely felt

motivated and enjoyed the creative process in accomplishing their assignment with the use of DT, thus prompting them to be extremely committed to completing the design assignment successfully. Such a finding is consistent with the findings of a study by Amabile (1996), who found motivation could induce a high level of commitment of an individual in the creative process.

This study also revealed that the overall process of DT would have a profound impact on the development of future designers who would be able to articulate the various different design strategies in an effective way to create innovative ideas that benefit the society at large.

In this regard, DT is one of the critical elements in the design process to help design students to focus on the real problems faced by the society, the impact of which would make them not only competent designers but also socially responsible professionals.

From the educational perspective, the findings of this study would have a profound impact on the current instructional practice as DT could facilitate a constructive learning process through which design students would be able to collaborate with one another to accomplish the learning objectives of their design assignments. Such an accomplishment through collaborative efforts is hardly surprising given that DT could help nurture students' social and meta-cognitive skills (Noweski et al. 2012).

Research limitations

There are some limitations, despite the important results that found in this study. First, this study investigated the effect of DT on the design undergraduates over one semester—14 weeks whereby the participants utilize the DT approach for 10 weeks only. More important themes in the context of creative skills and motivation to think creatively may emerged if the participants of study were allowed to use DT for a longer period of time. Second, this is case study that carried out in a class consists of design undergraduates using DT approach to design solutions for the community as part of coursework for a subject called Research in Design. The findings may differ if DT approach were implemented in different subjects and design projects. Third, the study concentrated on the effect of DT on creative skills and motivation to think creatively among the design undergraduates whereby other related dimensions related to creativity can be explored in order to get more valuable insights on the effect of DT on design students' creative process.

Conclusions

The research findings of this study highlight the effect of the design thinking approach in the creative process in design education such as to facilitate and support design students in their creative process as well as to motivate them to be actively involved in creative thinking. The findings showed that from the qualitative analysis, DT able to facilitate the creative thinking process through (i) instilling the creative confidence, (ii) collaboration among the team members and (iii) idea creation and critical thinking among the respondents and at the same time, DT also drive the motivation to think creatively among the respondents via (i) creating the interest to think among the users, (ii) enhance the motivation to think more creatively and (iii) infusing the passion to be a good designer among the respondents.

More revealingly, the findings suggest that creativity and motivation are linked, and as such, it is important to utilize appropriate strategies to synergize the two factors in design

education. As demonstrated, Design Thinking could be used as a human-centric solution strategy to boost students' creative confidence, problem solving, teamwork, and enjoyment and to help them to become more socially responsible.

To promote creativity, design educators need to identify the appropriate pedagogical strategies that could facilitate students to actively engage in the creative process and motivate them to think more creatively. To accomplish this, design educators would need to structure and strategize their teaching and learning activities in ways that infuse creative thinking among their students. The utilization of Design Thinking brings a new dimension in design education in which the impact of it could enhance the creative skills and motivation to think creatively among the design undergraduates.

References

- Amabile, T. M. (1996). *Creativity in context: Update to the social psychology of creativity*. London: Hachette UK.
- Amabile, T. M., & Pillemer, J. (2012). Perspectives on the social psychology of creativity. *The Journal of Creative Behavior*, 46(1), 3–15.
- Baer, M., Oldham, G. R., & Cummings, A. (2003). Rewarding creativity: When does it really matter? *The Leadership Quarterly*, 14(4–5), 569–586.
- Beefink, F., Van Eerde, W., Rutte, C. G., & Bertrand, J. W. M. (2012). Being successful in a creative profession: The role of innovative cognitive style, self-regulation, and self-efficacy. *Journal of Business and Psychology*, 27(1), 71–81.
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101.
- Callahan, K. C. (2019). Design thinking in curricula. *The International Encyclopedia of Art and Design Education*, 1–6.
- Carlgen, L. (2013). *Design thinking as an enabler of innovation: Exploring the concept and its relation to building innovation capabilities*. Gothenburg: Chalmers University of Technology.
- Carroll, M., Goldman, S., Britos, L., Koh, J., Royalty, A., & Hornstein, M. (2010). Destination, imagination and the fires within: Design thinking in a middle school classroom. *International Journal of Art & Design Education*, 29(1), 37–53.
- Cha, H. (2019). Applying design thinking to the educational problems: A student-centered instructional approach and practice in an undergraduate course. *Educational Technology International*, 20(1), 83–107.
- Crilly, N., & Cardoso, C. (2017). Where next for research on fixation, inspiration and creativity in design? *Design Studies*, 50, 1–38.
- Dorst, K. (2011). The core of 'design thinking' and its application. *Design Studies*, 32(6), 521–532.
- Edelman, J. A., Owoyele, B., Santuber, J., Talbot, A. V., Unger, K., & von Lewinski, K. (2020). Accessing highly effective performative patterns. In *Design thinking research* (pp. 15–33). Springer, Cham.
- Fischer, M. (2015). Design it! Solving sustainability problems by applying design thinking. *GAIA-Ecological Perspectives for Science and Society*, 24(3), 174–178.
- Goldman, S., Carroll, M. P., Kabayadondo, Z., Cavagnaro, L. B., Royalty, A. W., Roth, B., & Kim, J. (2012). Assessing d. learning: Capturing the journey of becoming a design thinker. In H. Plattner, C. Meinel, & L. Leifer (Eds.), *Design Thinking Research* (pp. 13–33). Berlin: Springer.
- Halili, S. H. (2019). Technological advancements in education 4.0. *The Online Journal of Distance Education and E-Learning*, 7(1), 63–69.
- Henriksen, D., Mishra, P., & Fisser, P. (2016). Infusing creativity and technology in 21st century education: A systemic view for change. *Journal of Educational Technology & Society*, 19(3), 22–37.
- Johansson-Sköldberg, U., Woodilla, J., & Çetinkaya, M. (2013). Design thinking: Past, present and possible futures. *Creativity and Innovation Management*, 22(2), 121–146.
- Kimbell, L. (2011). Rethinking design thinking: Part I. *Design and Culture*, 3(3), 285–306.
- Kröper, M., Fay, D., Lindberg, T., & Meinel, C. (2011). Interrelations between motivation, creativity and emotions in design thinking processes—An empirical study based on regulatory focus theory. In T. Taura & Y. Nagai (Eds.), *Design Creativity* (pp. 97–104). London: Springer.

- Liu, D., Jiang, K., Shalley, C. E., Keem, S., & Zhou, J. (2016). Motivational mechanisms of employee creativity: A meta-analytic examination and theoretical extension of the creativity literature. *Organizational Behavior and Human Decision Processes*, 137, 236–263.
- Mabry, L. (2008). Case study in social research. *The SAGE handbook of social research methods* (pp. 214–227).
- McCarthy, S. (2020). Design at Stanford: The D. school's Daddy. In Research & education in design: People & processes & products & philosophy: *Proceedings of the 1st international conference on research and education in design (REDES 2019)*, November 14–15, 2019, Lisbon, Portugal (p. 207). CRC Press.
- Meriam, S. B. (1998). *Qualitative research and case study applications in education*. San Francisco: Jossey-Bass Publishers.
- Mohammed, R. (2018). *Creative learning in the early years: Nurturing the characteristics of creativity*. Abingdon: Routledge.
- Mulet, E., Royo, M., Chulvi, V., & Galán, J. (2017). Relationship between the degree of creativity and the quality of design outcomes. *Dyna*, 84(200), 38–45.
- Noweski, C., Scheer, A., Büttner, N., von Thienen, J., Erdmann, J., & Meinel, C. (2012). Towards a paradigm shift in education practice: Developing twenty-first century skills with design thinking. In H. Plattner, C. Meinel, & L. Leifer (Eds.), *Design thinking research* (pp. 71–94). Berlin : Springer.
- Ohly, S. (2018). Promoting creativity at work-implications for scientific creativity. *European Review*, 26(S1), S91–S99.
- Ooi, K. B., Lee, V. H., Tan, G. W. H., Hew, T. S., & Hew, J. J. (2018). Cloud computing in manufacturing: The next industrial revolution in Malaysia? *Expert Systems with Applications*, 93, 376–394.
- Panke, S., & Harth, T. (2019). Design thinking for inclusive community design: (How) does it work? *Journal of Interactive Learning Research*, 30(2), 195–214.
- Rauth, I., Köppen, E., Jobst, B., & Meinel, C. (2010). Design thinking: An educational model towards creative confidence. In *Proceedings of the 1st international conference on design creativity (ICDC 2010)*.
- Renard, H. (2014). Cultivating design Thinking in students through material inquiry. *International Journal of Teaching and Learning in Higher Education*, 26(3), 414–424.
- Robinson, K. (2011). *Out of our minds: Learning to be creative*. Hoboken: Wiley.
- Royalty, A., & Roth, B. (2016). Developing design thinking metrics as a driver of creative innovation. In H. Plattner, C. Meinel, & L. Leifer (Eds.), *Design Thinking Research* (pp. 171–183). Cham: Springer.
- Runco, M. A. (2014). *Creativity: Theories and themes: Research, development, and practice*. Amsterdam: Elsevier.
- Sarkar, P., & Chakrabarti, A. (2011). Assessing design creativity. *Design Studies*, 32(4), 348–383.
- Scheer, A., Noweski, C., & Meinel, C. (2012). Transforming constructivist learning into action: Design thinking in education. *Design and Technology Education: An International Journal*, 17(3), 8–19.
- Serrano, L. M. M. (2020). The pedagogical potential of design thinking for CLIL teaching: Creativity, critical thinking, and deep learning. In Gomez-Parra, M. E., & Abril, C.A.H (Eds.), *Handbook of research on bilingual and intercultural education* (pp. 427–446). IGI Global: Pennsylvania.
- Shalley, C. E., Zhou, J., & Oldham, G. R. (2004). The effects of personal and contextual characteristics on creativity: Where should we go from here? *Journal of Management*, 30(6), 933–958.
- Tran, A. (2019, August). Design Thinking as a Methodology to Develop Creativity and Problem-Solving Skills among Students. In *VietTESOL international convention 2019*.
- Tu, J. C., Liu, L. X., & Wu, K. Y. (2018). Study on the learning effectiveness of Stanford design thinking in integrated design education. *Sustainability*, 10(8), 2649.
- Vanada, D. I. (2014). Practically creative: The role of design thinking as an improved paradigm for 21st century art education. *Techne serien-Forskning i Slöjdpedagogik och Slöjdvetsenskap*, 21(2), 21–33.
- von Thienen, J. P., Clancey, W. J., Corazza, G. E., & Meinel, C. (2018). Theoretical foundations of design thinking. In H. Plattner, C. Meinel, & L. Leifer (Eds.), *Design thinking research* (pp. 13–40). Cham: Springer.
- Wang, T. (2010). A new paradigm for design studio education. *International Journal of Art & Design Education*, 29(2), 173–183.
- Zhu, Y. Q., Gardner, D. G., & Chen, H. G. (2018). Relationships between work team climate, individual motivation, and creativity. *Journal of Management*, 44(5), 2094–2115.