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Research Article

Design and Visual Thinking Model for Thai Undergraduate Student Online Creative Thinking and Creative Products Promotion

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Abstract: The design thinking (DT) process is a thought process to solve problems and develop new ideas to find solutions that focus on a user-centered perspective. Visual Thinking (VT) is the beginning of visualization of a story that leads to an understanding of complex problems. Moreover, many scholars agree that DT and VT are tightly joined in educational learning management. Therefore, to nurture students' creativity and continuous development that can be used as a base for creating creative future products in the future, we developed a design and visual thinking model (DVTM). The DT process is combined with VT techniques to promote creativity and critical thinking. From the qualitative analysis, seven experts in various fields were selected to participate in a Connoisseurship Seminar. The content analysis made use of a five-level Likert type learning style suitability scale. The collected data were then analyzed by use of the mean and the standard deviation (S.D.). The final DVTM consisted of five steps including; Step 1) idea stimulation, Step 2) problem identification, Step 3) idea and visualization generation, Step 4) testing, and Step 5) presentation and sharing which were determined to be appropriate by the experts at a good level (mean = 4.46, S.D. = 0.41) This *Digital Learning Platform* (DLP) style should be applied in the activities of students at the undergraduate level.

Keywords: Creative thinking, creative products, design thinking, visual thinking, Thailand

1 Introduction

Entrepreneurship and innovation for most developing nations is the foundation upon which economic success and sustainability are assured (Mahmud et al., 2017). This is particularly true as the global COVID 19 pandemic in Thailand has wiped out normal avenues for productivity and growth (e.g. tourism, vehicle exports, and electronics manufacturing), and created a highly uncertain future for the labor market, and accelerated the arrival of the future of work (World Economic Forum, 2020). Moreover, within Thailand's educational sector, from universities to vocational schools, COVID 19 is forcing radical change at a dizzying pace. However, economic growth and education are joined at the hip, with new models using technological innovation as the keys to future success, sustainability, and national economic survival (Phuapan et al., 2016).

Additionally, numerous Thai and global studies have pointed out education's role in the need for critical thinking and creative thinking skills in the 21st-century workforce (Changwong et al., 2018; Moto et al., 2018). Therefore, with the COVID 19 pandemic and Delta mutations increasing in ferocity with each passing day, methods must be found to move education and teaching into the online world. Thus, solutions and their mechanisms must be found to continue to promote the workforce of tomorrow's critical thinking skills under the '*New Normal'* where a different teaching and learning process must be explored, developed, and implemented. As the New Normal, it must also fit within the cultural and technological contexts of their respective institutions and economies.

In Thailand, the Ministry of Education (MOE) is evolving methods to improve an educational system using *digital learning management* (DLM) tools that fit within the context of the pandemic and each school system's technological realities. As such, a combination of techniques is being integrated and tested. These include traditional classroom methods (*onsite*) and teaching online (*online*). Also, according to UNESCO (2020), Thailand's *Distance Learning Television (DLT) and online learning have become key pedagogical methods to ensure physical distancing recommendations for the time of uncertainty during the COVID-19 pandemic. Finally,* teaching via television (*on-air*) and home visits and student homework assignments (*on-hand*) additionally enhance self-study at home (Hwa et al., 2017).

As this disruptive change of world society continues, education's learning management processes must change as well. Keeping in mind commonly quoted framework goals from the *Partnership for 21st Century Learning*; these new models must still embrace the 4Cs of *critical thinking, creativity, collaboration,* and *communication.* This is consistent with a recent World Economic Forum's (2020) Future of Jobs Report survey in which *creativity, originality,* and *initiative* were stated as skills necessary for a global workforce. Similarly, Combs et al. (2009) stated that *c*ritical thinking and creative thinking skills are essential for students who plan to work and excel in the 21st-century workforce.

1.1 How is creativity nurtured in an online world?

It has been suggested that promoting and encouraging creativity can be achieved both directly and indirectly. Direct approaches include teaching, practicing, and training, while indirect approaches involve creating an atmosphere that promotes learning creativity independence. Tools to do this can be as simple as handing out '*Da Vinci notebooks*' in which students write questions that feed their *curiosity* (Gelb, 2020). In an online world, the same process can be replicated by the use of a multimedia *Digital Learning Platform* (DLP) and digital bulletin board messaging-type features. Thus, *collaboration* and *communication* ensue as each team looks to find the answers, and where each student's input to answering each question creates *originality* of thought.

Other scholars have added to the basic precepts found in Bloom's digital learning taxonomy and stated that the development of an online teaching system must also include the validation of the learning goals and assessment techniques (Silberman et al., 2015; Suartama et al., 2019). It is also believed that mixing and reversing classes can be an effective tool to maximize collaboration impact. Finally, learning objectives must demonstrate a link between assessing each student's classroom or online content and activities (Bocconi & Trentin, 2014).

In Thailand, the authors' university has activated a DLP as a tool to develop modern teaching and learning techniques that motivate students to learn. Within this process, teachers act as *information facilitators* in an *active learning environment* where lecture time is significantly reduced with the emphasis being placed on learners thinking within the context of the research. In this '*teach-less, learn-more*' environment, it is expected that Thai teachers adapt their roles to respond to the needs of new online teaching platforms (UNESCO, 2020). However, their adoption and knowledge of these new online environments are expected to be self-taught.

Furthermore, Thai higher education learning processes are evolving out of necessity to include *process-based learning* (PBL). PBL entails training students to understand the process of thinking, researching and furthering their body of knowledge in their various academic courses. Also, PBL emphasizes student activities that promote learning and practice to clearly understand the content of their material and knowledge gained.

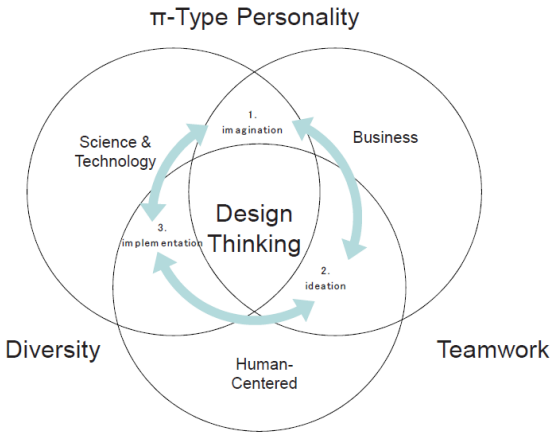
Another aspect enhancing creativity and critical thinking is '*learning by doing*' (Combs et al., 2009). This process is fortified by an ongoing course learning assessment (*formative assessment*) which focuses on the evaluation of activities throughout the course (Combs et al., 2009; Mahapoonyanont, 2020). Thereafter, a *summative assessment* is used to measure learning at the end of the course, where the focus is given to practical results as compared to exam results. These Thai university goals are consistent with Stiggins (2002), whose guidelines for raising educational standards suggest the use of the development of evaluation systems for the development of learning in classrooms, including both formative assessments as well as summative assessment processes.

1.2 Design thinking education (DTE)

A well-accepted definition of creativity is the creation of new products that are both novel and appropriate in a particular situation. Moreover, 'product' is something that consists of an idea, an artwork, an invention, or even a student's classroom assignment (Davis, 2018).

In DTE, real-world issues are posed to teams from diverse backgrounds (Figure 1), who engage in projects using external resources to find solutions and present proposals to solve specific problems (Kurokawa, 2013). Also, the main objective in DTE is the establishment of 'creative confidence', which in short is a student's trust in their creative problem-solving abilities (Jobst et al., 2012). Strengthening this trust is the main goal of education at design thinking schools.

Figure 1. DTE overview as proposed by Japan's Science and Technology Foresight Center (CTFC)



Source: Kurokawa (2013)

Research has also shown that DTE creates better collaboration, creativity, and efficiency (Cites & Rye, 2020). Thus, DTE is becoming more widespread in various fields and levels of education, meeting the needs of both teachers and learners.

1.3 Visual thinking (VT)

Another technique used in promoting creativity is visual thinking, which is focused on the use of visual images in connecting ideas (Huh, 2016). Visual thinking is also intuitive, non-rational, and unsystematic. It has also been stated from research that images are the main element used in thinking and therefore, VT is an individual's primary mode of thought (Arnheim, 2004).

Moreover, VT has been described as "an active problem-solving process" (Goldschmidt, 1994), consisting of an analytical process of perceiving, interpreting, and producing visual messages, an interaction between seeing, imaging, and drawing (Huh, 2016). Moreover, after a 15-year study on VT, it was concluded that when research-based teaching methods are used, VT improves critical thinking and language skills through visual image discussions (Jaros, 2012). Finally, for educators, practical visualization tools used for VT creativity exercises can make use of tools such as mind maps, concept maps, storyboards, art and maps, story maps, infographics, andsketch notes (Fernández-Fontecha et al., 2019).

Therefore, DTE and VT have become globally recognized mechanisms for promoting creativity. They encourage students to be designers from which new things and innovation are incubated. When combined as a learning model and placed online, they have the potential to foster positive interactions between learners and teachers, increase classroom attentiveness, and student motivation to learn. Moreover, the use of VT technologies creates a good atmosphere for teaching, and more importantly, it helps teachers to prioritize and develop effective teaching and learning mechanisms. Therefore, the researchers have applied these approaches to the design thinking process in the following sections.

2 Methods

The conceptualization for DTE, VT, creative thinking, and creative products was drawn from the literature, from which analysis and synthesis of the information led to the development of a *design and visual thinking model* (DVTM) shown in Figure 1. Thereafter, the DVTM was assessed and reviewed by a panel of seven experts in a *Connoisseurship Seminar*.

2.1 Connoisseurship seminar experts

The criteria for inclusion on the study's panel of Thai experts included their knowledge of teaching style, innovation, and creativity. Furthermore, each had to have obtained a doctoral degree and had a minimum of five years of teaching expertise. From the use of purposive sampling, the following participants were selected:

1. An associate professor who was head of a research center for Innovation and Technology Management,

2. An associate professor who was head of the Department of Civil Education,

3. A Head of the Technical Knowledge Management Division within a major Thai telecommunications firm,

4. A Department of Computer Engineering lecturer,

5. An associate professor who was acting chief for a Multi-disciplinary / Interdisciplinary Studies Department,

6. An associate professor who was teaching in a Department of Educational Technology and Communications, and lastly,

7. An associate professor in the Department of Educational Technology.

Furthermore, each expert had obtained a doctoral degree and had expertise in computer education, technology, curricula development, education, and research. Each expert was then asked to use a five-point Likert Scale for model assessment in which 5 = *very good*, 4 = *good*, 3 = *fair*, 2 = *not so good*, and 1 = *minimal*.

2.2 Model's suitability assessment

Furthermore, each expert had obtained a doctoral degree and had expertise in computer education, technology, curricula development, education, and research. Each expert was then asked to use a five-point Likert Scale for model assessment in which 5 = *very good*, 4 = *good*, 3 = *fair*, 2 = *not so good*, and 1 = *minimal*.

The DVTM's suitability assessment form was synthesized from research conducted by Stufflebeam (2011) who defined the evaluation process as the delineation of obtained information which is used for judging alternative decisions in the process of gathering information needed by the public. Thus, the importance of meta-evaluation is the validation of research evaluation (Stufflebeam, 2011).

From their research, four components were identified. These included feasibility standards, utility standards, propriety standards, and accuracy standards (Tongchiw, 2013). Using Stufflebeam's four meta-evaluation standards, seven experts analyzed and discussed how the DVTM could employ these concepts through the *Connoisseurship Seminar*, followed up by a group chat mechanism.

Thereafter, descriptive statistics including the mean and standard deviation (S.D.) was used to analyze the data collected. Also, content analysis was used for the learning model's quality assessment. The criterion was used to determine the weight of the quality assessment as a 5-order characteristic, with the mean value ranges as follows: [4.51 – 5.00] → 5, [3.51 – 4.50] → 4, [2.51 – 3.50] → 3, [1.51 – 2.50] → 2, or [1.00 – 1.50] → 1.

3 Results

3.1 Results of the experts' connoisseurship seminar

The DVTM's learning style was revised based on several issues raised by the experts and their subsequent recommendations. These included:

Issue 1 was concerned with the DVTM's components, from which there was a consensus amongst the experts that design thinking and visual thinking needed to be combined into one model.

Issue 2 was concerned with the DVTM's steps from which it was agreed that the main steps and sub-steps should be combined. Additionally, these steps should contain the learner's roles, the teacher's roles, teaching materials, and each step's output. Moreover, there should be a weekly overview and evaluation mechanism to encourage and motivate students to continue, whose results are intended to promote creativity and creativity.

Issue 3 was concerned with how the application of technology was used to support learning. It was suggested that the project make use of a '*Digital Learning Platform*' (DLP) to manage the learning process and changes.

Issue 4 was the experts' concern for the creation of earning activities according to learning styles and the need for additional techniques related to '*Active Learning Management*'.

Issue 5 was the modification of the DVTM in which the design thinking process needed to be combined with the visual thinking techniques, thus becoming the primary variable. This then left the dependent variable as *creative thinking* (CT) and *creative products* (CP) interconnected as one, with both analog and digital tools, or online and offline. As shown in Figure 2.

3.2 Appropriateness of the DVTM

Table 2 shows the results from the content analysis from the experts' input concerning the relative importance of each standard in the proposed DVTM. These results indicated that the experts felt that US had a very high level of importance ($\bar{x} = 4.64, \text{S.D.} = 0.48$), followed by FS ($\bar{x} = 4.29, \text{S.D.} = 0.40$), AS ($\bar{x} = 4.46, \text{S.D.} = 0.47$), and the PS ($\bar{x} = 4.43, \text{S.D.} = 0.53$). Overall, the proposed learning model was deemed to be at an appropriately overall 'high' level ($\bar{x}$ = 4.46, S.D. = 0.41)

Table 1. The mean suitability level of the DVTM

Standards	Experts (*n*=7)		Scale/Interpretation
	$\bar{x}$	S.D.	
Feasibility standards (FS)	4.29	0.40	High/Good
Utility standards (US)	4.64	0.48	Very high/Very Good
Propriety standards (PS)	4.43	0.53	High/Good
Accuracy standards (AS)	4.46	0.47	High/Good
Average	4.46	0.41	High/Good

3.3 DVTM final model

From the panel of experts' input, the initial visual learning model was redesigned, in which two concentric circles are used to detail the titles of the information perceived necessary for an online DVTM (Figure 2). These included 1) idea stimulation, 2) problem identification, 3) idea and visualization generation, 4) testing, and finally, 5) presentation and sharing. These five components are proposed as contributing to the model's teaching and learning success.

Figure 2. Design and visual thinking model (DVTM) for Thai undergraduate student creative thinking and creative products promotion

3.4 Idea stimulation – Step 1

Step 1 is first concerned with student research idea stimulation. In some ways, this can be thought of as a Da Vinci notebook of daily questions. However, it is the teacher's role to act as a facilitator in this process by presenting future problems, issues, and case studies. Moreover, to stimulate interest and inspire creative design work, teachers should provide content and resources that are suitable and conducive to learning.

These include a suitable learning environment as well as the tools to support learning in both an online and on-site format that facilitate knowledge creation. Learners play a role in jointly exploring the issues by using a 5W1H (Who? What? Where? When? Why? How?) strategy, asking questions to analyze problems and formulating problems by focusing on the problem by voting until the critical problem is reached. There are tools to facilitate commenting, including virtual bulletin boards, and comment-gathering tools, and virtual voting tools.

3.5 Problem identification – Step 2

Step 2's problem identification helps students analyze and synthesize the problem using step 1 techniques. Also, issues from Step 1 are discussed to determine the root cause of the problem to determine the issue of the problem. At this point, the teacher's role is to suggest strategies for practicing thinking with diagrams or sketching ideas to find the point of the problem (visual thinking). This step is also used as a guideline to help learners notice connections and important issues. Useful tools in this process are Journey Map Software and Persona.

3.6 Idea and visualization generation – Step 3

Step 3 is involved with idea and visualization generation, in which new ideas are created and students team together to come up with solutions by trying to come up with innovative problem-solving options (Kurokawa, 2013). In a DTE environment, teams first define and analyze the problem, then explore possible solutions through collaboration and external research to prioritize the solutions to the problem. Ideally, each team is comprised of individuals from different backgrounds and educational expertise. At this point, visualization tools can be used to create an infographic of the problem and possible solutions. Instructors once again play a role in guiding the planning to make the information presented as easy to remember as possible by using storytelling strategies integrated into the infographic design. Idea generation tools are brainstorming software and problem prioritization tools such as *Priority Matrix*. Creative tools can include presentation software such as *Slideware*.

3.7 Testing – Step 4

In Step 4's testing, learners put their infographic-designed work to the test with a sample audience who had never seen the data before. Ideally, testing should be conducted on groups in which gender, age, race, language, and religion are mixed. Also, test groups should be limited to 5-10 individuals to view the work and add comments. Thereafter, instructors take a guiding role in reviewing infographics before they are released to the public by use of stimulating questions to show the correlation of the data to check the consistency of the results produced for the objectives through an online collaborative feedback collection tool such as *Feedback Capture Grid*.

3.8 Presentation and sharing – Step 5

In Step 5's final presentation and sharing phase, students present their work produced by creative tools such as drawing software *Sketchbook* and *Slideware*. Through tools for dissemination tools such as social media E.g. *Facebook*,*Line*, or *WhatsApp*), print media, and web media, students can present through narration or maybe a picture and reflect on the information obtained from the publication of the infographic. It also reflects the learning gained from the creation process from the beginning until the end of the knowledge gained. Instructors have a summary role and provide feedback on how to absorb constructive criticism and track comments related to content or visualization to improve subsequent design concepts.

3.9 Measuring and evaluation of the learning model

Instructors should use a measurement and evaluation approach consistent with the learning model's objectives, by applying a pre-test and post-test to measure creativity developed from the DVTM. Also, teachers should evaluate individual and group work using creativity assessment forms at the end of the learning process. The assessment of each learner's learning development is assessed weekly until the final creative work is achieved individually.

4 Discussion

From this study, we determined that the design thinking process and the concept of visual thinking that integrate well together. Moreover, there is significant support for these findings from other studies, but maybe some confusion as to their specific meaning and use. In one report, the confusion was identified and clarified. In it, it was stated that *design thinking* (DT) is used for problem-solving, while *visual thinking* (VT) is the tool that can simplify complex ideas through visualization (Alscher, 2021). Throughout every step of the DT process, VT can help explain ideas more effectively. Whether it is the process of identifying problems, conceptualizing solutions, or expressing ideas, VT is an optimum choice.

4.1 Design thinking (DT)

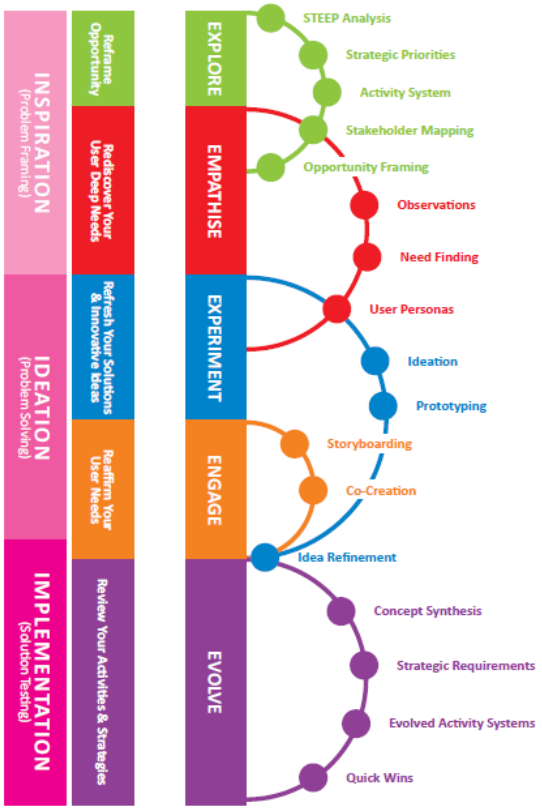
Moving into the public sector, Bhutan has been a leader in the use of DT for the creation of innovation (Hwa et al., 2017). As such, for the DT's use by the people of Bhutan, the primary phases, methods, and tools were outlined and detailed as shown in Figure 3. From it, we learn that there is an initial phase requiring problem identification, followed by problem-solving, then solution testing. Furthermore, Bhutan's citizen and public servant guide to DT states that DR is a human-centered problem-solving approach, which is based on *collaborative teamwork*, *learning by doing*, the *embrace of experimentation*, the *understanding of pattern relationships and systems*, and finally, the *ability to visualize and show* the results of your research. As a whole, Bhutan's guidelines are very similar to the outcomes from our research as well.

In Taiwan, researchers also confirmed the human-centered focus of DT in creative problem solving not only for designers of medical products but other disciplines as well (Yang & Man, 2018). Also in Taiwan, the authors look at how an off-shoot from DT has grown through industrial demand and government policies. The authors detail a lengthy list of DT benefits including its use in improving teaching, student participation, deepens students' discussions on design-related topics, and creates a favorable atmosphere for teaching, to list but a few benefits (Tu et al., 2018).

Once again, the hands-on approach that DT uses was highlighted from multiple case studies. In the State of Georgia in the United States, research on DT concluded that for K-12 learners using graphic design classes with problem-solving techniques, DT enhanced creativity, engagement, collaboration, evaluation, refinement, and presentation techniques (Lord, 2019).

In India, DT researchers mapped DT tenets to constructivism learning approaches, and felt overall, DT was an excellent method to be used within business school environments (Pande & Bharathi, 2020).

Figure 3. Bhutan's DT mind map



Source: Hwa et al. (2017).

4.2 Visual thinking (VT)

Visual thinking is related to the DT process throughout every step, which is a tool that promotes the use of problem-solving processes more efficiently. Also, from numerous studies, VT has been determined to be an excellent tool in the simplification of complex problems through visualization (Alscher, 2021).

In Korea, English language teaching was determined to be enhanced through a process of picture books using VT techniques. Once again, the importance of the teacher as a facilitator has been noted in which the teacher encouraged the students to take risks and to make mistakes in using a foreign language (Yeom, 2018). From these critical comments, it was suggested that critical/aesthetic thinking skills can be developed through continued visual practices in a secondary EFL setting. Anecdotal reports from teachers suggesting that students who use VT in their other subjects create a positive influence on critical thinking skills in general (Housen, 2002).

Practically speaking, from *PowerPoint* to *Vivid Grammar Graph* to *SQVID* (simple, quality, vision, individual, diversity/change), VT can take on many forms, from simple to complex. However, at all times teachers must remember that simple concepts and communication are the winning ones (Roam, 2008).

5 Conclusion

The DVTM learning model was determined to foster creativity and improved creative output according to the panel of experts' input for the study. Moreover, the DVTM method to achieve student creative thinking and creative products was determined to consist of five steps. These included Step 1) idea stimulation, Step 2) problem identification, Step 3) idea and visualization generation, Step 4) testing, and finally, Step 5) presentation and sharing. Experts rated the learning style's suitability at a high level, indicating that the elements and steps of design thinking in combination with visual thinking techniques are relevant and appropriate with the model's use in promoting creativity and creative products at the undergraduate level. Finally, as Thailand's educational ministry shifts its budget from schools to the development of curricula, online teaching and ICT devices to enhance the effectiveness of online learning will become crucial in educational development (UNESCO, 2020).

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