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# The development of instructional model based on design thinking process with family and community engagement to enhance learning and innovation skills for senior high school students

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**Abstract**

This research aimed to explore the guideline for learning and innovation skills development of senior high school students. The study also aimed to develop and assess the quality of the instructional model. Furthermore, it compared senior high school students' (11th Graders) learning and innovation skills between post-test and the criterion (70%). The samples consisted of 35 senior high school students (11th Graders), selected through clustered random sampling technique from an extra-large size provincial high school, Thailand. Content analysis, Descriptive statistics, and One-sample *t*-test were used for data analysis. The findings revealed that: (1) Teachers must act as a facilitator, coach, and mentor to enable students to create innovation. Furthermore, through a community-based career and innovation project, parents and the community members should be involved in learning activities with the school; (2) The instructional model was developed consisting of 4 components: principle, objective, learning activities, and assessment. The instructional model's learning activities included six steps: step 1 Empathizing through communication; step 2 Define problem with partners; step 3 Collaborative Ideation with partners; step 4 Create innovation with partners; step 5 Illustrate and Utilize innovation; and step 6 Exhibit innovation culture. The instructional model had the highest level of appropriateness ($M$ = 4.56, $SD$ = 0.10), and its effectiveness index was 0.6584; and (3) senior high school students' (11th Graders) learning and innovation skills after the instructional model implementation were enhanced and significantly higher than the stated criterion (70%) at a significant level of .01.



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## Introduction

Learning and innovation skills are being recognized as essential 21st century skills, competencies that assist in distinguishing between students who are prepared for increasingly complex life and work environments and those who are not. Critical thinking and problem solving; communication and collaboration; creativity and innovation are all essential fundamentals for preparing students for future work, learning, and living responsibilities. The Critical thinking and problem-solving concept is an important viewpoint that allows students to think critically and conduct in-depth investigations on their own, whereas the Communication and collaboration concept allows students to effectively collaborate with others; that is, articulate their thoughts and ideas clearly and effectively through communication with diverse teams. The Creativity and innovation concept, which is equally important to students' perceptions of learning, allows them to think creatively, allowing them the aptitudes required to solve problems through the formation of an idea from which the innovation process will be developed (Battelle for Kids, 2019a; 2019b; Ferrés & Masanet, 2017; O'Hara, 2017; Soderlund, 2020).

According to the previous research conducted by foreign researchers, it was found that Thai senior high school students excelled in academic subjects but lacked important 21st century skills such as creativity, collaboration, communication, critical thinking, and problem-solving ability. As a result, Thai students' learning achievement cannot be used to support the claim that Thai students excelled in both academic subjects and skills (Casner-Lotto & Barrington 2006; Lichtenberg et al., 2008; Van Ark et al., 2009). The findings were consistent with the results of an international assessment of mathematics and science (TIMSS 2015) and the Program for International Student Assessment - PISA (PISA 2012 and PISA 2015), which revealed a problem with Thai education quality. The TIMSS 2015 results revealed that Thai students ranked 26th out of 57 countries in mathematics and science. Furthermore, PISA 2012 and PISA 2015 results revealed that Thailand was ranked 50 and 55, respectively, with a mean score in Reading, Mathematics, and Science lower than the OECD. These international assessment findings can be summarized as Thai students having low academic abilities in Reading, Mathematics, and Science. It is critical to develop students' abilities in comprehensive reading, critical thinking, problem solving, and creativity, particularly in Mathematics and Science, which are essential knowledge for creative thinking and innovation creation in order to develop Thailand's economy and industry (Office of the Education Council, 2018).

The Design Thinking Process concept can allow students to create innovation that meets the social needs of a community by adhering to the Human-Centered Design concept (Thailand Creative & Design Center, 2017). According to The Stanford d.school Bootcamp Bootleg (2010), the concept of Design Thinking Process has five steps for creating innovation. Empathy, Define, Ideate, Prototype, and Test are all options. However, the disadvantage of implementing the Design Thinking Process concept reveals that students face design challenges. Students cannot create innovations that meet the social needs of a community because they are unable to empathize in order to understand the true problem or need of users. As a result, if students do not empathize with the real problem or need of community users, they will be unable to create innovations that meet the social needs of the community (The Stanford d.school Bootcamp Bootleg, 2010).

According to IDEO.org (2015), students should have the opportunity to create innovation with the community. They must empathize with the real problem or need of community users in order to generate ideas for creating innovation that meets the community's social needs. As a result, the concept of Family and Community Engagement should be used to provide students with the opportunity to create innovative solutions that meet the social needs of the community. The concept of Family and Community Engagement is an important viewpoint that allows parents, school staff, and community members to collaborate to increase opportunities for physical activity before, during, and after the school day in order to improve children's and adolescents' learning, development, and health. Schools and teachers who take the time to establish and strengthen effective relationships with parents and the community are rewarded with improved learning, well-being, and high expectations for student success (Berg et al., 2006; Department of Education, Queensland Government, 2020). Therefore, in this article, we developed the instructional model based on design thinking process with family and community engagement to enhance learning and innovation skills for senior high school students.

## Literature Review

### *Design Thinking Process*

The Design Thinking Process concept allows students to innovate and problem solve while adhering to the Human-Centered Design concept. The Design Thinking Process is a problem-solving methodology that focuses on solutions. When used to tackle complex problems that are ill-defined or unknown, it is extremely useful because it helps to understand the human needs involved, reframe the problem in human-centric ways, generate numerous ideas in brainstorming sessions, and take a hands-on approach to prototyping and testing. The Design Thinking process can be divided into five key stages. Stage 1: Empathize—Research Users' Needs, Stage 2: Define—State Users' Needs and Problems, Stage 3: Ideate—Challenge Assumptions and Create Ideas, Stage 4: Prototype—Start to Create Solutions, and Stage 5: Test—Try the Solutions Out (The Stanford d.school Bootcamp Bootleg 2010; Thailand Creative & Design Center 2017). However, the disadvantage of implementing the Design Thinking Process concept reveals that students face design challenges. Students cannot create innovations that meet the social needs of a community because they are unable to empathize in order to understand the true problem or need of users. As a result, if students do not empathize with the real problem or need of community users, they will be unable to create innovations that meet the social needs of the community. Furthermore, this study employs the process of Stanford D school as the main process in this study because this process can facilitate pupils for creating innovation through the double diamond design process, which was invented by UK Design Council. The double diamond design process is similar to the process of Stanford D school that aims to solve a concrete human need. It also helps designers to find desirable solutions for consumers. It is beneficial to apply as learning activities that encourage students to use five key stages of Stanford D school in order to empathize with human needs, generate a creative solution, and create a prototype that can test the solutions out (The Stanford d.school Bootcamp Bootleg, 2010).

### *Family and Community Engagement*

The perspective of Family and Community Engagement is an important viewpoint that allows school, parent, and community to allow parents, school staff, and community members to collaborate to increase opportunities for physical activity before, during, and after the school day in order to improve children's and adolescents' learning, development, and health. Schools and teachers who take the time to establish and strengthen effective relationships with parents and the community are rewarded with improved learning, well-being, and high expectations for student success. There are five key elements of family and community engagement to make a positive difference in students' education. First, Effective communication is an exchange between students, parents, communities and schools that is inclusive and involves information sharing and opportunities to learn from each other. Second, Partnerships between parents, students and schools promote student learning, wellbeing and high expectations for student success. Third, Relationships between the school and wider community strengthen the ability of schools and families to support student learning, wellbeing and developmental outcomes. Fourth, Parents, students and community members play meaningful roles in school decision-making. Last, Respectful relationships between students, parents and the school community are valued and enhance the promotion of student learning and wellbeing. (Berg et al., 2006; Department of Education, Queensland Government, 2020).

### *Instructional Model*

The instructional model provides a cohesive structure comprised of tried-and-true components that can be tailored to different teaching styles, content areas, and student needs. Teaching methods are chosen within the instructional framework to improve specific skills. These differ between and within lessons. Teachers select methods that are most likely to improve learning and are most relevant to the needs of their students. The methods are classified as instructional strategies. Students learn best when they are truly engaged in what they are learning, when they can explore, debate, discuss, examine, defend, and experiment with the concepts and skills they are ready to learn. There are several types of instructional challenges or pedagogical techniques, such as: Direct or teacher-centered teaching; Indirect teaching, in which students construct their own knowledge with the help of teachers; Independent learning; Experiential learning, in which students participate in the experience and use analytic skills to reflect on their experiences; and Interactive learning, in which students interact with each other and with the material (Joyce & Weil, 2000).

### *Learning and Innovation Skills*

Learning and innovation abilities are being recognized as critical 21st century skills, competencies that assist in distinguishing between students who are prepared for increasingly complex life and work environments and those who are not. Critical thinking and problem solving; communication and collaboration; creativity and innovation are all essential fundamentals for students to be prepared for future work responsibilities, learning, and living (Battelle for Kids, 2019b). The Critical thinking and problem-solving concept is an important viewpoint that allows students to think critically and conduct in-depth investigations on their own, whereas the Communication and collaboration concept allows students to effectively collaborate with others; that is, articulate their thoughts and ideas clearly and effectively through communication with diverse teams. The Creativity and Innovation concept, which is equally important to students' perceptions of learning, allows them to think creatively, allowing them the aptitudes required to solve problems through the formation of an idea in which the innovation process will be developed (Battelle for Kids, 2019a; Ferrés & Masanet, 2017; O'Hara, 2017; Soderlund, 2020).

## Methodology

This research was conducted using the three phases involved in research and development as follows.

Phase 1: Studying the guideline for learning and innovation skills development of senior high school students.

A structured interview was conducted with experts from Thailand Creative & Design Centre (TCDC) and Life Education Thailand to gather information about the guideline for the development of learning and innovation skills for senior high school students using the Design Thinking Process with Family and Community Engagement. Structured interviews topics included learning contents, learning activities, and evaluation, such as: (1) In your opinion, how should senior high school students be educated using the design thinking process to encourage students to create innovation that meets the needs of the community?; (2) To apply the concept of family and community engagement, how do you envision learning activities that encourage family and community members to participate in learning activities for knowledge transfer about career skills in order to encourage students to create innovation that meets community needs? The Index of Item - Objective Congruence was used to check the content validity of structured interview forms submitted to 3 experts, who have expertise in the field of Educational Measurement and Evaluation. The Item - Objective Congruence Index (IOC) was 1.00.

Phase 2: Developing and assessing the quality of the instructional model based on design thinking process with family and community engagement for senior high school students' learning and innovation skills development.

2.1 Information from the structured interview was combined with that from a critical analysis and synthesis of design thinking process, and family and community engagement were used as bases for developing the instructional model based on design thinking process with family and community engagement for senior high school students' learning and innovation skills development.

2.2 Quality assessment of the instructional model was done by 5 experts, who have expertise in the field of curriculum and instruction, design thinking process, family and community engagement, and science education. A 5-level Likert rating scale was used to assess the suitability of the instructional model. The content validity of the suitability evaluation forms was checked by three experts, who have expertise in the field of Educational Measurement and Evaluation using the Index of Item - Objective Congruence (IOC). The Item - Objective Congruence Index (IOC) ranged from 0.67 to 1.00. Then, in order to study the effectiveness index of the instructional model based on design thinking process with family and community engagement for senior high school students' learning and innovation skills development, the instructional model was used in a pilot study with senior high school students from an extra-large size provincial high school in Thailand during semesters 1 and 2 of the 2020 academic year. There were 35 senior high school students (10th Graders) in the part of pilot study.

Phase 3: Implementing the instructional model to compare senior high school students' learning and innovation skills between post-test and the criterion (70%).

3.1 The instrument was a rubric-based assessment of learning and innovation skills form. The components and observed variables of learning and innovation skills were slightly adapted from Battelle for Kids (2019a). The components and observed variables of this study included the areas of critical thinking and problem solving, communication and collaboration, and creativity and innovation. Table 1 provides an example of scores corresponding to each of the four levels of analytical rubrics.

**Table 1** An example of scores corresponding to each of the four levels of analytical rubrics for learning and innovation assessment

| Dimension | Scales | | | |
|---|---|---|---|---|
| | Level 4 | Level 3 | Level 2 | Level 1 |
| Critical thinking and problem solving | | | | |
| The ability to search, analyze, and synthesize information effectively in order to develop a suitable solution. | Demonstrates the ability to search, analyze, and synthesize information effectively in order to develop 3 or more suitable solutions. | Demonstrates the ability to search, analyze, and synthesize information effectively in order to develop 2 suitable solutions. | Begins to demonstrate the ability to search, analyze, and synthesize information effectively in order to develop only one suitable solution. | Demonstrates a limited ability in searching, analyzing, and synthesizing information to develop a suitable solution. |
| Communication and collaboration | | | | |
| The ability to effectively articulate one's thoughts and ideas, whether orally, in writing, or nonverbally. | Demonstrates the ability to effectively articulate one's thoughts and ideas, whether orally, in writing, or nonverbally. Communication options are clear and strongly support the effectiveness of collaboration and interaction with others. | Demonstrates the ability to articulate one's thoughts and ideas, whether orally, in writing, or nonverbally. Communication options are clear to collaborate with others but unsuitable to interact with others. | Begins to demonstrate the ability to articulate one's thoughts and ideas, whether orally, in writing, or nonverbally. Communication options are unclear and unsuitable to collaborate and interact with others. | Communication options are unclear and minimally support the effectiveness of collaboration and interaction with others. |
| Creativity and innovation | | | | |
| The ability to prompt brainstorming activities, creative thinking as a group, as a unit, which allows for critical reflections on ideas that help generate creative ideas that produce innovation development | Demonstrates the ability to prompt brainstorming activities, creative thinking with others as a group, as a unit, which allows for critical reflections on ideas that help generate creative ideas that produce new and suitable innovation development. | Demonstrates the ability to prompt brainstorming activities, creative thinking with others as a group, as a unit, which allows for critical reflections on ideas that help generate creative ideas. However, information got from critical reflections cannot produce new and suitable innovation development. | Begins to demonstrate the ability to prompt brainstorming activities, creative thinking with others as a group, as a unit. However, the critical reflections on ideas don't help generate creative ideas that produce new and suitable innovation development. | A collection of available ideas is reformulated. |

**Source:** Battelle for Kids (2019a)

3.2 The content validity of a rubric-based assessment form was determined using the Index of Item - Objective Congruence (IOC) from 3 experts, who have expertise in the field of Educational Measurement and Evaluation. The Index of Item - Objective Congruence (IOC) ranged from 0.67 to 1.00. The Pearson's Correlation Coefficient was used to determine the reliability of a rubric-based assessment form, and the Pearson's Correlation Coefficient was 0.87.

3.3 The instructional model was implemented with 35 senior high school students from an extra-large size provincial high school in Thailand during the first and second semesters of 2021 academic year for a total of 40 weeks. The instructional model was implemented in the subject of Independent Study (IS). Students were educated using six steps of learning activities to help them improve their learning and innovation skills (Figure 1). Senior high school students' learning and innovation skills were assessed using a rubric-based assessment form during the implementation of the instructional model at weeks 5, 10, 15, and 20. Students were assessed for the ability of empathizing users' needs, defining users' problems, ideating the proposed solutions, and testing the solution in week 5, 10, 15, and 20 respectively. Furthermore, students were monitored to enhance the ability of implementing their solution and presenting the result of using innovation in the hands of users. After the implementation of the instructional model, senior high school students' learning and innovation skills were compared between post-test and the stated criterion (70%).

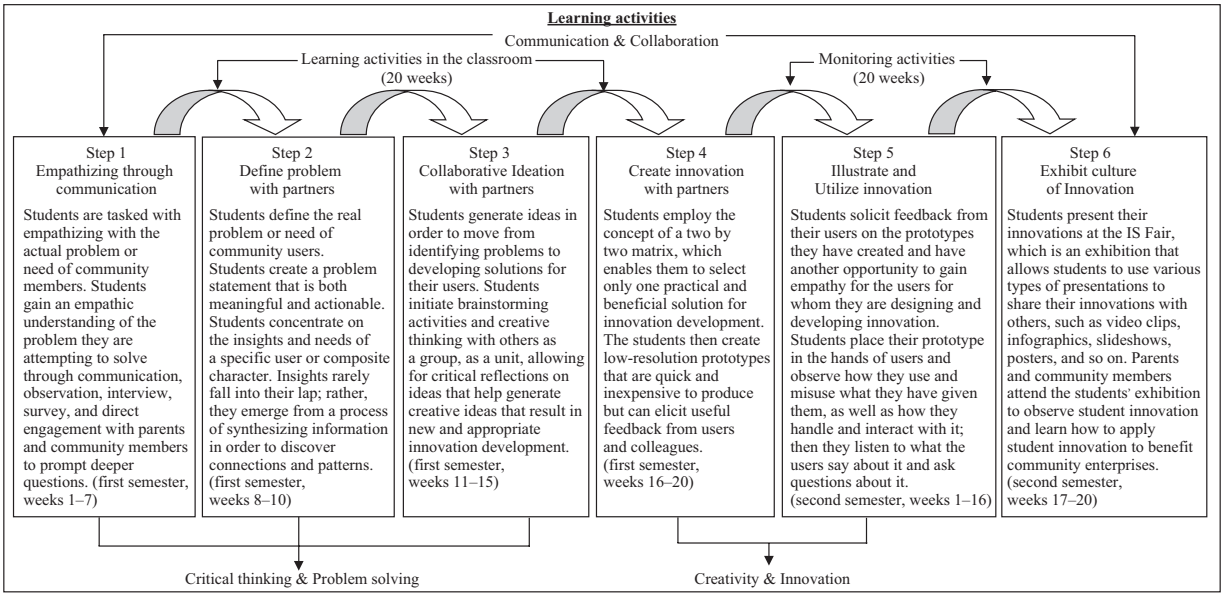


**Figure 1** The instructional model's learning activities

### *Participants*

The population consisted of 547 senior high school students (11th Graders), whereas the sample consisted of 35 senior high school students (11th Graders), who were selected through clustered random sampling technique from 15 classrooms in an extra-large size provincial high school, Thailand in the first and second semesters of 2021 academic year. The characteristics of participants were senior high school students (11th Graders) that were studying Independent Study (IS). Furthermore, there were 20 parents and community members that were involved with the students' project, which employed Design Thinking Process with Family and Community Engagement.

### *Research Instruments*

The research instruments consisted of structured interview, the instructional model, suitability evaluation form, and a rubric-based assessment of learning and innovation skills form.

### *Data Analysis*

The results of studying the guideline for learning and innovation skills development of senior high school students were analyzed using content analysis. Descriptive statistics were used to assess the suitability of the instructional model. The results of using the instructional model for a pilot study were analyzed using the effectiveness index, whereas a One-sample *t*-test was used to compare senior high school students' learning and innovation skills between post-test and the stated criterion (70%).

## Results and Discussion

1. According to the interview with experts in the field of design thinking process and family and community engagement, the results of studying the guideline for learning and innovation skills development of senior high school students revealed that the learning and innovation skills development guideline for senior high school students should encourage students to have three important characteristics. To begin, students should have up-to-date T-shaped knowledge in various sciences such as Technology, Social Sciences, and Science. Second, students can search for and apply knowledge in various sciences and arts fields, which promotes creative integration and innovation. Third, students can think creatively and work collaboratively to create innovation. Teachers must be trained in order to fully comprehend and apply the concept of Design Thinking Process with Family and Community Engagement as a facilitator, coach, mentor, and problem solver in order to enable students to create innovation. Teachers must first survey the community context to determine where students can go to empathize with the actual problem or need of community members in order to create innovations that meet the community's social needs. Furthermore, through a community-based career and innovation project, parents and community members should be involved in learning activities with the school. Figure 2 shows the guideline for learning and innovation skills development of senior high school students.

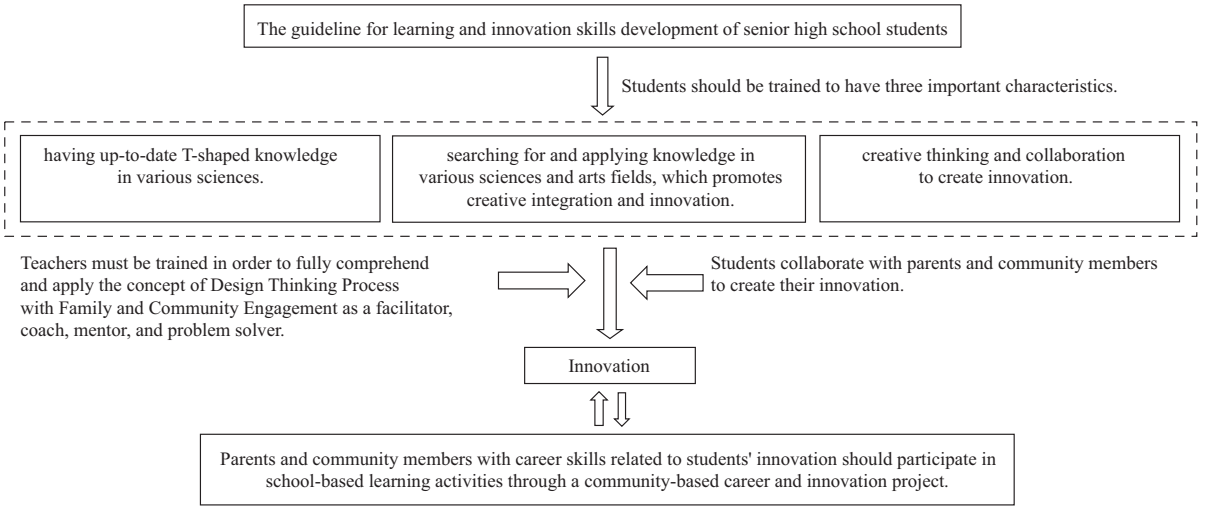


**Figure 2** The guideline for learning and innovation skills development of senior high school students

2. Based on the development of the instructional model, the findings revealed that the instructional model based on design thinking process with family and community engagement to enhance learning and innovation skills for senior high school students was developed with four components: principle, objective, learning activities, and assessment (Figure 3). A suitability evaluation of the instructional model revealed that the instructional model had the highest level of appropriateness ($M = 4.56$, $SD = 0.10$), and its effectiveness index was 0.6584.

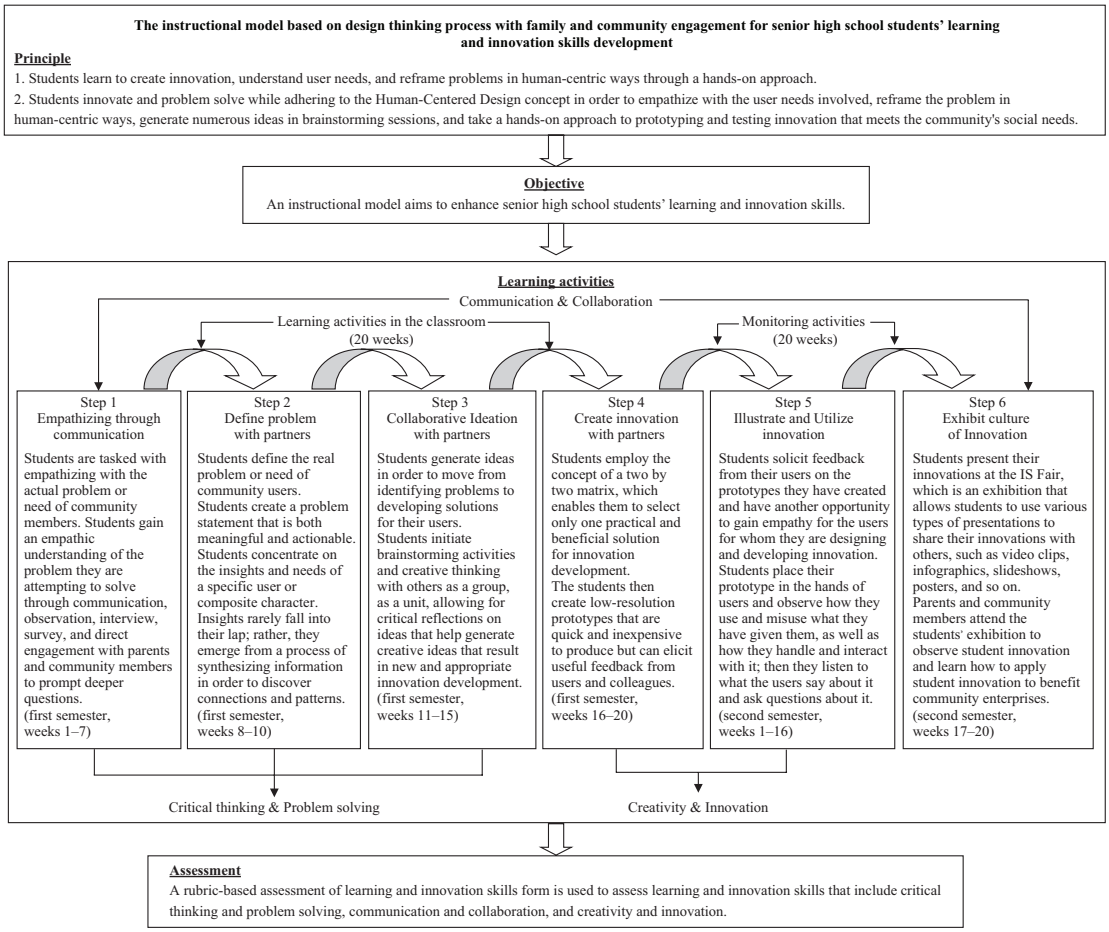


**Figure 3** The instructional model based on design thinking process with family and community engagement

This is an indication that all the instructional model components were in line with the criteria of enhanced model development and the needs of senior high school students. The highest level of appropriateness was because the instructional model was systematically developed from studying the guideline for learning and innovation skills development of senior high school students, critical analysis-synthesis of related approaches before designing learning activities and before model development. After development, the instructional model was assessed by experts and a pilot study was conducted to study the effectiveness index and modifications made, thus, making the model highly appropriate. The findings were in line with Paramatikul (2019), who developed Learning and Innovation Skill by using integration Stem Education Learning Management Robotics Technology Model in Principle for Upper Elementary School Students. The results of learning activities' evaluation revealed that it was at an excellent level. The results were also in conformity with Khaopray and Keawurai (2018), who developed a curriculum based on authentic instruction to enhance the ability in environmental education instruction of teacher students. The results on curriculum evaluation and pilot study proved that the curriculum was suitable and potentially practical for implementation.

3. Table 2 shows that after the implementation of the instructional model based on design thinking process with family and community engagement, senior high school students' learning and innovation skills were enhanced and significantly higher than the stated criterion (70%) at a significant level of .01. Furthermore, students created projects as the solution that can solve problems or meet the users' demands. There were 10 students' projects that were created for serving users' needs for example smart scale, the screen color of shirt, bioplastic etc. According to the assessment of students' learning and innovation skills at week 5, 10, 15, and 20, the results showed that students had the ability of empathizing users' needs, defining users' problems, ideating the proposed solutions, and testing the solution out.

Several factors contributed to the significant improvement of senior high school students' learning and innovation skills. During the instructional model implementation process, Senior high school students participated actively in the implementation process via onsite and online platforms (Google meet, Google classroom) and were educated through the 6 key steps of an instructional model's learning activities to help students improve their learning and innovation skills. Students actively participated in learning activities in which teachers, parents, and the community provided students with opportunities to learn and improve their learning and innovation skills through activities based on the Design Thinking Process with Family and Community Engagement. Students learn to create innovation, understand user needs, and reframe problems in human-centric ways through a hands-on approach. They innovate and problem solve while adhering to the Human-Centered Design concept in order to empathize with the user needs involved, reframe the problem in human-centric ways, generate numerous ideas in brainstorming sessions, and take a hands-on approach to prototyping and testing innovation that meets the community's social needs. Furthermore, Parents, school staff, and community members collaborate to increase opportunities for students to create their innovation. Parents and community members volunteer to share real-world learning experiences with students.

The learning activities were designed with the goal of improving the learning and innovation skills of senior high school students. Through the 6 key steps of the design thinking process with family and community engagement, students were taught how to create innovation that meets the social needs of a community. First, through communication with parents and community members, students gained an empathic understanding of the problems or users' needs. Second, students defined the problems or user needs that they had gathered with parents and community members during the first step. Third, students collaborated with parents and community members to generate ideas for innovative solutions to the problem or need statement they had created. Fourth, students began developing a prototype for their innovation. This step was designed to encourage students to develop the best possible prototype of their innovation and to improve their prototypes based on user feedback. Fifth, students conducted user testing on their product or process innovation in order to gain a thorough understanding of the product or process innovation and

**Table 2** Comparison of senior high school students' learning and innovation skills after the implementation of the instructional model based on design thinking process with family and community engagement with the criterion (70%)

| Testing | *n* | Full score | Criteria score | *M* | *SD* | *t* | *p* value |
|---|---|---|---|---|---|---|---|
| post-test | 35 | 36 | 25 | 27.24 | 3.10 | 3.88†† | .000 |

*Note:* ††$p < .01$, one-tailed

its users. Sixth, students presented their innovation as a video clip, power point presentation, and infographic in the IS Fair, which was an exhibition of senior high school students' IS projects at School.

The findings were in conformity with Klahan and Ponegrn (2021), who developed learning activities based on a Design Thinking Process and Project-based Learning to enhance innovators in grade 10 students. The results revealed that student's innovator abilities and student's work pieces were at a good level. The results were also in line with Yang and Man (2018), who applied Design Thinking Process in student's project: a case of EGF products. The findings revealed that Design thinking process can help design students build up their creative confidence and encourage them to become design thinkers in future. Equally, the results were consistent with Phu (2019), who studied about developing creativity for children: role of parents. The findings revealed that parents are people who spent lots of time in caring and teaching their children therefore parents had essential roles in educating creativity for their children, fostering creativity, developing creativity via arts education, Childrens' play, and roles of parents in enhancing their children's creative thinking skills.

## Conclusion and Recommendation

This research had as the focal point to enhance senior high school students' learning and innovation skills through the development of the instructional model based on design thinking process with family and community engagement. From the research findings, the instructional model was appropriate and effective in enhancing senior high school students' learning and innovation skills. The design thinking process enhances learners' empathic understanding of creating innovation which meets the social needs of a community while the family and community engagement provides the opportunity for learners to create innovative solutions with parents and community members, who share real-world learning experiences with students. The results revealed that senior high school students' learning and innovation skills after the instructional model implementation were enhanced and significantly higher than the stated criterion (70%) at a significant level of .01. Thus, an enhancement of learning and innovation skills should involve design and implementation of theoretical and activity-based instruction where learners are given an opportunity to create innovation, understand user needs, and reframe problems in human-centric ways through a hands-on approach. Learners can innovate and problem solve while adhering to the Human-Centered Design concept in order to empathize with the user needs involved, reframe the problem in human-centric ways, generate numerous ideas in brainstorming sessions, and take a hands-on approach to prototyping and testing innovation that meets the community's social needs. Moreover, Parents, school staff, and community members should actively participate and collaborate in learning activities to increase opportunities for students to create their innovation in which parents and community members volunteer to share real-world learning experiences with students.

### *Recommendations for a Proposed Instructional Model based on Design Thinking Process with Family and Community Engagement for Learning and Innovation Skills Development of Senior High School Students*

Based on the findings of the implementation of the instructional model, it was revealed that senior high school students' learning and innovation skills after the instructional model implementation were enhanced and significantly higher than the stated criterion (70%) at a significant level of .01. Furthermore, students created projects as the solution that can solve problems or meet the users' demands. Teachers and team instructors should consider learners', parents', and community members' roles in order to gain a thorough understanding of how to apply the concept of design thinking process and family and community engagement in the classroom. Teachers and teams that include parents and community members must act as a facilitator, coach, mentor, and problem maker to enable students to create innovation. Furthermore, other educational institutions should focus on developing senior high school students' learning and innovation skills in order to prepare them to be Thais 4.0 and first-world citizens who promote and support innovation, creativity, research, and development in a value-based economy.

### *Recommendations for Future Research*

The research scope focused on enhancing senior high school students' learning and innovation skills. Further research should focus on monitoring senior high school students' learning and innovation skills so that students can apply their innovation to add economic value to community enterprises. Moreover, in order to generalize the research findings, future studies should expand the sample to other institutions with different characteristics as this study considered only a small sample from an extra-large size provincial high school, Thailand.

## Conflict of Interest

The authors declare that there is no conflict of interest.

## Acknowledgments

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