

# The Imagineering Learning Model with Inquiry-Based Learning via Augmented Reality to Enhance Creative Products and Digital Empathy

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## Abstract

The objectives of this research are (1) to study and synthesise the conceptual framework of the imagineering learning model with inquiry-based learning via augmented reality to enhance creative products and digital empathy, (2) to develop the imagineering learning model with inquiry-based learning via augmented reality to enhance creative products and digital empathy, and (3) to study the results after using the imagineering learning model with inquiry-based learning via augmented reality to enhance creative products and digital empathy. The participants in this research include seven experts from various institutions, all of whom are specialised in the design and development of instruction models and instruction systems. The research tools consist of (1) the imagineering learning model with inquiry-based learning via augmented reality, and (2) the evaluation form on the suitability of the imagineering learning model with inquiry-based learning via augmented reality. According to the results of this research, it is found that (1) the conceptual framework of this research includes instruction system, imagineering learning, inquiry-based learning, augmented reality technology, creative products, and digital empathy, (2) the imagineering learning model with inquiry-based learning via augmented reality consist of four factors, i.e., input factor, learning process, output, and feedback, and (3) the study of the results after using the imagineering learning model by seven participants shows that 3.1) the overall suitability of the development of the imagineering learning model with inquiry-based learning via augmented reality (overall elements) is at the highest level (Mean = 4.69, SD. = 0.47), and 3.2) the overall suitability of the development of the imagineering learning model with inquiry-based learning via augmented reality is at the highest level (Mean = 4.70, SD. = 0.46).

**Keywords:** imagineering learning with inquiry-based learning, augmented reality technology, creative products, digital empathy

## 1. Introduction

In pursuance of section 22 of the National Education Act B.E. 2542, education shall be based on the principle that all learners are capable of learning and self-development, and are regarded as being most important. The instruction process shall aim at enabling the learners to develop themselves at their own pace and to the best of their potentiality. According to section 66 of the same act, the learner shall have a right to receive competency development in using technology for education in the very first instance available so as to have sufficient knowledge and skills to use technology for education to seek knowledge by their own on a continuous lifetime basis (National Board of Education, 1999). In the 21<sup>st</sup> century, educators are particularly challenged when facing younger generations, as those generations are ICT savvy and exposed to diverse information sources. The use of ICT in education provides students with more learning possibilities in terms of content, methods and access (Chatwattana, Kanyawimon, & Jaipaitoon, 2022).

The application of learning technology in the virtual world combined with the physical world in learning management is regarded as a new dimension in the field of educational media as such instruction will encourage learners to have more interest and more enthusiasm to learn new things, create new experiences, and have more engagement in learning (Wannapiroon et al., 2021). Chatwattana et al. (2022) stated that interactive media can be adapted and employed in instruction management to help learners understand the lessons better because interactive media can interact directly with learners through computer technology and communication technology. Accordingly, learners are able to learn independently, control the work by their own, and interact

with others with real-time results.

Imagineering learning is a new concept of learning management that is intended to improve the characteristics of learners in the 21<sup>st</sup> century by promoting these learners to learn by themselves while equipping them with creative thinking skills and the ability to create innovations (Office of the Education Council, 2014; Partnership for 21<sup>st</sup> century Skills, 2008). The concept of imagineering learning consists of six steps, i.e., imagine, design, develop, present, improvement, and evaluate. The objective of this concept is to encourage self-learning, placing an emphasis on turning imagination into concrete inventions or innovations (Chatwattana & Nilsook, 2017).

Inquiry-based learning is a style of learning in which learners create new knowledge and new understanding by themselves, which can be done by connecting their experiences with their existing knowledge and understanding. Inquiry-based learning allows learners to scrutinize different arguments and doubts, which will give rise to questions which are then needed to be further explored. This way of learning encourages learners to have the skills in acquiring knowledge based on scientific principles. Thereby, there are five steps in inquiry-based learning, i.e., engagement, exploration, explanation, elaboration, and evaluation (Khemmani, 2010).

Augmented reality technology is a technology that combines reality and the virtual world by using devices and software to display three-dimensional images, graphics, and texts, which are overlaid with the physical world. Thereby, this technology can be employed through various devices such as computers, smartphones, tablets, wearable devices, etc. (Bojukrapan, 2018; Souththaboualy, Chatwattana, & Piriyaawong, 2022). Mixed virtual practice is an effective instructional media for use in learning environments as it can increase learners' interest and motivation and also improve their academic performance (Ditcharoen & Ratthirom, 2016; Yildirim, 2020). The research of Hanid et al. (2020) found that learning by means of interactive augmented reality technology via games can be used effectively in both teaching and learning.

Creative products refer to the design, invention, and development of a product based on creativity, and it is a unique product that possesses new characteristics.

Digital empathy is a skill related to the use of technology, including communication and interaction with other users, with ethics and good manners. If users have empathy, they will empathise and understand those who are different from them, and they will not be ignored when others are mistreated online or facing with cyberbullying (Chatwattana et al., 2022).

Referring to the aforementioned principles and theories, the researchers have had an idea to develop the imagineering learning model with inquiry-based learning via augmented reality with an intention to use it as a guideline for instruction management that can pave the way to creative learning, creative products, and digital empathy. These skills are believed to invigorate learners to create their own products while raising the awareness of ethics in the digital learning society.

## **2. Research Objectives and Hypothesis**

### *2.1 Research Objectives*

- 1) To study and synthesise the conceptual framework of the imagineering learning model with inquiry-based learning via augmented reality to enhance creative products and digital empathy.
- 2) To develop the imagineering learning model with inquiry-based learning via augmented reality to enhance creative products and digital empathy.
- 3) To study the results after using the imagineering learning model with inquiry-based learning via augmented reality to enhance creative products and digital empathy.

### *2.2 Research Hypothesis*

The suitability of the imagineering learning model with inquiry-based learning via augmented reality to enhance creative products and digital empathy is at the high level.

## **3. Methodology**

This research is related to the design and development of the imagineering learning model with inquiry-based learning via augmented reality to enhance creative products and digital empathy, and the research methodology includes the following.

### *3.1 Research Participants*

seven experts from various institutions specialised in the design and development of instruction models and instruction systems.

### 3.2 Research Tools and Statistics Used for Data Analysis

To develop the imagineering learning model with inquiry-based learning via augmented reality to enhance creative products and digital empathy, the researchers employed the following research tools, i.e., (1) the imagineering learning model with inquiry-based learning via augmented reality, and (2) the evaluation form on the suitability of the imagineering learning model with inquiry-based learning via augmented reality. The statistics used for data analysis are mean and standard deviation.

### 3.3 Research Methodology

The researchers designed the methodology based on the concepts and the theories of the system approach (Khemmani, 2010; Utranan, 1982) and based the design and the development of this model on SDLC technique (Robert et al., 2013). The methodology can be summarised into three steps as illustrated in Figure 1.

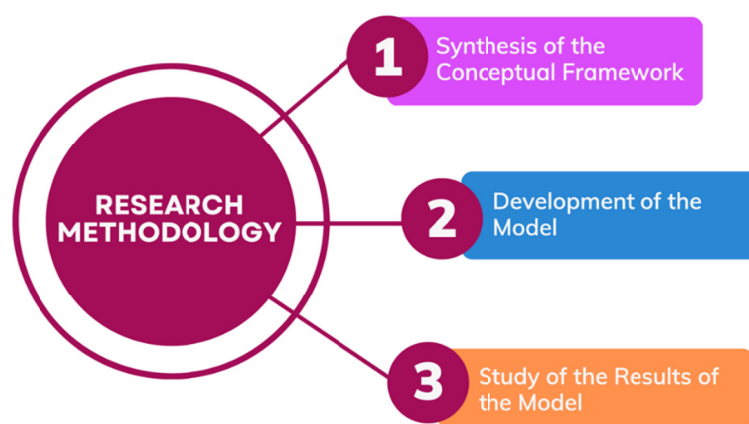


Figure 1. Research methodology

**Step 1** is related to the study, the analysis, and the synthesis of the literature works and research studies relevant to the development of the imagineering learning model with inquiry-based learning via augmented reality in order to find out the guidelines needed to establish the conceptual framework of this research, i.e., instruction system, imagineering learning, inquiry-based learning, augmented reality technology, creative products, and digital empathy.

**Step 2** is about the development of the imagineering learning model with inquiry-based learning via augmented reality. In this step, the researchers adopted the principles of system approach in the design and the development, which consist of four factors, i.e., input factor, learning process, output, and feedback.

**Step 3** is concerning the study of results after using the imagineering learning model with inquiry-based learning via augmented reality. The researchers used the research tools to study the results after this model had been used by seven participants derived by means of purposive sampling. These participants come from various institutions and all of them are all experts specialised in the design and development of instruction models and instruction systems. The mean score range and interpretation of results (Kanasutra, 1995) are listed in Table 1.

Table 1. Mean score range and interpretation of results

Average score range	Meaning of interpretation
4.50–5.00	The suitability is at the highest level.
3.50–4.49	The suitability is at a high level.
2.50–3.49	The suitability is at a moderate level.
1.50–2.49	The suitability is at a low level.
1.00–1.49	The suitability is at the lowest level.

## 4. Results

The results of the development of the imagineering learning model with inquiry-based learning via augmented reality to enhance creative products and digital empathy can be summarised as below.

#### 4.1 Results of the Synthesis of the Conceptual Framework of the Imagineering Learning Model with Inquiry-Based Learning via Augmented Reality to Enhance Creative Products and Digital Empathy

According to the study, the analysis, and the synthesis of the literature works and research studies relevant to the development of the imagineering learning model with inquiry-based learning via augmented reality, the researchers found out the guidelines needed to establish the conceptual framework of this research, i.e., instruction system, imagineering learning, inquiry-based learning, augmented reality technology, creative products, and digital empathy. The conceptual framework herein is illustrated in Figure 2.

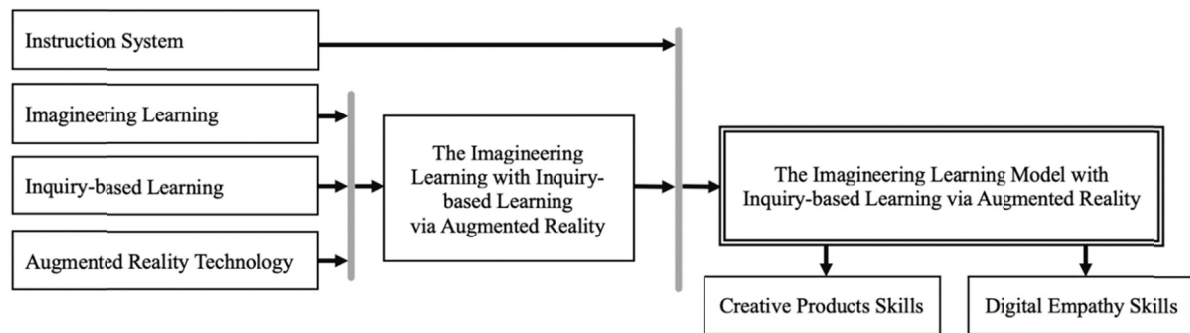


Figure 2. Conceptual framework of the imagineering learning model with inquiry-based learning via augmented reality to enhance creative products and digital empathy

#### 4.2 Results of the Development of the Imagineering Learning Model with Inquiry-Based Learning via Augmented Reality to Enhance Creative Products and Digital Empathy

The development of the imagineering learning model with inquiry-based learning via augmented reality to enhance creative products and digital empathy is intended to be used as a guideline to design and develop the imagineering learning system with inquiry-based learning via augmented reality to enhance creative products and digital empathy. The skills associated with the creation of creative products and digital empathy are considered the characteristics that are essential for future learners to make use of technology in an ethical manner, communicate and interact with other users with good manners. The design and development of this learning model are based on the system approach, which includes four elements, i.e., input factor, learning process, output, and feedback, as shown in Figure 3.

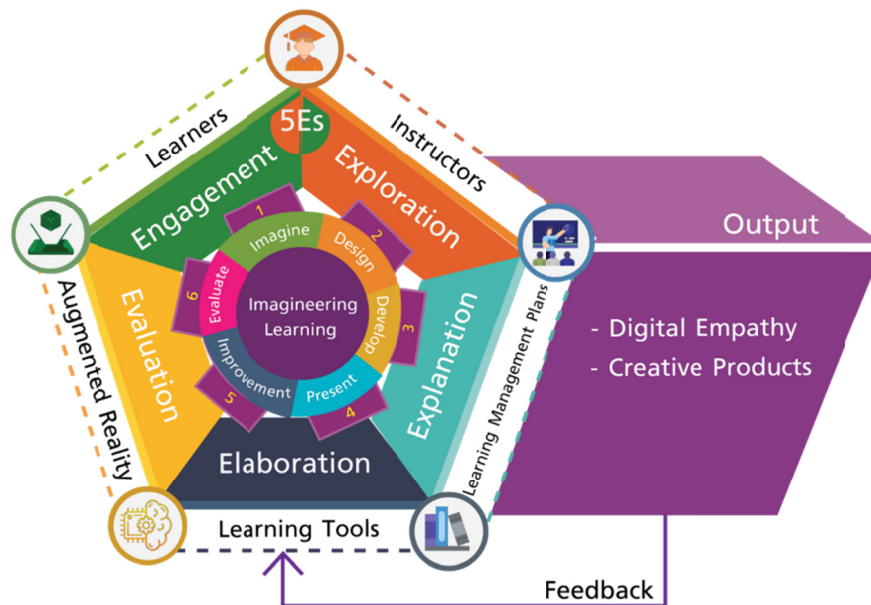


Figure 3. Imagineering learning model with inquiry-based learning via augmented reality to enhance creative products and digital empathy

Figure 3 represents the imagineering learning model with inquiry-based learning via augmented reality to enhance creative products and digital empathy, which consists of four main elements as follows.

- 1) Input factor: It refers to the elements relevant to instruction management, which includes analysis of characteristics of users (learners and instructors), learning management plans, learning tools, and augmented reality technology.
- 2) Learning process: The researchers had synthesised the six steps of the imagineering learning process (imagine, design, develop, present, improvement, and evaluate) along with the five steps of the inquiry-based learning process (engagement, exploration, explanation, elaboration, and evaluation), and then developed the learning process within the imagineering learning model with inquiry-based learning via augmented reality to enhance creative products and digital empathy.
- 3) Output: It refers to the outcome generated from the learning process, which is the skill to create creative products. This skill is concerning the ability to design, invent, and develop a product based on creativity, and it is a unique product that possesses new characteristics. The output also includes digital empathy, which refers to the skill related to the understanding and the utilisation of digital technology in an ethical manner.
- 4) Feedback: This refers to the information derived from the output, which is then used to enhance the learning process and the input factor. The feedback herein consists of the results of measurement on the skill to produce creative products and the skill related to digital empathy.

#### *4.3 Results of the Study on the Suitability of the Imagineering Learning Model with Inquiry-Based Learning via Augmented Reality to Enhance Creative Products and Digital Empathy*

In reference to the development of the imagineering learning model with inquiry-based learning via augmented reality to enhance creative products and digital empathy, the results can be concluded as seen in Tables 2 and 3.

Table 2. Results of evaluation on the suitability of the imagineering learning model with inquiry-based learning via augmented reality (overall elements)

Items for evaluation	Assessment results		Interpretation
	Mean	SD.	
1. The principles and concepts of the imagineering learning model with inquiry-based learning via augmented reality can be applied to develop the instruction system.	5.00	0.00	Highest
2. The elements of the imagineering learning model with inquiry-based learning via augmented reality cover all main elements required in the instruction system.	4.71	0.49	Highest
3. The theories of the imagineering learning model with inquiry-based learning via augmented reality are comprehensive and appropriate for designing the conceptual framework.	4.57	0.53	Highest
4. The sequence of elements in the design of the imagineering learning model with inquiry-based learning via augmented reality is clear and consistent.	4.71	0.49	Highest
5. The ordering of the elements in the imagineering learning model with inquiry-based learning via augmented reality is appropriate and easy to understand.	4.57	0.53	Highest
6. The overall elements in the imagineering learning model with inquiry-based learning via augmented reality are complete and can be used as a guideline to further develop the imagineering learning system with inquiry-based learning via augmented reality in the future.	4.57	0.53	Highest
Overall average	4.69	0.47	Highest

According to Table 2, it is found that the overall suitability of the development of the imagineering learning model with inquiry-based learning via augmented reality to enhance creative products and digital empathy (overall elements) is at the highest level (Mean = 4.69, SD. = 0.47). It can be concluded that the imagineering learning model with inquiry-based learning via augmented reality has all complete elements that can be used as a guideline to further develop the imagineering learning system with inquiry-based learning via augmented reality to enhance creative products and digital empathy, which are the characteristics that the learners in the 21<sup>st</sup> century and the digital era must have.

Table 3. Results of evaluation on the suitability of the imagineering learning model with inquiry-based learning via augmented reality

Items for evaluation	Assessment results		Interpretation
	Mean	SD.	
1. Input factor			
1.1 Analysis of characteristics of learners	4.86	0.38	Highest
1.2 Analysis of characteristics of instructors	4.57	0.53	Highest
1.3 Learning management plans	4.57	0.53	Highest
1.4 Learning tools	4.86	0.38	Highest
1.5 Augmented reality technology	4.57	0.53	Highest
2. Learning process			
2.1 Imagineering learning process	4.71	0.49	Highest
2.2 Inquiry-based learning process	4.57	0.53	Highest
2.3 Virtual media of augmented reality technology	4.86	0.38	Highest
3. Output			
3.1 Creative products	4.43	0.53	High
3.2 Digital empathy	4.43	0.53	High
4. Feedback			
4.1 Results of measurement on creative products skills	5.00	0.00	Highest
4.2 Results of measurement on digital empathy skills	5.00	0.00	Highest
Overall average	4.70	0.46	Highest

Table 3 shows that the overall suitability of the development of the imagineering learning model with inquiry-based learning via augmented reality to enhance creative products and digital empathy is at the highest level (Mean = 4.70, SD. = 0.46). This can be summarised that the imagineering learning model with inquiry-based learning via augmented reality contains the elements that are appropriate to be used as a guideline to further develop the imagineering learning system with inquiry-based learning. This can be conducted by using virtual media derived from augmented reality technology as a tool to promote learning and instruction activities,

which shall generate the skills to produce creative products and digital empathy.

## 5. Conclusion

In this research, the researchers have applied the principles, concepts, and theories, as well as the new teaching innovations in the 4.0 era, which are corresponding to the current situations, to develop the learning model in which learners are able to learn anywhere and anytime. The said learning model mainly encourages learners to generate learning experiences on their own, and equips them with skills and capability to set up their own learning plans and evaluate their learning results by themselves. The model also contains instruction activities that promote learning and interaction through the social network. According to the study, the analysis, and the synthesis on the literature works and research studies relevant to the development of the imagineering learning model with inquiry-based learning via augmented reality, the researchers found out the guidelines needed to establish the conceptual framework of this research, which includes instruction system, imagineering learning, inquiry-based learning, augmented reality technology, creative products, and digital empathy. According to the summary above, it is consistent with objective 1.

The imagineering learning model with inquiry-based learning via augmented reality to enhance creative products and digital empathy is a concept based on the application of technologies in the virtual world in the instruction management, which is complying and appropriate to the learners in this digital age. The model consists of four main elements: (1) Input factor refers to the analysis of characteristics of users (learners and instructors), learning management plans, learning tools, and augmented reality technology. (2) Learning process refers to the learning process within the imagineering learning model with inquiry-based learning via augmented reality. It is developed from the integration of the six steps of the imagineering learning process (imagine, design, develop, present, improvement, and evaluate) and the five steps of inquiry-based learning (engagement, exploration, explanation, elaboration, and evaluation) with an aim to promote the skills to produce creative products and digital empathy. (3) Output refers to the skill to produce creative products and the skill concerning digital empathy. (4) Feedback refers to the results of measurement on the skill to produce creative products and the skill related to digital empathy. According to the summary above, it is consistent with objective 2.

Regarding the results of evaluation on the suitability of the Imagineering learning model with inquiry-based learning via augmented reality to enhance creative products and digital empathy, it is found that (1) the overall suitability of the development of the imagineering learning model with inquiry-based learning via augmented reality (overall elements) is at the highest level (Mean = 4.69, SD. = 0.47), and (2) the overall suitability of the development of the imagineering learning model with inquiry-based learning via augmented reality is at the highest level (Mean = 4.70, SD. = 0.46). In reference to the evaluation results above, it can be concluded that the imagineering learning model with inquiry-based learning via augmented reality to enhance creative products and digital empathy contains the elements that are appropriate to be used as a guideline to further develop the imagineering learning system with inquiry-based learning. This can be conducted by using virtual media derived from augmented reality technology as a tool to promote learning and instruction activities, which shall generate the skills to produce creative products and digital empathy. It is corresponding to Chatwattana (2021), who said the application of system approach theories in the design and the development of this model together with the management of learning environments in a way that can facilitate learners with the aid of existing technologies shall create a learning society in digital universities. Moreover, this study is in accordance with the research of Jularlark, Chatwattana, & Piriyasurawong (2021), who applied the design and development process based on SDLC technique in the design and development of instruction systems, resulting in the complete elements that could enhance the system efficiency and the satisfaction of users. In addition, it is in line with the research of Nilsook, Chatwattana, & Seechaliao (2021), who said the project-based learning management, of which the concepts are similar to those of imagineering learning, is consistent with the development of learners in vocational education in Thailand. Thereby, the said instruction management is believed to generate the skills to create inventions and innovations, as well as the characteristics associated with presentation, discussion, communication, originality, discretion, creativity, and collaborative working skills. According to the summary above, it is consistent with objective 3.

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