Imagineering on Augmented Reality and Digital Twin for Digital Competence

Akekathed Sanglub, Prachyanun Nilsook, and Panita Wannapiroon

***Abstract*—Information technology in the age of industry and design, there are contents which are driven along with class management and business that have been applying digital technology to increase the efficiency and value for products and workings including making creative economy with digital aptitude. Currently, the utilizing smart device is circulated as many organizations have been making many applications to create competitive inventors – they can help organization to increase competency, product and working with less consuming resources but high value gathering both product and service. This article would like to present new way of digital competency development following 1) Imagineering Approach which consisted of the six following steps: 1. imagination, 2. design, 3. development, 4. presentation, 5. improvement, and 6. evaluation; 2) the Augmented Reality and Digital Twin Environment consisted of six factors: 1. Imagine the possibilities; 2. Study by digital twin technique; 3. Procedures for Identifying Specific Learning; 4. Learning efficiency enhancement; 5. Industrialize the process.; 6. Monitor and measure. The author presents the framework of Augmented Reality and Digital Twin (ARDT) for development digital competence.**

***Index Terms*—Imagineering, augmented reality, digital twin, digital competence.**

I. Introduction

In recent years, many researchers have applied the model of inventor development from several ideas. Imagineering is Engineering and Sciences knowledge integration to create creative innovation which we can call Imagineering who takes responsibility for creating innovative product which support economy and adding value from idea and design including applying other sciences such as e-commerce content to compete in world market.

In this study, the author has applied the idea of Imagineering to develop process of Imagineering by Augmented Reality and Digital Twin concept that represent the convergence of the physical and the virtual world where every industrial product will get a dynamic digital representation, throughout, the product development life cycle, right from the design phase to the deployment phase, organizations can have a complete digital foot prints of their products. These "connected digital things" generate data in real time, and help businesses in better problems analysis and prediction in advance or give early warnings to prevent downtime and develop new opportunities, and even, planning better products for the future with lower costs by using simulations to encourage the process of making Digital Competence for Creative Content makers who create things to drive creative design together with the creation of the ARDT – showed the significant value in the areas of speed to market with a new product, improved operations, reduced defects, and emerging new business models to drive more revenue.

Manuscript received April 10, 2018; revised September 23, 2018.

A. Sanglub is with the Division of Information and Communication Technology for Education in Faculty of Technical Education, King Mongkut's University of Technology North Bangkok Thailand (e-mail: akekathed.s@sskru.ac.th)

P. Nilsook and P. Wannapiroon are with the Faculty of Technical Education, King Mongkut's University of Technology North Bangkok (KMUTNB), Bangkok, Thailand (e-mail: prachyanun.n@fte.kmutnb.ac.th, panitaw@kmutnb.ac.th).

II. Literature Review

A. Imagineering

Imagineering is a combining the words between imagination and engineering. The term, Imagineering, was coined during the early 1940s. Since the beginning of new Millennium, Imagineering has grown to the scale of a mass paradigm, because of the increasing scope and availability of automated engineering. Automated engineering is enabled by sophisticated software and artificial intelligence. [1] Imagineering in education was found that the imagine step developed the ability to identify problems, the study step developed the ability to seek new knowledge, the design step developed the ability to apply knowledge, the develop step enhanced the ability to solve problems, the present step developed the ability to communicate and the evaluate step developed. [2] The Imagineering in business approaches can provide adequate responses to the changes, in particular, the relevance of Imagineering as an event design strategy within business event. [3]

B. Augmented Reality

Augmented Reality has strong potential to provide both powerful contextual, on-site learning experiences and serendipitous exploration and discovery of the natural connected information in the real world. Augmented Reality experiences to not only corporate settings but also academic venues through personal computers and mobile devices, several educational approaches with AR technology are more feasible. [4] Professionals and researchers have been developing pragmatic theories and applications for the adoption of Augmented Reality into both academic and corporate settings. By virtue of those studies, some innovations of Augmented Reality have been developed and are being used to enhance the education and training efficiency of students and employees. [4] Augmented Reality that most distinguishes it from other existing technologies is the media power of generating a "mixed reality" wherein the

doi: 10.18178/ijiet.2019.9.3.1201

surrounding environment is real but the objects portrayed in the environment are virtual. For example, timing of purchase would be important, as consumers who are about to purchase certain products may be more highly involved and more likely to employ more extensive and more readily accessible information sources. Constructs such as need for cognition or need for emotion may also be interesting to explore in that some consumers are more dependent on visualized information. [5] Augmented Reality e-commerce may be useful for home improvement store chains that offer products and services. Initially, environmental data that includes spatial data or image data may be received from scanning sensors in which the Augmented Reality environment may present a three-dimensional (3D) virtual representation of the specific product. [6]

C. Digital Twin

Digital Twin is an emerging and effective method for real-time interaction and further convergence between physical space and information space. To solve the problems mentioned above, digital twin-driven product manufacturing will be discussed in this section. [7] The technologies mainly focus on physical product data rather than the data from virtual models. On the one hand, data generated in various phases of the whole product lifecycle may form the information between different phases of product lifecycle. And on the other hand, a lot of duplicate data exists to solve the problems, Digital Twin, with the characteristics of ultrahigh synchronization and fidelity and convergence between physical and virtual product, etc., has high potential application in product design, product manufacturing, and product service. [7] Digital Twin simulation tools enable designers to accurately predict performance earlier in the design cycle, to analyze multiple designs, reduce reliance on multiple physical prototypes and expensive testing, optimize design for maximum performance and shorten design time and cost. [8]

D. Digital Competence

Digital Competence framework, propose a description a list of competences that belong to every competence; Digital Competence to access and search for online information, to articulate information needs, to find relevant information; to select resources effectively; to navigate between online sources; to create personal information strategies and interact through a variety of digital devices and applications; to understand how digital communication is distributed, displayed and managed; to understand appropriate ways of communicating through digital means, refer to different communication formats; to adapt communication modes and strategies to the specific audience and create content in different formats including multimedia; to edit and improve content that s/he has created or that others have created; to express creatively through digital media and technologies and protect own devices and to understand online risks and threats; to know about safety and security measures, and identify possible technical problems and solve them; to create content innovation in the education and the business; and etc. [9]

III. Purpose of the Study

The purpose of the study is to synthesize and design the conceptual framework of Imagineering on Augmented Reality and Digital Twin for Digital Competence.

IV. Methodology

The research methodology designing Imagineering on Augmented Reality and Digital Twin for digital competence were as follows.

1) Complete a review of related literatures on the Imagineering process written by [1], [2], [3], [10]-[15], and create a new process of Imagineering.
2) Synthesize documents in the Augmented Reality and Digital Twin environment which consists of [4]-[8], [16]-[20],
3) Develop the conceptual framework of Imagineering Augmented Reality and Digital Twin for Digital Competence. [19]

V. Result

Document synthesis in the Imagineering process can help the author to create a new process called the Imagineering process which consists of the six following steps: 1) Imagination: the ability to come up with topics of interest using brain-storming and imagination,- which results in a topic that all group members are interested in; 2) Design: the ability to research from documents or experts including the implementation of planning and designing the task by sketching or drawing a storyboard, for example, to achieve the prototype model; 3) Developing: the ability to work step by step; 4) Presentation: the ability to prove the group's work empirically to the public by presentation method; 5) Improvement: the ability to improve or adjust and summarize work done together; and 6) Evaluation, the ability to evaluate work quality and consider own output - the group's output, and whether the finished work is satisfying. All six aspects focus on the self-learning process by actualizing students' imagination into practical and objective inventions or innovations, [2] consequently they are able to arrive at well-thought judgment of what action or tool should be used to fill in what lacks. To become creative in producing outputs they are almost always successful, it is trusted that starting with having bright speculative meanings of new concepts could bring about ways and means to arrive at a valid generalization. [10]

The document synthesis in the Augmented Reality and Digital Twin, following [5], [7], [11], [12], [16]-[18], [20] is show in Table I.

Document in the Augmented Reality process and the Digital Twin process were synthesized to create a new process called ARDT. According to Table I. the synthetic of ARDT has six important characteristics; 1) imagine the possibilities; 2) study by digital twin technique; 3) procedures for identifying specific learning; 4) learning efficiency enhancement; 5) industrialize the process; 6) monitor and measure.

TABLE I: THE SYNTHETIC AUGMENTED REALITY AND DIGITAL TWIN (ARDT)

The Process of Augmented Reality and Digital Twin [ARDT]	AR Process				DT process			
	[16]Chang, K. E. and Other (2017)	[12] Techakosit and Nilsook (2016)	[18] Chiang, T.H. and Other (2014)	[5] Yim, M. Y. C. and Other (2017)	[20] Parrott and Warshaw (2017)	[7] Tao, F. and Other (2018)	[11] Grieves, M.,& Vickers, J. (2017)	[17] Boschert, S. & Rosen, R. (2016)
1. Imagine the possibilities		✓	✓		✓		✓	✓
2. Study by digital twin technique	✓	✓	✓	✓	✓	✓	✓	✓
3. Procedures for Identifying Specific Learning	✓	✓	✓	✓	✓	✓	✓	✓
4. Learning efficiency enhancement	✓	✓	✓	✓	✓	✓	✓	
5. Industrialize the process.		✓	✓	✓	✓	✓	✓	✓
6. Monitor and measure.	✓	✓	✓	✓	✓	✓	✓	✓

Imagine the possibilities, the first step would imagine and make shortlist a set of scenarios that could gain benefit from having Digital Twin. The right scenario may be different for every organization and circumstance, but will likely have following key characteristics: 1) the considered production or manufacturing process is valuable enough for the enterprise to invest for building a Digital Twin. 2) There are outstanding and unexplained processor product-related issues that could potentially unlock value either for the customers or the enterprise. [20] To achieve deeper phases of knowledge construction and inquiry abilities, however, small groups or teams who work together may achieve greater efficacy in a manner that promotes the learnt responsibility for their own learning as well as the learning of others, in terms of future studies. [18]

Study by Digital Twin technique, the Digital Twin learning is usually written in the primary system language of the enterprise, which uses the above steps to model of the physical asset and processes. In addition, throughout the process, standards and security measures may be applied for purposes of data management and interoperable connectivity. [20] Applications of ARDT in the development of teaching strategies-establishment of a teaching environment, improvement of learning effectiveness, application of psychological factors- related to learning, and other related research. [16]

Procedures of Identifying Specific Learning consider operation business, and organizational change management factors in identifying which configurations could be best candidates. Focus on which areas have potential to scale across equipment, sites, or technologies. Companies may face challenges going too deep into a specific Digital Twin of a highly. Complex equipment or manufacturing process, while the ability to deploy broadly across the organization tends to drive the most value and support: focus on going broad rather than deep. [20] Other interesting of ARDT variables, for example, timing of purchase would be important as consumers who are about to purchase certain products may be more highly involved and more likely to employ more extensive and more readily accessible information sources. [5]

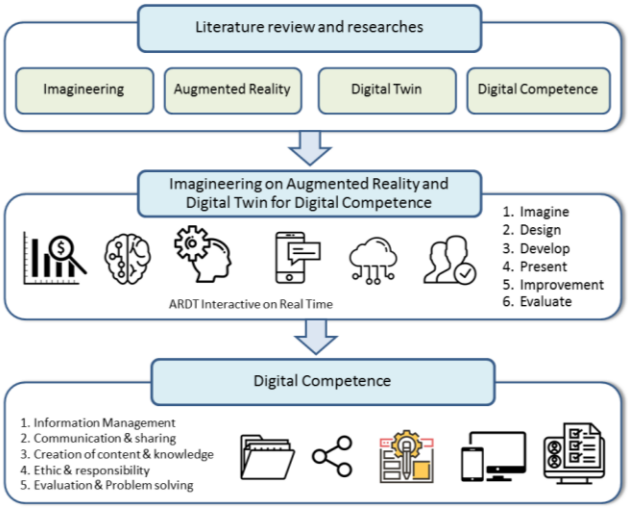

Fig. 1. Conceptual framework of imagineering on augmented reality and digital twin for digital competence.

Learning efficiency enhancement, ARDT can be used for enhancing the effectiveness of content and teaching in the traditional style including extending the context outside the classroom rather than just using textbooks. ARDT can also assist learners in understanding details with a shorter learning time. [12] For business Consider accelerate learning, manage risk proactively and maximize return on initial investments, can be a subset of business divisions, or products to limit scope, but with the ability to show value to the enterprise. While you should want to be agnostic to any type of data sources (for example, new sensors and external data sources), you also need a solution that can support the expansion of an end-to-end solution as soon as the initial value is delivered, consider building on this momentum to continue the drive for greater results which communicate the value realized to the larger enterprise. [20]

Industrialize the process, The Digital Twin development and deployment process use established tools, techniques, and playbooks. Manage expectations from the pilot team and other, [20] the virtual product should reflect the real-time state of the physical product in the real world. Moreover, Digital Twin also enables the physical product and virtual product to communicate with each other in real-time and coevolve with each other over time, [7] the phases of creation and production are realized during the operational phase with many of those problematic issues due to human interaction. We propose that the idea of the Digital Twin, which links the physical system with its virtual equivalent which can mitigate these problematic issue. [11]

Monitor and measure solutions should be monitored to objectively measure the value delivered through the Digital Twin. Identify whether, there were tangible benefits in cycle time, yield throughput, quality, utilization, incidents, and cost per item, among others which make changes to digital twin

processes iteratively, and observe results to identify the best possible configuration. [20] In this sense, simulation merges the physical and virtual world in all life cycle phases. Current practice already enables the users to master the complexity, [17] can create content, create innovation.

According to the process of Imagineering and Augmented Reality and Digital Twin Environment synthesis, it is possible to present the conceptual framework of Imagineering on Augmented Reality and Digital Twin for Digital Competence, as show in Fig. 1.

VI. Conceptual Framework

The author studied, analyzed, and synthesized the relevant document and research by integration different theories in order to create conceptual framework of Imagineering on Augmented Reality and Digital Twin for Digital Competence (ARDT) that could be applied to develop the Digital competence, the synthesis of the conceptual framework of ARDT consisted of three elements, 1) literature review and researches: the synthesized conceptual framework was the designed based on the integration of the following theories: Imagineering, Augmented Reality, Digital Twin and Digital Competence.

2) Imagineering on Augmented Reality and Digital Twin included: 1) imagine; 2) Design; 3) Develop; 4) Present; 5) Improvement; 6) Evaluate. for Digital Competence: according to the integration of the relevant theories and researches, the conceptual framework of the Imagineering on Augmented Reality and Digital Twin for Digital Competence as shown in Fig. 1

3) Imagineering on Augmented Reality and Digital Twin for develop Digital Competence on the integration the study is such as 1) Information Management; 2) Communication & Sharing; 3) Creation of Content & Knowledge; 4) Ethic & Responsibility; and 5) Evaluation & Problem Solving. [19]

VII. Conclusion

This paper presents a comprehensive design framework that focuses on connecting Augmented Reality and Digital Twin concept that represents the convergence of the physical and the virtual world expectation to be most useful for the iterative redesign of an existing product instead of the novel design or a completely new product.

According to the document analysis that is associated with the process of Imagineering on Augmented Reality and Digital Twin for Digital Competence. The process of Imagineering on Augmented Reality and Digital Twin for Digital Competence (ARDT) consists of six phases; 1) imagine; 2) Design; 3) Develop; 4) Present; 5) Improvement; 6) Evaluate, for Digital Competence.

Acknowledgment

This research received a partial thesis research grant for graduate student from the Graduate College at Kink Mongkut's University of Technology North Bangkok I gratefully acknowledge support from the Faculty of Technical Education, Research Centre for Vocational Education Technology, Institute Research of Science and Technology, at King Mongkut's University of Technology North Bangkok (KMUTNB)..

References

[1] S. Fox, "Mass imagineering: Combining human imagination and automated engineering from early education to digital afterlife," *Technology in Society*, vol. 51, pp. 163-171, 2017.

[2] P. Nilsook, N. Utakrit, and J. Clayden, "Imagineering in education: A framework to enhance students' learning performance and creativity in thinking," *Educational Technology*, pp. 14-20, 2014.

[3] F. Ouwens, "The role of Imagineering as an event design strategy in the business event industry," *Event Design: Social Perspectives and Practices*, pp. 37-49, 2014.

[4] K, Lee, "Augmented reality in education and training," *TechTrends*, vol. 56, no. 2, pp. 13-21, 2012.

[5] M. Y. C. Yim, S. C. Chu, and P. L. Sauer, "Is augmented reality technology an effective tool for e-commerce? An interactivity and vividness perspective," *Journal of Interactive Marketing*, pp. 89-103, 2017.

[6] D. Morrison, *U.S. Patent Application No. 15*, pp. 273, 425, 2017.

[7] F. Tao, J. Cheng, Q. Qi, M. Zhang, H. Zhang, and F. Sui, "Digital twin-driven product design, manufacturing and service with big data," *The International Journal of Advanced Manufacturing Technology*, vol. 94, no. 9-12, pp. 3563-3576, 2018.

[8] S. Ferguson, E. Bennett, and A. Ivashchenko, "Digital twin tackles design challenges," *World Pumps*, 2017, pp. 26-28, 2018.

[9] A. Ferrari, "DIGCOMP: A framework for developing and understanding digital competence in Europe," 2013.

[10] D. M. Balajadia, "Imagineering: Fostering constructivism among pre-service teachers," in *Proc. 2017 3rd International Conference in Science in Information Technology (ICSITech)*, pp. 447-452, 2017.

[11] M. Grieves and J. Vickers, "Digital twin: Mitigating unpredictable, undesirable emergent behavior in complex systems," *Transdisciplinary Perspectives on Complex Systems*, pp. 85-113, 2017.

[12] S. Techakosit and P. Nilsook, "The learning process of scientific imagineering through AR in order to enhance STEM literacy," *International Journal of Emerging Technologies in Learning (iJET)*, vol. 11, no. 07, pp. 57-63, 2016.

[13] J. Trowsdale, "Imagineering: Re-Creating spaces through collaborative art-making. Creativity," *Theories–Research -Applications*, vol. 3, no. 2, pp. 274-291, 2016.

[14] S. Techakosit and P. Nilsook, "The development of STEM literacy using the learning process of scientific imagineering through AR," *International Journal of Emerging Technologies in Learning (iJET)*, vol. 13, no. 1, pp. 230-238, 2018.

[15] F. Qiyue, *Imagineering*, 2013.

[16] K. E. Chang, J. Zhang, and T. C. Liu, "Workshop on virtual, augmented and mixed reality in education (VAMrE 2017) summary," in *Proc. 2017 IEEE International Symposium In Mixed and Augmented Reality (ISMAR-Adjunct)*, pp. 293-293, 2017.

[17] S. Boschert and R. Rosen, "Digital twin — The simulation aspect," *In Mechatronic Futures*, pp. 59-74, 2016.

[18] T. H. Chiang, S. J. Yang, and G. J. Hwang, "Students' online interactive patterns in augmented reality-based inquiry activities," *Computers & Education*, vol. 78, pp. 97-108, 2014.

[19] A. Ferrari, "Digital competence in practice: An analysis of frameworks," 2012.

[20] A. Parrott and L. Warshaw, "Industry 4.0 and the digital twin," 2017.

Akekathed Sanglub was born in Sisaket province, Thailand, on June 5, 1983. He is a Ph.D. candidate in information and communication technology for education, Faculty of Technical Education, King Mongkut's University of Technology North Bangkok (KMUTNB) Bangkok, Thailand. A master of education degree program in educational technology, Srinakharinwirot University, Thailand in 2009 and the bachelor degree in computer education, Sisaket Rajabhat University, Thailand in 2005. He worked at the Faculty of Education, Sisaket Rajabhat University, Sisaket, Thailand from 2012 to present. Mr. Sanglub'a research focus on active learning environment, augmented reality, digital twin, digital competence and digital literacy.

Prachyanun Nilsook is an associate professor at the Division of Information and Communication Technology for Education, King Mongkut's University of Technology North Bangkok (KMUTNB) Thailand. He currently works in the field of ICT for education. He is a member of Professional Societies in the Association for Educational Technology of Thailand (AETT).

Assoc. Prof. Nilsook research topics and interests include instructional design, e-learning, e-training, ICT management, ICT in education, knowledge management in higher education, human performance technology and imagineering.

Panita Wannapiroon is an assistant professor at the Division of Information and Communication Technology for Education, King Mongkut's University of Technology North Bangkok (KMUTNB) Thailand. Presently she works in the field of ICT in education. She is a member of Professional Societies in the Apec Learning Community Builders, Thailand (ALCoB), and Association for Educational Technology of Thailand (AETT).