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Editorial Statement

As an editor in chief of International Journal of Industrial Education and Technology (IJIET), I would like to welcome and present you the second issue which is mainly to offer the research contents and articles in the fields of industrial education including education and technology. IJIET is consisted by three contents which are review article, book review, and research articles, respectively. For this IJIET issue, I would like to invite you to read all interesting contents authored by the professional and intelligent group of writers who are volunteers to share their outcomes of research and professional discussions.

On behalf of the editorial boards, I would like to sincerely delight to thank you very much for your kindly support. If you would like to make us the comments and give us the suggestions regarding on this issue, I would be appreciated and sincerely accepted that to make things better.

With best regards,
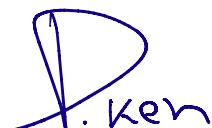
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Editor in Chief
International Journal of Industrial Education and Technology (IJIET)

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Review Article

Review of Esports and Video Game Research with Analysis of "Among us" Game Casting

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ABSTRACT

Although research in esports is getting more attention, both in quantity and in scope, the number of publications is still low compared to other important themes. This article aims at introducing researchers from different fields to esports research, thus inspiring more interdisciplinary research regarding this exciting topic. In addition, the article analyzes the currently popular game of "Among Us" in the context of law and criminology. Along this direction, online game streaming and casting are suggested as a means for data collection in qualitative research.

Keywords: Esports; Qualitative research; Game streaming; Game casting, Artificial intelligence (AI)

1. INTRODUCTION

Around the beginning of this millennium, video games have established themselves as a new kind of sports, called esports. Instead of playing for fun, video games become more competitive and serious. For some researchers, they are not only serious, but also interesting enough for research.

When watching esports games or video game streaming, we are often awed by players' hand-eye coordination as well as their speed of thought. We may feel that we cannot make it that way ourselves. How can we research about it?

For the moment, let us put aside the aspect of hand-eye coordination and focus on the strategy aspect of the game. As researchers, we have time to observe and analyze the essence of the games we choose. Once the essential principles are within our grasp, we can choose which moves to make and when to make them. Then we can imagine developing computer programs in order to beat the best professional game players, in the same way IBM's Deep Blue beat Garry Kasparov in chess or DeepMind's AlphaGo beat Lee Sedol in Go.

Although research in artificial intelligence (AI) or informatics mentioned in last paragraph is probably one of the first area of esports research that one can think about, most research are in other disciplines. According to Table 1, until the year 2018, esports research publication in the field of informatics accounted for only one-fifth of the whole esports research corpus. The field of media studies took the largest proportion with 24.7%, business came third and sports science came fourth with 17.3% and 13.3%, respectively. If we combine sociology and law together as social science, they took as much as 18% proportion [1].

Table 1 Distribution of Esports Research Corpus Per Area of Study Through March 2018 [1]

Discipline	Number of Publications	Percentage of Corpus (%)
Media Studies	37	24.7
Informatics	30	20
Business	26	17.3
Sports Science	20	13.3
Sociology	15	10
Law	12	8
Cognitive Science	10	6.7

We can also see that, with a common theme of esports, various disciplines with different research methodologies are involved. In this article, however, we focus on qualitative research, discussed in detail in Section 5. Prior to that Section, the growth of esports, different types of esports and gamers, as well as some inspiring AI research are discussed in Sections 2-4.

In Section 6, the author chooses one of the most currently popular game, "Among Us," as a special case and discusses a possible research direction in law and criminology in Section 7. In Section 8, the author proposes the use of game streaming and casting as a data collection method for qualitative research with an example. Then, the last section concludes this article.

2. THE GROWTH OF ESPORTS

Nowadays, the video game industry is one of the most steadily growing markets, gaining hundreds of billion dollars each year with the growth of approximately 6.2% [2].

High-speed communication in the Internet has enabled real-time online gaming and high-quality live streaming of videos. This leads to the emergence of new professions, such as e-sportspersons and video game casters. Like traditional sportspersons, e-sportspersons compete with one another in sporting events, from which they receive prize money. Video game casters, on the other hand, functions like sports commentator who explains the audience what happens in the game. Some casters in YouTube channels can even make comments about their own games while they are playing non-competitively.

World Cyber Games (WCG), sometimes called Esports Olympics, had been held for two decades since the year 2000 and become more popular each year until the year 2014, when it was halted. The event re-established itself in 2019 in Xi'an, China. This year, the event took place online due to the COVID pandemic. Apart from WCG, there are popular North American events such as Championship Gaming Series (CGS) and Major League Gaming (MLG) [3].

Figure 1. World Cyber Games 2004 at the Bill Graham Civic Auditorium in San Francisco. [4]

3. GAMERS, GAME STREAMERS, GAME CASTERS, AND ESPORTS VIDEO GAMES

"Gamers" is the word used for those who play video games, often as their profession. Other two technical terms widely used are game caster and game streamer. Game streamers are gamers who live broadcast their games while playing. Unlike game streamers, game casters may do more than them by recording the games into interesting videos available online, e.g., in YouTube.

Good casters have their unique style of narrating their games to make audience more emotionally engaged. They also edit their videos to make them more interesting. It is not unusual for a famous caster to be viewed millions of times on YouTube within a few days after publishing his or her videos.

Not every popular video game is suitable for esports. Video games is a generic term used for all types of games played on and used by some kind of screen. Among a vast amount of video games developed, only some are selected for esports tournaments. Examples of established esports games include SC2, CS:GO, Halo 4, SSF4, LoL, and FIFA12 [5]. Based on their study on the next generation of esports infrastructure, Rai and Yan gave the following conclusion [6].

"Usually, e-Sports put a higher demand on the players' abilities than common computer games, not only superb coordination capacity between hands and eyes, rapid response capacity and skillful handling capacity of mouse and keyboard, but also complex strategic and tactical thinking ability."

4. ROLES OF ARTIFICIAL INTELLIGENCE (AI) IN VIDEO GAMES

In December, 2017, AlphaZero (AZ), a computer program developed by an AI research company named DeepMind, showed that it could teach itself to beat best players in chess, Go, and Shogi. Note, however, that all of the aforementioned best players in three games are not human beings. They are all computer systems named Stockfish, elmo, and AlphaGo Zero, respectively.

The supremacy of artificial intelligence (AI) in board game starts with the breakthrough achieved by Deep Blue, a chess playing computer developed by IBM. In May 1997, Deep Blue became the first computer to beat the reigning world champion, Garry Kasparov, in chess. This win was seen as a sign that artificial intelligence was catching up with human intelligence [7].

DeepMind stated in its preprint, "The game of chess represented the pinnacle of AI research over several decades. State-of-the-art programs are based on powerful engines that search many millions of positions, leveraging handcrafted domain expertise and sophisticated domain adaptations. AlphaZero is a generic reinforcement learning algorithm – originally devised for the game of go – that achieved superior results within a few hours, searching a thousand times fewer positions, given no domain knowledge except the rules [8]."

In May 2017, AlphaGo did similar thing to Deep Blue by beating the world champion Ke Jie, but this time the game was Go instead of chess [9]. In the same year, deep reinforcement learning is applied to "Doom," a more complicated, 3-dimensional, first-person shooter video game [2], [10].

Figure 2. World Cyber Games 2004 at the Bill Graham Civic Auditorium in San Francisco. [11]

In addition, if we consider some other strategic video games, such as "Among Us," we can easily see that the complexity far exceeds the board game of Go and chess. To begin with, the problem formulation is much more difficult because there are several ways to win the game. The player can move almost arbitrarily as opposed to the regulated move within designated square.

Therefore, since the board game is now completely conquered, it is interesting for AI to enhance its research horizon to more complicated video games.

5. QUALITATIVE RESEARCH AND ESPORTS

Qualitative research is an important research type with established and reliable methodology, applicable to a large span of disciplines. In Table 1, almost all disciplines of esports research publication relies heavily on qualitative procedures.

There are several strategies of inquiry used in qualitative research. Creswell discussed five of them, namely, ethnography, grounded theory, phenomenological research, narrative research, and case studies [12].

5.1 Research in Business

The business discipline concerns exploring motivations for esports consumption, understanding the networks and organizations surrounding players, and designing effective marketing techniques. The esports research publications are found in quantitative approach using surveys and case studies as well as qualitative one using grounded theory as the strategies of inquiry [13], [14], [15].

5.2 Research in Sports Science

Most qualitative research of esports in sports science use case studies as the strategies of inquiry. For example, Rambusch, Jakobsson, and Pargman [16] conducted interviews with players at World Cyber Games (WCG) and discussed important elements shaping and influencing gameplay in Counter-Strike on four levels: player actions during play, interactions within and between teams, players and fans on the Internet, and the Counter-Strike gaming scene [1].

5.3 Research in Cognitive Science

Research in cognitive science and psychology focuses on player performance as well as cognitive and behavioral differences between novices and experts. The qualitative research works use case studies and grounded theory as the strategies of inquiry. They collected data from naturalistic observations to better understand the cognitive processes required for competitive play [17], [18].

5.4 Research in Informatics

Qualitative esports research is not the majority in this field. Many publications focus on developing sophisticated processes of data collection using information technology, including physiological data collection [19], text mining [20], and players' input from esports matches such that the data can later be used for machine learning [21].

However, qualitative investigation using case studies and collecting data from interview can be found in [22], [23]. In [22], Freeman and Wohn interviewed esports player to understand how they give and receive social support among themselves. In [23], the researchers conducted interviews of esports players to provide qualitative context for their quantitative findings, the performance metrics in the LoL game.

6. CASE STUDY: AMONG US

In order to study strategies used in video games, we focus on "Among Us" due to its popularity. The popularity partly stems from its appeal to human intuitive mechanism of finding out who belongs to our side, whom we should trust and who lies to us.

Just imagine yourself with a group of astronaut colleagues in a spaceship with two serial killers and try to survive. You feel terrified, don't you? That's the essence of the game "Among Us," in case you are chosen to be a "crewmate" (good guy). If you listen to game casting, you'll often hear such things as "will he kill me?" or "that guy walks strangely." But since it is just a game, these words are somehow spoken while laughing at the same time.

"Among Us" is a game of 4-10 players of which objectives can be briefly summarized as follows. A spaceship consists of crewmates and imposters. If you are imposters, you win by killing all crewmates. If you are crewmates, you win by completing all tasks or vote out all imposters. For crewmates, you can discuss with other spacemen to find out who imposters are. This, however, can only be done in two occasions, either when a corpse is found or an emergency button is pressed. Note that the roles of crewmates and imposters are randomly assigned just before the game starts.
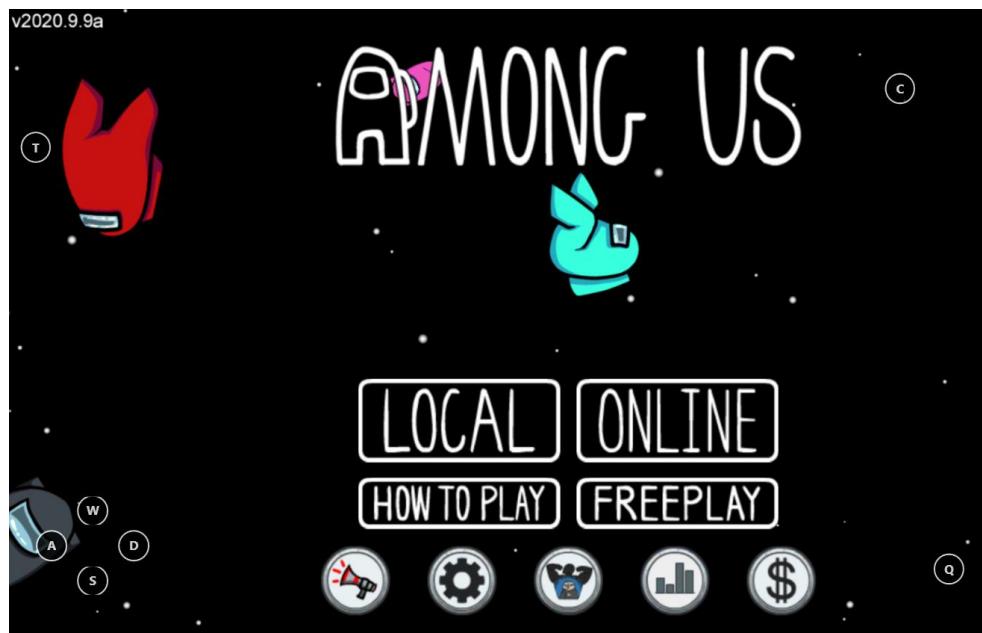
Figure 3. Capture of "Among Us" Introduction Screen.

7. AMONG US' RELATIONSHIP TO LAW AND CRIMINOLOGY RESEARCH

In "Among Us," once a corpse is reported or the emergency button is pressed, all players can discuss about the situation and decide whom will be voted out of the spaceship. The discussion can resemble a non-traditional courtroom where everybody can simultaneously be the prosecutor, defendant, lawyer, detective, witness, and judge. However, when a group of players play together so many games, they will become attached to a specific role. Any behavior that is deviant from that role will be suspiciously observed by others, for example, a "detective" who suddenly stops asking questions in a particular game.

In research related to criminal interrogations and crimes in the court, game theory is frequently applied to analyze the players' rational choices in strategic situations. In "Among Us," as players discuss about which players should be voted out, each player's welfare depends on his/her as well as other players' strategies, words, and actions.

In the following, we will summarize the essence of real-world crime, comparing it with that in the game "Among Us."

7.1 Asymmetry of Information

In real-world criminal interrogation, there is asymmetry of information among different parties involved. For example, guilty suspects know that they have committed the crimes, whereas innocent suspects know that they have not. The police, on the other hand, may or may not be able to distinguish guilty suspects from innocent ones. Even if the police know who is guilty, they have to present the evidence to convince the trier of fact in the interrogation [25].

In "Among Us," there is similar asymmetry of information to that in real-world criminal interrogation. Additionally, the game imposes more asymmetry by allowing the imposters more visual range than normal crewmates. The imposters can even turn off the light (which any crew can later turn on) to further limit the visual range of crewmates.

There are two ways that an individual crewmate can certainly know the identity of an imposter. The first, of course, is to be near enough to the crime scene when the murder takes place. Secondly, if the murder is committed near the camera, the crewmates can see it from the monitor room.

If a crewmate does not see the murder, either at the crime scene or in the monitor room, he at least has some ways to identify fellow crewmates, thus reducing the number of potential imposters. The first is by having an alibi, in case one can make sure that some fellows are with them all the time when the murder occurs. Secondly, the game allows a few crewmates a privilege of being able to scan their identity. If all crewmates with such a privilege go to the scanner together, they all will know that imposters are not among them.

At the start of the game "Among Us," everybody is a suspect. As the game proceeds, someone has been killed and some meetings have taken place, some players will become more suspicious than others. Some players, including imposters, may take the police role by asking more questions than others, but his or her role can be switched to suspects at any time if the evidence suggests.

7.2 Asymmetry of Information

In real-world criminal Apart from having more information regarding the crime, the guilty suspects or "imposters" know more than others about the available or potentially available evidence. Therefore, they know roughly in advance what the witnesses will say. Innocent suspects cannot predict this due to their innocence [25].

In "Among Us," let us consider an innocent suspect who did not report the corpse by him/herself. In this case, he or she cannot even know for sure which useful alibi can be given.

The one who reports the corpse location may lie about it for some reasons. For example, the reporter who is not an imposter may lie about the location in order to confuse the imposters. (In one Among Us match observed by the author, this strategy worked so well that it made the imposter exclaim "How can that be?" after the reporter gave false murder location. The poor imposter is then voted out due to his remark.)

7.3 Possible Research Questions

The above analysis may lead to the following research questions: Which methods of interrogation are used to find imposters in the game? How effective and efficient are such methods? Comparing these methods with real-life criminal interrogations used by police or jury in the court, what are similarities and differences? Also, by observing interrogation methods in the game, what insight can be applied to real-life criminal interrogations?

8. AN EXAMPLE OF DATA COLLECTION FOR QUALITATIVE RESEARCH FROM GAME CASTING OF "AMONG US"

To quote from Creswell [12], "The idea behind qualitative research is to purposefully select participants or sites (or documents or visual material) that will best help the researcher understand the problem and the research question." In this case, we select to observe "Among Us" games played by a famous group of Thai gamers who have been playing together for more than a year. They regularly stream their plays online via YouTube with more than one million views per clip. After playing, each individual player usually edits the streamed video and publishes the edition on his/her own YouTube channel. These videos are therefore perfect qualitative audio and visual materials for research. The researcher can investigate them both

objectively as well as subjectively, since these gamers are also very good at expressing their inner thought while playing games.

In this article, the author takes a note from a situation in the game when the players are discussing who should be voted out of the spaceship. For the sake of readers who might not be familiar with the game, we take a simple example that can be understood easily.

Figure 4. Screen Capture As Sometimes Kills Zylnazter. [26]

Situation: Sometimes killed Zylnazter right before MISTERHE4's eyes. Sometimes reported the corpse himself as if he was innocent.

Discussion

MISTERHE4: Well, Tae (Sometimes' real name).

Sometimes: What I want to report is …

MISTERHE4: Do you have something to tell me?

Sometimes: Did you see something? I…I…

MISTERHE4: Keep talking. Make it reliable, though.

Sometimes: Let me ask first. Who walks past me a moment ago from the camera room? Is it Es (Arifeenz's real name), right?

MISTERHE4: The green one.

NongPat: Es and James.

Sometimes: Did you see like what I saw?. It is Ake (MISTERHE4's real name), right before my eyes. What have you done, Ake?

Jamezconer: Calm down. What happened?

(Sometimes and MISTERHE4 told their stories while accusing each other)

MISTERHE4: The one who could do this was Tae (Sometimes' real name). If it had been me, I would have reported the corpse myself.

Sometimes: I see. And you would have blamed me, right?

MISTERHE4: Yes, but it is you in reality. Why do you have to do this to me?

Result: Sometimes is voted out of the spaceship with three votes. MISTERHE4's got two votes.

<u>Interpretation</u>: MISTERHE4's last three sentences are one of the factors in the decision to eject Sometimes out of the spaceship. To report the crime for which one is guilty is one way to direct attention to someone else. This strategy does not work this time, but it might work in other situations.

Figure 5. Screen Capture As Sometimes Is Being Voted Out. [26]
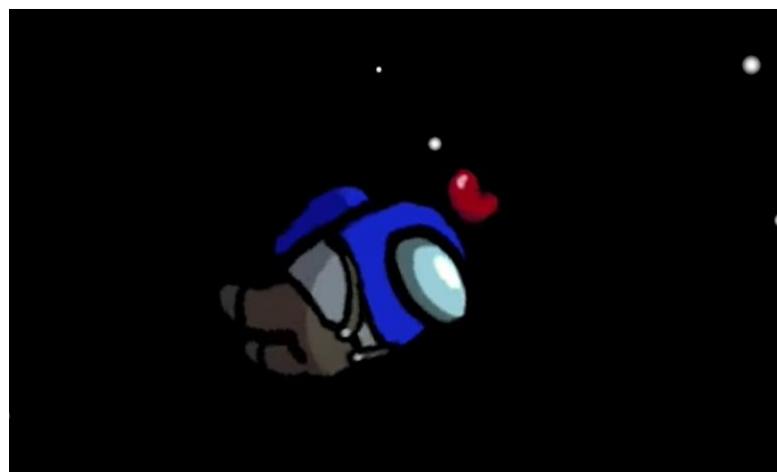
Figure 6. Screen Capture As Sometimes Is Ejected Into Space. [26]

It can be seen from the case study of Among Us that, while game casting and streaming conveniently provide us qualitative audio and visual materials, it is important to code and interpret in a suitable way such that useful knowledge is derived and irrelevant information is discarded.

9. CONCLUSION

With the current trend, research in esports and video games are expected to continue increasing in scope and number. In this article, several research disciplines of which some attention are drawn to esports are discussed. Although our case study just shows how a simple game of "Among Us" can be researched in a particular discipline, there can also be several related fields of research. For example, one might think about the area of game theory and focus on the tactics used to support one's own strategy as well as destroy the opponent's.

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Book Review

Book Review: Rewiring Education: How Technology Can Unlock Every Student's Potential Author: John Couch and Jason Towne

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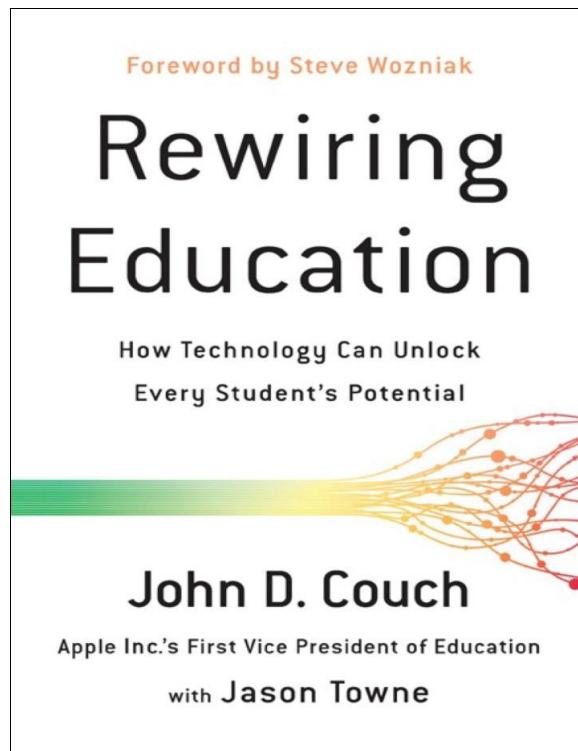
This book points out that how currently technological innovation can revolutionize learning and teaching to unlock a student's potential. There are an introduction and 15 chapters in this book. The authors name each chapter as a one keyword involved with the main ideas or argument of chapter and subchapter as a short phrase also. These are easy to understand. The reviewer divides this book's content as three main sections of this book. First, the authors would like to make sure that a reader understands what keys success of pedagogy in psychological term is, details in chapter 1-7. Second, how to utilize technology, details in chapter 8-13. Finally, the remaining provides which technologies have the most potential to drive the education system currently and beyond. Each chapter introduces or shares an educational research, a result of research-and-development's collaboration between schools and technology companies, and a case study to illustrate what coming up the authors' idea or argument is next in the chapter.

In the introduction and chapter 1, "**Rewiring**", the book presents the issues of the current educational system in the US especially in elementary and secondary schools. Even though, the common methods "repairing" and "replacing" are used to improve the education system, efforts have not been successful. The authors offer "rewiring" that means upgrading educational operating system or "**rewiring education**" to transform passive traditional educations to active models of learning which better connect students, teachers, parents, and society together.

In the chapter 2, "**Design**", the book mentions that the people in our educational system must believe every child has potential to learn and succeed and must help them together with the proper use of technology.

In the chapter 3, "**Potential**", the authors focus on student's potential and mention that do not use cognitive bias and confirmation bias to label student as an underachiever. These biases limit student's potential based on our possible assumption. Recognizing these biases is the heart of rewiring education. The authors also state that even though nature and nurture are responsible for our intelligence and abilities, correctly using technology can be educational equalizers.

In the chapter 4, "**Motivation**", the authors present what motivation is, and what self-determination is. These helps a reader better understand how to motivate a student for learning. Motivation is a prerequisite for effective of learning. The authors divide self-determination as intrinsic motivation that is something good in long term within and extrinsic motivation that depends on external factors and better for short term. However, the authors mention that technology has the power to use both types. At the end, the authors also mention "helping kids discover their own passions and interests, encouraging and nurturing an intrinsic motivation and self-determination, and believing that they can be as successful will lead to more self-confidence, grit, initiative, and ultimately better learning".

In the chapter 5, "**Learning**", the authors state that what the different between education and learning is and define Learning should be formed "retrieving", "memorizing" and then "understanding" facts. Furthermore, the authors convince that personalized learning; teaching and learning for students as individuals not isolation, is the backbone of successful teaching and learning.

In the chapter 6, "**Space**", the authors present form of learning spaces or environments which is the most effective for the learner.

In the chapter 7, "**Challenges**", the book describes about the first Apple's educational research project "Apple Classrooms of Tomorrows" or ACOT that focuses on using technology in education and looking for the best learning model. The result is a new tech-supported pedagogy called "Challenge-Based Learning (CBL)".

In the chapter 8, "**CBL**", the authors give us more details of CBL framework which is unsimilar PBL (Project-Based Learning). The PBL projects are assigned to students while CBL is created or designed by their own. There are three phases of CBL framework: to decide the problem, to break the problem down, and to do action plan. The authors also shortly describe it as follows: Feel, Imagine, Do, and Share. Moreover, the authors emphasize technologies can offer answers to complete CBL.

In the chapter 9, "**Access**", the authors propose that we need a new set of principles called "21st Century ABCs of Learning": **Access**, **Build**, and **Code,** to rewire education and mentions that "it doesn't matter how good a technology is if those whom it's intended don't have **access**". The authors also dive into the online learning such as Massive Open Online Courses (MOOCs) and Khan Academy and Apple Camp.

In the chapter 10, "**Build**", the authors describe the core to rewire education is not only one that kids have **access** to key technologies, but also be taught problem solving by using tools and **building** things in order to help them to be a "Maker". The authors state online or interactive games especially MMORPG (Massively Multiplayer Online Role-Playing Game) is an open-world model of learning. In addition, kids as digital natives can make own creativity by coding in the games.

In the chapter 11, "**Code**", the authors point out that critical thinking, problem solving, creativity can be learned in **coding**. Moreover, it gives kids a significant boost in self-confidence.

In the chapter 12, "**Teaching**", the authors describe that technology has changed through Artificial Intelligence (AI), adaptive learning software, virtual and augmented reality. It is now possible for us to begin designing and implementing to support personalized learning environment. Furthermore, "the role of teachers changes from to being a conveyer to a facilitator- asking opened questions, guiding to open-ended activities, offering feedback".

In the chapter 13, "**Technology**", the authors share case studies, or classroom models which integrating technology and finally conclude that no matter what model you use as a starting point to integrate technology in your classroom, just make sure that using it to its full potential.

In the chapter 14, "**Transformative**", the book provides which transformative technologies have the most potential to rewire education such as AI for adaptive learning that built-in gamification devices, intelligent assistants such as Apple's Siri, Amazon's Alexa, most common methods for finding answers, IoT (Internet of Things), mobile technology, 3D printing, and interactive books: eBook and Apple iBook.

In the chapter 15, "**Futuristic**", the authors quite believe that Augmented Reality (AR) will play a significant role in the future such as ARKit, Apple's AR technology.

Now the world is driven exponentially by modern technology and innovation. Therefore, the reviewer really agrees with the authors' suggestions to unlock hidden potential of kids who as digital natives by technology. However, their schools or families should support the kids to collaborate with mentioned transformative technologies to meet the successful teaching and learning. Besides, from technical point of view, we must closely advise or take care of kids to beware of cyber security threats while access into online technology. Certainly, as the reviewer, I encourage this book for especially parents, teachers, educational leaders, and who may be interested in future education.

REFERENCE
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Research Articles

The Use of Smartphone Games as Media for Non-Formal Education Management to Strengthen the Self-Esteem of Teenage Dropouts

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ABSTRACT

This research had objectives (1) to construct instructional media in the forms of smartphone games for non-formal education management to strengthen the self-esteem of teenage dropouts and (2) to study the effects of using smartphone games for non-formal education management to strengthen the self-esteem of teenage dropouts. It was conducted using the one-group pretest-posttest design in the pre-experimental research design. The sample consisted of 12 teenage dropouts who were purposively selected. The interview population consisted of two experts in non-formal education, an expert in psychology and a technology expert in game design. The instruments were composed of a structured interview form, a recording form of the focus group, lesson plans, smartphone games, a behavioural observation form of the self-esteem, a form of diary record, and the self-esteem scale. The data from the interviews and the focus group were analyzed in terms of the content analysis, whereas, the data from the behavioral observation form of the self-esteem, the form of diary record, and the self-esteem scale were analyzed in terms of the descriptive statistics such as frequency, percentage, average mean, standard deviation, and difference between the average means. The comparative results between the average self-esteems before and after the experiment showed that the average self-esteems in each dimension after the experiment were higher than those before the experiment in all five dimensions. As the results from the behavioral observation form of the self-esteem, the form of diary record showed that 66.70-100.00 % of those 12 teenage dropouts who participated in the experiment had the self-esteems in all five dimensions at the very-good level.

Keywords: Self-esteem; Teenage dropout; Learning media of smartphone games; Non-formal education

1. INTRODUCTION

Nowadays in Thailand, social and economic conditions result in that lots of teenagers in the schooling system drop out due to various problems such as poverty, family problems, personal adjustment, being arrested or involved in criminal cases, sickness, accident suffering, family migration, and working to support family, and so on [1]. There are various impacts of the dropping out problems such as 1) on the teenagers themselves that they lack the knowledge required for living; that they have negative attitudes towards education; that they lack self-confidence and they lack educational opportunities for self-development; 2) on the government budget and educational costs that the free education provided is waste and that the government have to provide more for the social problem-solving; and on the Thai society that the teenage dropouts may have violent behavior or may have committed various crimes in society [2].

According to the results from the Promotion Program of the Officials Promoting the Student Conduct in 2018 suggesting that those teenagers without any activities are likely to hang around game stores as the first type of places [3] which is consistent with the report by The Office of Electronics Transaction Development [4] on the Survey of the Internet Use in Thailand in 2016, the most popular activity among the teenagers is playing games online on smartphone. One of the reasons why these teenagers turn to playing games is that they have the low self-esteem [5]. They are likely to have fun and satisfaction towards the success of playing games to meet their prides [6]. Therefore, learning management through games should be the most suitable choice for these teenagers to learn which leading to have higher self–esteem [7].

The self-esteem is the self-thinking and feelings in a person through both negative and positive self-assessment to judge his/her own values through cumulative data from his/her experiences or from others. The self-esteem gives rise to self-respect, self-rejection, feeling of self-worth in society, self-reliance, and the recognition of his/her own family and community leading to his/her own success or failures in life [8]. The self-esteem matters the development of being an adult; children with low self-esteem or self-negative feelings are comparatively like the disabled of personality leading to failure in all areas of life [9].

Due to the importance of strengthening the teenagers' self-esteem (SE) and the teenagers' interest in playing smartphone games (SGs) as mentioned above, the authors are interested in researching the use of the SGs as the learning media (LM) for non-formal education management (NFEM) to strengthen the SE of teenage dropouts (TDs) in order to have guidelines for the SE development among the teenagers who are growing to be the human resources of quality of society in the future.

2. OBJECTIVES

This study was aimed as follows:

1. To construct learning media in forms of smartphone games for non-formal education management to strengthen the self-esteem of teenage dropouts, and

2. To study the effects of using the smartphone games for non-formal education management to strengthen the self-esteem of teenage dropouts.

3. CONCEPTUAL FRAMEWORK

The conceptual framework can explain the process of creating a gaming smartphone to enhance the self-esteem of the dropout teenagers. This research was conducted based on important theories, namely: Knowles' Theory of Andragogy for self-directed learning, Piaget's Developmental Psychology of Adolescents for self-identity and self-esteem, Rosenberg's Theory of Self-esteem for self- good feelings, self-respect, self-positive attitudes, self-capabilities, and self-feeling of achievement as well as the concepts related to gaming smartphone design, games in terms of competition, challenges, fun and imagination, and Malone's Theory of Game-based Learning. The created game was used to organize five activities to enhance self-esteem in all five aspects. The related theories were summarized as shown in the conceptual framework in Figure 1.

Figure 1. Conceptual framework.
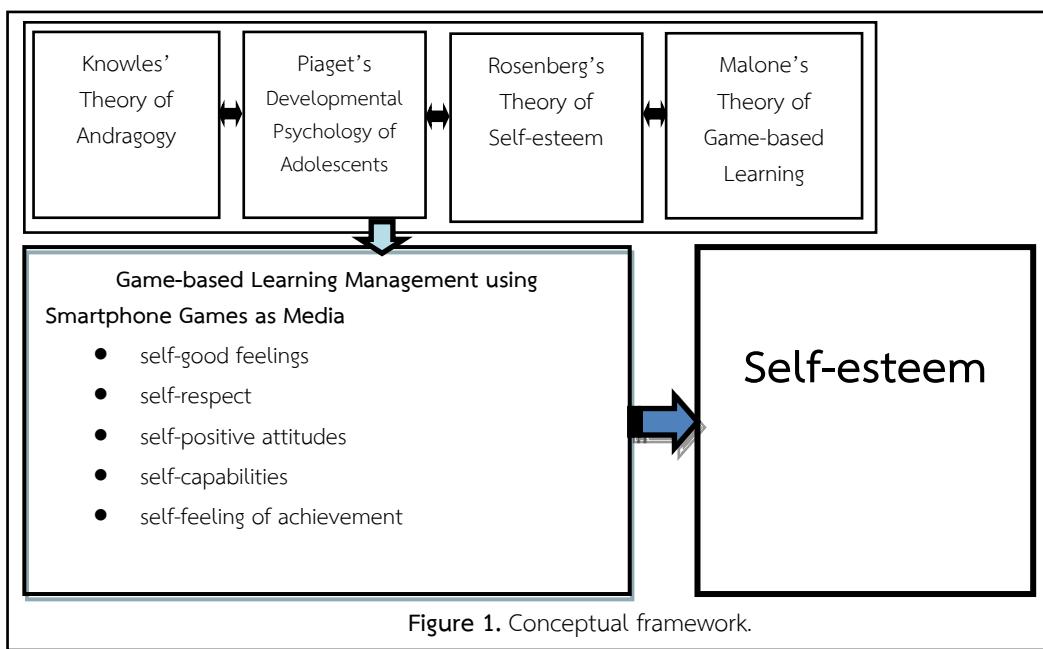
4. METHODS

This research was undertaken through the mixed methods of the qualitative research approach and the pre-experimental research approach in order to completely achieve the objectives.

4.1 Research Procedures

Phase 1: Construction of the SGs and the lesson plans.

4.1.1 Data from experts' interviews and the focus group of the TD were to be collected for constructing the SGs.

4.1.2 Construction and quality determination of the SGs were to be done.

4.1.3 The five lesson plans and the document supplementary to the lesson plans were to be created.

Phase 2: Try-out of the SGs for NFEM to strengthen the SE of TDs.

4.2.1 The learning media of the SG was to be taken to try out among those TD in the experiment.

4.2.2 The SE of the TDs was to be measured.

4.2 Populations and Samples

4.2.1 As for the qualitative research, data were collected from the samples as follows:

4.2.1.1 The interview population consisted of two experts in non-formal education, an expert in psychology, and technology experts in game design.

4.2.1.2 The focus-group population consisted of eight TDs aged between 15-19 years old playing in the game stores in Kitchakute district, Chanthaburi province.

4.2.2 As for the pre-experimental research, data were collected from the sample of 12 TD aged between 15–19 years old playing in the game stores in Kitchakute district, Chanthaburi province, who were purposively selected and voluntary to take part in the experiment.

4.3 Tools

In this study, the following tools were used:

4.3.1 The structured interview form to collect the data from the experts to construct the SGs.

4.3.2 The recording form of the focus group including topics about playing games to be summarized and collected from the focus group to construct the SGs.

4.3.3 The lesson plans constructed by the corresponding author to manage the learning using the SGs.

4.3.4 The behavioral observation form of the SE constructed by the corresponding author to record the behaviors of the experimental group.

4.3.5 The form of diary record constructed by the corresponding author for the experimental group to record their feelings after the learning through the smartphone game of each lesson plan.

4.3.6 The SGs used as the LM for the NFEM to strengthen the SE of TDs.

4.3.7 The SE scale, translated Thai version adapted from the standard version by Rosenberg [10] to measure the SE of the experimental group before and after the use of the SGs as media for NFEM to strengthen the SE of TDs.

4.4 Construction and Quality Determination of the Tools

4.4.1 The structured interview form which was constructed by the corresponding author to collect the data for construction of the SGs was composed of three open-ended questions (for free answers) about 1) the SGs suitable for teenagers, 2) the theories related to the teenagers' SE, and 3) the design and construction of the SGs to strengthen the SE among the teenage dropouts.

4.4.2 The topics in the recording form of the focus group which were designed and specified by the corresponding author to guide the focus group to obtain the useful data for the construction of the SGs to strengthen the SE among the TDs were about 1) behaviors of the teenage dropouts, 2) features of the SGs wanted by the teenage dropouts, and 3) duration of playing the SGs.

The structured interview form and the topics of the focus group were submitted to the thesis advisor to determine the validity of the language expression and the consistency with the objectives and then they were revised according to the recommendations before using to collect data.

4.4.3 The five lesson plans, which were constructed by the corresponding author for NFEM to strengthen the SE of teenage dropouts, applied the Knowles' Theory of Andragogy [11] together with the Piaget's Developmental Psychology of Adolescents [12] for the teacher's roles; the Malone's Theory of Game-based Learning [13] for the design of the SGs suitable to the TDs and the Rosenberg's Theory of SE [8] for the design of the SGs to strengthen the teenage dropouts' SE in five dimensions including self-good feelings, self-respect, self-positive attitudes, self-capabilities, and self-feeling of achievement and each learning plan took 90 minutes to learn.

4.4.4 The behavioral observation form of the SE constructed by the corresponding author to record the behaviors of the experimental group including general behaviors and the SE behaviors in five dimensions: self-good feelings, self-respect, self-positive attitudes, self-capabilities, and self-feeling of achievement.

4.4.5 In the form of diary record constructed by the corresponding author for the experimental group to record their feelings after the learning through the smartphone game of each learning plan, there were two open-ended questions including the first one was about what obtained after joining the activity and the second one was about the feelings of the SE in five dimensions: self-good feelings, self-respect, self-positive attitudes, self-capabilities, and self-feeling of achievement.

In order to determine the quality of the lesson plans, the behavioral observation form and the form of diary record, the Index of Item Objective Congruence (IOC) was used to determine the content validity in terms of the consistency with the research objectives and all these three tools were submitted to the thesis advisor and three experts each in non-formal education, psychology and technology. As a result, the IOC of each item was equal to one which meant that all these three tools were valid in terms of their contents and appropriate to be used. Finally, the recommendations were followed before using in this study.

4.4.6 The SGs which were constructed to be played on smartphones of the Android operating system were based on 1) the Rosenberg's Theory of Self-esteem [8], 2) the data from the structured interview with the panels, and 3) the data from the focus group undertaken the TDs and were developed and constructed step by step as follows:

4.4.6.1 Specify the objective to use the SGs as the LM for NFEM to strengthen the SE of the TDs and the name of them as "SE-ROSEN".

4.4.6.2 Create their structures and contents in terms of plot, content, and language which use appropriate and up to date for the sample group according to recommendations by the experts in psychology whereas the detailed instructions on how to create them were recommended by the experts in technology.

 4.4.6.3 Based on the results from 4.4.6.2, write codes of instructions for them, set how to play them together with rules and choose the Android operating system together with instruction set (Software), integrate C program, then bring the game plots to create graphics.

4.4.6.4 Set off constructing them.

4.4.6.5 Revise SGs according to the comments from trail session.

The resulting content design results in a smartphone game based on the advice of psychology experts and the advice of tech **experts and the advice of tech experts are as shown in Figure 2.**
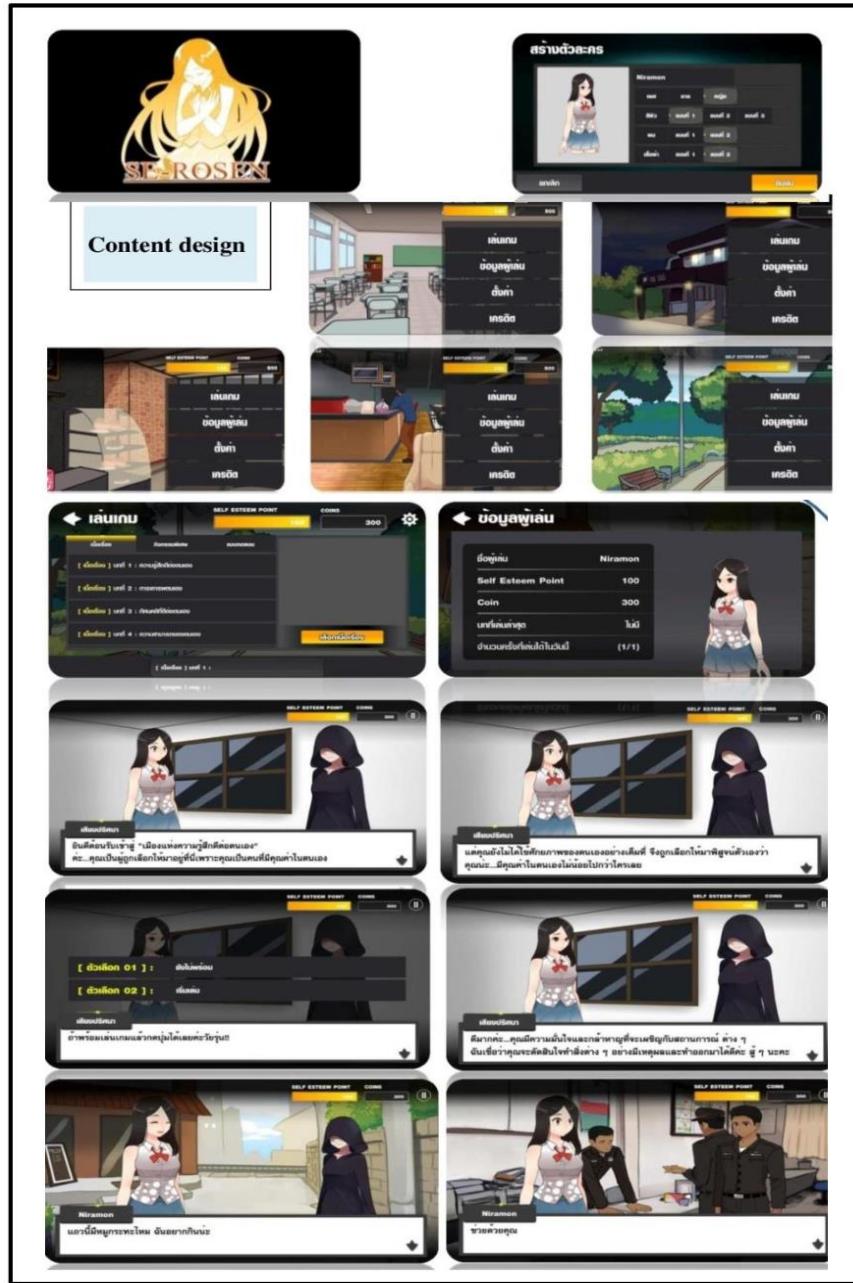
Figure 2. Smartphone games.

4.4.6.6 Write a guide how to play them as the offline games to played on smartphones of the Android operating system.

4.4.6.7 Evaluate them by the try-out of them with the 15–19 years old TDs other than those selected to be the experimental group and improve them according to the evaluated results.

All SGs together with their construction steps were submitted to the three experts of each in non-formal education, psychology, and technology to determine the content validity in terms of the consistency between the content and the study objectives including usability of instruction, menus, language used suitable for players, beautiful and attractive pictures, and etc; measured by IOC. As a result, the IOC of each item was equal to one which meant that all these SGs were valid in terms of their contents and appropriate to be used.

4.4.7 This scale translated and adapted from the standard one of Rosenberg [10] was composed of 10 items of each rating scale including strongly agree, agree, disagree, and strongly disagree.

The SE scale which had been already translated into Thai was submitted to the expert panels including an expert in psychology and two experts in NFEM to determine the appropriateness of the translated SE scale for use with the TDs and the consistency index showed the range of 0.67-1.00, which was considered that the SE scale developed by the author can be used.

4.5 Experimentation and Data Collection

This pre-experimental research design was conducted following the one-group pretest–posttest design [14] and the procedures were as follows:

4.5.1 All 12 participants (teenage dropouts) in the experimental group were measured by the SE scale [10] before the experiment and the results were kept.

4.5.2 The NFEM using the learning plans and the SGs was done in five learning sessions of 90 minutes each period and once a week for total 450 minutes.

4.5.3 During each learning activity in the NFEM in 4.5.2; the SE of each participant was observed and recorded through the behavioral observation form by the researchers.

4.5.4 Meanwhile, after each learning activity, each participant was also asked to observe and record his feelings and opinions about through the form of diary record.

4.5.5 Again, all 12 participants (TDs) in the experimental group were measured by the SE scale [10] after the experiment and the results were taken to compare with those in 4.5.1.

4.6 Data Analyses

Results from the comparison between the SE before and after the experiment were analyzed in terms of the descriptive statistics such as frequency, percentage, average mean, standard deviation, and difference between the average means. Results from the behavioral observation were analyzed and classified in groups according to behavioral features of the SE and from the form of diary record of each TDs were analyzed and classified in groups according to the five dimensions of the Self-esteem. Moreover, the number of the TDs reflecting the SE was also analyzed in terms of percent.

5. RESULTS

The results are as follows:

5.1 Results from the Construction of the LM of the SGs to Strengthen the SE of the TDs

The summarized results from the interviews from two experts in NFEM, an expert in psychology and an expert in technology, from the focus group held among 15–19 years old dropouts in game stores in Kitchakute district in Chantaburi province and from the contents of the Knowles' Theory of Andragogy [11] together with the Piaget's Developmental Psychology of Adolescents [12], the Rosenberg's Theory of SE [8], and the Malone's Theory of Game-based Learning [13] were synthesized and resulted in as follows:

5.1.1 The LM of the offline SGs in the Android operating system were in detail as follows:

5.1.1.1 a smartphone game to strengthen the SE in dimension of self-good feelings,

5.1.1.2 a smartphone game to strengthen the SE in dimension of self-respect,

5.1.1.3 a smartphone game to strengthen the SE in dimension of self-positive attitudes,

5.1.1.4 a smartphone game to strengthen the SE in dimension of self-capabilities, and

5.1.1.5 a smartphone game to strengthen the SE in dimension of self-feeling of achievement.

5.1.2 The lesson plans for NFEM to strengthen the SE of the TDs were composed of 5 learning plans for each dimension as follows:

5.1.2.1 the lesson plan for using with the smartphone game to strengthen dimension of self-good feelings spent 90 minutes to organize the learning activity,

5.1.2.2 the lesson plan for using with the smartphone game to strengthen dimension of Self-respect spent 90 minutes to organize the learning activity,

5.1.2.3 the lesson plan for using with the smartphone game to strengthen dimension of self-positive attitudes spent 90 minutes to organize the learning activity,

5.1.2.4 the lesson plan for using with the smartphone game to strengthen dimension of self-capabilities spent 90 minutes to organize the learning activity, and

5.1.2.5 the lesson plan for using with the smartphone game to strengthen dimension of self-feeling of achievement spent 90 minutes to organize the learning activity.

5.1.3 The behavioral observation form, the form of diary record and the SE scale adapted from the standard version of Rosenberg [10].

5.2 Results from the Use of the SGs as the Media for NFEM to Strengthen the SE in 5 Dimensions of the TDs

5.2.1 Comparative results between the SE averages before and after the experiment as show in   Table 1.

Table 1 Comparative Results between the SE Averages before and after Using the LM of the SGs for NFEM to Strengthen the SE in five Dimensions of the TDs.

Dimensions of the Self-esteem	Total scores	Before participating in the learning activities		After participating in the learning activities		$\overline{X}$
		μ	$\square$	μ	$\square$	
Self-good feelings	100	31.75	2.45	66.08	2.64	34.33
Self-respect	100	28.25	2.30	67.25	2.49	39.00
Self- positive attitudes	100	30.17	2.59	67.83	2.52	37.66
Self-capabilities	100	29.75	2.45	64.33	1.87	34.58
Self-feeling of achievement	100	31.25	2.60	66.08	2.31	34.83

The results above showed that the dropouts' SE averages of using after the experiment are higher than those before in all dimensions. The difference of the SE before and after showed the higher averages in all five dimensions as follows: The self-good feelings had a higher average score of 34.33 points; the self-respect had a higher average score of 39 points; the self-positive attitudes had a higher average score of 37.66 points; the self-capabilities had a higher average score of 34.58 points; and the self-feeling of achievement had a higher average score of 34.83 points. These results showed that using the SGs for NFEM to strengthen the dropouts' SE was effective because all of the TDs had increased SE in all dimensions.

5.2.2 Results from the behavioral observation.

The results from behavioral observation from the TDs in the activities in the five learning plans in terms of general behaviors and the SE behaviors in five dimensions including self-good feelings, self-respect, self-positive attitudes, self-capabilities, and self-feeling of achievement showed that the dropouts' SE was at the very-good criterion. Thus, 8–12 dropouts or 66.70–100 percentage (%) were determined in playing the SGs, self-dependent, and able to help guide others. Therefore, it can be concluded that using the SGs as the LM for NFEM to strengthen the SE among the TDs is successfully effective.

5.2.3 Results from the diary record.

The results of the analyses of the reflection and opinions of the TDs after participating in all five lesson plans reflected that the use of smartphones as a means of promoting SE can raise awareness of the SE in all five areas: self-good feelings, self-respect, self- positive attitudes, self-capabilities, and self-feeling of achievement. The results of the assessment of the SE from the diary record showed that all TDs had increased awareness of the SE; thus, total of 12 the TDs could reflect the sense of the SE correctly and creatively.

6. DISCUSSIONS

The study results were discussed in accordance with the objectives as follows:

6.1 Construction of the SGs as the LM for the NFEM to Strengthen the SE of the TDs

Smartphones are widely popular among teenagers because they are both portable communication devices on which their owners can play games. Most teenagers like to play games on their smartphones because their smartphones can be carried anywhere and they can learn and be entertained by themselves anytime. It is therefore appropriate to create a smartphone game as a learning tool that meets the need of teenagers and this corresponds to Chumwuttisak and Silanoi [15]. It is said that SGs are quality educational media that make teaching and learning interesting and enable the young learners' learning according to objectives as well. These SGs are also very helpful in building pride and meeting the needs of teenagers because they make them feel as if they lived in the world of recognition and these reasons are also in line with the concept of Piaget [12] concluding that being recognized is a psychological need for adolescents. Smartphone game playing makes young people happy and feeling accepted in simulations or in the fantasy world [16]. The corresponding author therefore had created learning materials in the form of SGs for the TDs to learn from the simulations for real-life applications. Creation of offline SGs can meet the needs of teenagers because the SGs make them more concentrate, have more courage to make their own decisions and have privacy of theirs. The highlight of the SGs is that the game players can learn anytime and anywhere; thus they gain knowledge from lessons while playing games and the smartphone game is a learning resource that is not limited to the classroom.

In order to design the SGs, the corresponding author used the Malone's Theory of Game-based Learning [13]. Such elements as amusement, competition, challenge, and imagination were inserted in them to make the learning materials for NFEM based on these games to strengthen the SE of TDs. The construction of the SGs as the LM was based on the Rosenberg's Theory of SE [8] which was composed of five dimensions including 1) self-good feelings, 2) self-respect, 3) self-positive attitudes, 4) self-capabilities, and 5) self-feeling of achievement. Meanwhile, the Knowles' Theory of Andragogy [11] was applied in developing the learning plans and because adolescents were early adult; therefore, teachers are responsible for organizing conditions conducive to learning, exchanging knowledge between teachers and students, accepting individual differences, and being persons who guide, educate and facilitate learning.

In this study, the integration of the interview results from experts, the summarized concepts based on the Knowles' Theory of Andragogy [11] together with the Piaget's Developmental Psychology of Adolescents [12], the Rosenberg's Theory of SE [8], and the Malone's Theory of Game-based Learning [13] to construct the offline SGs on the Android operating system to enhance the teenage dropouts' SE was successfully effective because   the dropouts in Kitchakute district, in Chantaburi province had already used the smartphones in the Android operating system; moreover, the offline SGs satisfied them because   most of them preferred privacy. In addition, this was in line with the study on developing the set of activities to strengthen the SE by Iampracha and Premchuen [17] in which useful recommendations by experts and related theories had been taken to develop counseling activities to promote the SE among students and these activities were successfully appropriate for the students because after the experiment, the students had significantly ($p<.01$) higher Self-esteem. These results also confirmed that the development of the activities to strengthen the SE which was based on the recommendations by experts and related theories was effective in the students' SE promotion.

Therefore, the construction of the LM of the SGs to strengthen the SE of the TDs is so based on the data of quality, according to the teenage dropouts' contexts and reliable that these LM can be used effectively to strengthen the increased SE among teenagers.

6.2 Results from the Use of SGs as Media for NFEM to Strengthen the SE of TDs

These results showed that after the experiment, all experimental participants had higher SE in all dimensions; particularly, "the self-respect was the highest ($\overline{X}$ before the experiment=28.25 and $\overline{X}$ after the experiment=67.25; so the highest increases = 39.00). This may be because the TDs were interested in practicing and learning to have the SE in the dimension of self-respect most because they preferred to attract attention from others. This was according to Piaget [12] who argued that teenagers generally needed the acceptance of others and the self-respect to make themselves be confident to live in society.

The increased averages of all five dimensions of these confirmed that the SGs were effective for NFEM for the dropouts and were constructed in line with the dropouts' preference. Moreover, this was consistent with the study by Chumwuttisak and Silanoi [15] on using a game-based teaching model in developing proper attitudes towards democratic citizenship revealing that after the experiment, the participants had an average of the attitudes towards the democratic citizenship 84.54 % higher than that before. This result supports that using the SG as a learning medium is effective to enable the students to learn according to the objective. It can be considered as a method that is suitable for the target group, arousing their interest, modern and responding to their needs as well.

Results from the behavioral observation revealed that the experimental group had fun and were beamingly cheerful and they could confidently accept their own successes or failures. In addition, these results are in accord with the theory by Coopersmith [18] suggesting that those with high SE will have bright and cheerful faces and expressions and are also in line with the Rosenberg's Theory of Self-Esteem [8] suggesting that teenagers can confidently accept their own successes or failures and are independent and assertive.

The results from the forms of the diary record that all TDs had increased awareness of the Self-esteem; thus, total of 12 the TDs or 100 % could reflect the sense of SE correctly and creatively. These results show that the LM constructed in this research can strengthen the teenage dropouts' SE successfully in all five dimensions including self-good feelings, self-respect, self-positive attitudes, self-capabilities, and self-feeling of achievement according to the Rosenberg's Theory of Self-esteem [8].

In conclusion, the use of smartphone games for non-formal education management to strengthen the self-esteem of teenage dropouts can be so successful because the smartphone games can meet their needs, arouse their interests and can be learned at anytime and anywhere that the teenage dropouts can be the ones ready to learn and improve themselves, have higher self-esteem, get back to schools, pursue careers in good faith, and have the quality human resources and beneficial to the development of the country in the future.

7. RECOMMENDATIONS

7.1 Recommendations from the result

7.1.1 Teachers and agencies in the NFEM may apply the SGs resulting from this study to strengthen the SE among learners provided that the contents of the SGs and learning plans should be modified according to the learners.

7.1.2 Since the SGs developed in this study are offline and make the students unable to communicate immediately; therefore, teachers and NFEM agencies should consider making the other type of the SGs in online system so that learners can instantly communicate with others through the games.

7.1.3 Teachers and agencies in the NFEM may apply this study results to further construct the SGs to teach knowledge, skills or attributes in other areas.

7.2 Recommendations for further study

7.2.1 The use of the SGs to create such personal properties as achievement–oriented motivation and positive thinking etc; should be further researched.

7.1.2 The construction of the SGs in IOS to strengthen the SE or the construction of the online SGs for more access to play etc; should also be further investigated.

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Soft Skills Enhancement for Electronics and Telecommunication Engineering Students at Rajamangala University of Technology Suvarnabhumi

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ABSTRACT

This article presents soft skills to students in Electronics and Telecommunication Engineering, Faculty of Engineering and Architecture, Rajamangala University of Technology Suvarnabhumi. By enhancing soft skills, which are important to students in the digital disruptions era, there are through the implementation of activities to recognize interaction, socialization, emotional control, positive thinking, and problem-solving through soft skills enhancement. Skills by organizing three appropriated activities included in the selected topics in Telecommunication Engineering course code 504-44-19, the number of students that enrolled in the course is 26 people. The results showed that the activities of cultivating and developing student's soft skills of electronics and telecommunication engineering students, Faculty of Engineering and Architecture, Rajamangala University of Technology Suvarnabhumi in all three aspects, the lecturer had an average satisfaction level of 4.705, the standard deviation was equal to 0.48. In the field of cultivating and developing skills in soft Skills, the average satisfaction level was 4.692, the standard deviation was equal to 0.56, and in terms of benefit and application of knowledge, the average satisfaction level was 4.750, the standard deviation was equal to 0.51. The overall outcome of the activities was the most favorable at 4.717 and the standard deviation was 0.50.

Keywords: Enhancement; Activity; Soft skills; Industry; Engineering

1. INTRODUCTION

In modern time, the learning world has changed a lot and it is a change that is expected to affect the learning system in the university which is a challenge that the university must prepare to counter it systematically. Teachers and professors are very important in being a role models or setting an example for students and students are having the intention to continuously develop themselves. Educational institutions are under pressure from the establishment to produce quality graduates ready to work in the highly competitive workplace or labor market both within and outside the country. In the past, the education system had focused on the teaching of hard skills (Knowledge skills) that had activities to drive for a competition to achieve victory in academic knowledge. But there was still a controversy over the development of student affairs to nurture, indoctrinate, and develop soft skills (Emotional skills). Academics have been researching the importance of emotional soft skills by integrating teaching techniques in teaching and learning. Using two developed questionnaires [1], the findings indicated that, from the perspectives of teachers and students, the emphasis on soft skills concerning the integration of emotional skills in the course of instruction was significant. Similarities in critical thinking, problem volving skills, communication skills, have recognized the importance of soft skills for career success. Researchers suggested that soft skills were better [2]. There was an interview with teachers that focusing on academic teaching and found that allowing students to do activities in their own time was considered as a waste of time and unable to develop student knowledge while the student affairs were lacking cooperation from the instructors by not allowing students to participate in activities. Viewing from a different perspective or the policy of student development in both academic and student affairs is not going in the same direction. There is a possibility that the reason for receiving the information may result in students who are not being indoctrinated and developed as it should be.

Bloom's Taxonomy [3] classified learning objectives into three domains; 1. Cognitive domain involves the behavior of the brain that is related to the intellect, knowledge, thinking, and intelligence of the ability to think about stories effectively which is an intellectual ability with cognitive behavior. There are six levels of cognitive behavior, including Remembering, Understanding, Applying, Analysis, Evaluating, and creating. 2) Affective domain, these aspects are popularity values, attitudes, beliefs, interests, and virtues. This behavior may not occur immediately, therefore the teaching and learning activities that organized by the appropriate environment will make the behavior of learners change in the desired way. 3) Psychomotor domain which learning behavior that indicates proficiency in work consists of learning behavior in five stages, including perception, guided response, organization, and personality. Educational management guidelines for Electronic and Telecommunication Engineers Faculty of Engineering and the Architecture Rajamangala University of Technology Suvarnabhumi give importance to teaching that focuses on developing life skills along with academic skills development.

Bloom's Taxonomy and the faculty are consistent with important skills for students in the AI era which AI stands for artificial intelligence refers to a branch of computer science that attempts to make computers able to logically thinking, learning, and working like the human brain. These skills can be categorized into two skills which are hard skills and soft skills. Based approach to teaching and learning to develop students into creative works which are based on the theory of learning in the Cognitive domain, Affective domain, and Psychomotor domain [4], the researcher is interested in developing emotional soft skills to prepare students before going into the workplace so that they can adapt or apply these skills by designing three activities to encourage students changing their attitudes. Preparing for the situation knowingly and emotionally, and this will allow

students to know how to practice themselves to be able to live or work in an enterprise with a positive mindset. The activities for cultivating and developing students in soft skills are divided into three activities: preparation before leaving the workplace, techniques, and charming at work which will be discussed later in this research article.

2. GUIDELINES FOR ENHANCING SOFT SKILLS

The instructor should play a role and be a good role model for students by indoctrinating to nurture students to grow with virtue and good ethics. From the study of sources, it is acknowledged that the ideology of the youth year 2019 is studying to obtain a degree might be less important with today's technology because it is allowing them to access knowledge sources more conveniently and faster than sitting in a university and also not wasting time to study things that they are not interested in because they are forced into the curriculum. This results in many universities must reform teaching and learning methods to keep up with the technology and concepts of the new generation of young people that have changed. As the author became a cooperative communication teacher, the author exchanged ideas with workplace administrators and found that the establishment needs good people or people that think positively with the organization rather than smart people but lacking soft skills. Because good people with soft skills can improve hard skills not so difficult. Soft skills are a key factor in project success. For some jobs, the skills of soft skills are more important than hard skills [5]. For the reason that has been empirically endowed with changes in the fast-technological world, therefore, studying in the electronic and telecommunications engineering, Faculty of Engineering and Architecture has, guidelines for indoctrinating and developing students in soft skills which are the skills that businesses need the most in modern times through teaching and learning in engineering topics.

3. RESEARCH OBJECTIVE

1. Propose an approach to develop the emotional skills through activities.
2. Assess the satisfaction of student participation.

4. METHODOLOGY

This research is quantitative. The population of this research was used for students at the Faculty of Engineering and Architecture, Rajamangala University of Technology Suvarnabhumi. The sample group at this research was selected the students in electronics and telecommunications engineering, Faculty of Engineering and Architecture, and consisted of 26 students by selecting a purposive sample. The instrument used in this research was a questionnaire consisting of three aspects.

Preliminary agreement in this research

1. This research, regardless of gender, age, economic background, society, mood, and learning time of the sample group, does not affect the research.

2. This research trial assumes that students who study in this program have the same qualifications in all respects because they have been selected to study under the same program.

3. For the convenience of this research and to reduce travel obstacles, researcher needs to select a purposive sample group, whose details are shown in Figure 1.
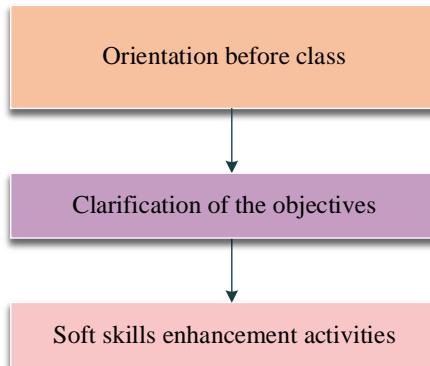
Figure 1. Steps before soft skills enhance students in soft skills.

Figure 1 shows the steps before enhancing the soft skills, there is a 3-step process as follows:

1. Student orientation before studying.

The students in the sample group were students in electronics and telecommunication engineering program, Faculty of Engineering and Architecture, Rajamangala University of Technology Suvarnabhumi that enrolled in the selected topics in Telecommunication Engineering course code 504-44-19 amount of 26 persons for academic year 2/2562.

2. Clarify the objectives of teaching and learning so that students have the same understanding of teaching and learning in the course Selected Topics in Telecommunication Engineering course code 504-44-19. There is a combination of soft skills in courses for three weeks, 1.5 lessons/week. After completing all activities, students should assess their satisfaction in organizing activities to indoctrinate and develop their soft skills.

3. Implement activities to enhance students in soft skills as in Figure 2.

Figure 2 shows teaching and learning management for enhancing skills in soft skills, proceed according to the process as follows.

3.1 Leading into lessons is a guideline for teaching and learning in selected topics in Telecommunication Engineering course code 504-44-19 and discussing the importance of soft skills in work which should have this skill in the digital disruption era.

3.2 Soft skills enhancement activities for soft skills training are defined in three weeks of 4.5 lessons. After completing the activities, distributed questionnaires, and interviewed the sample group of 26 people.
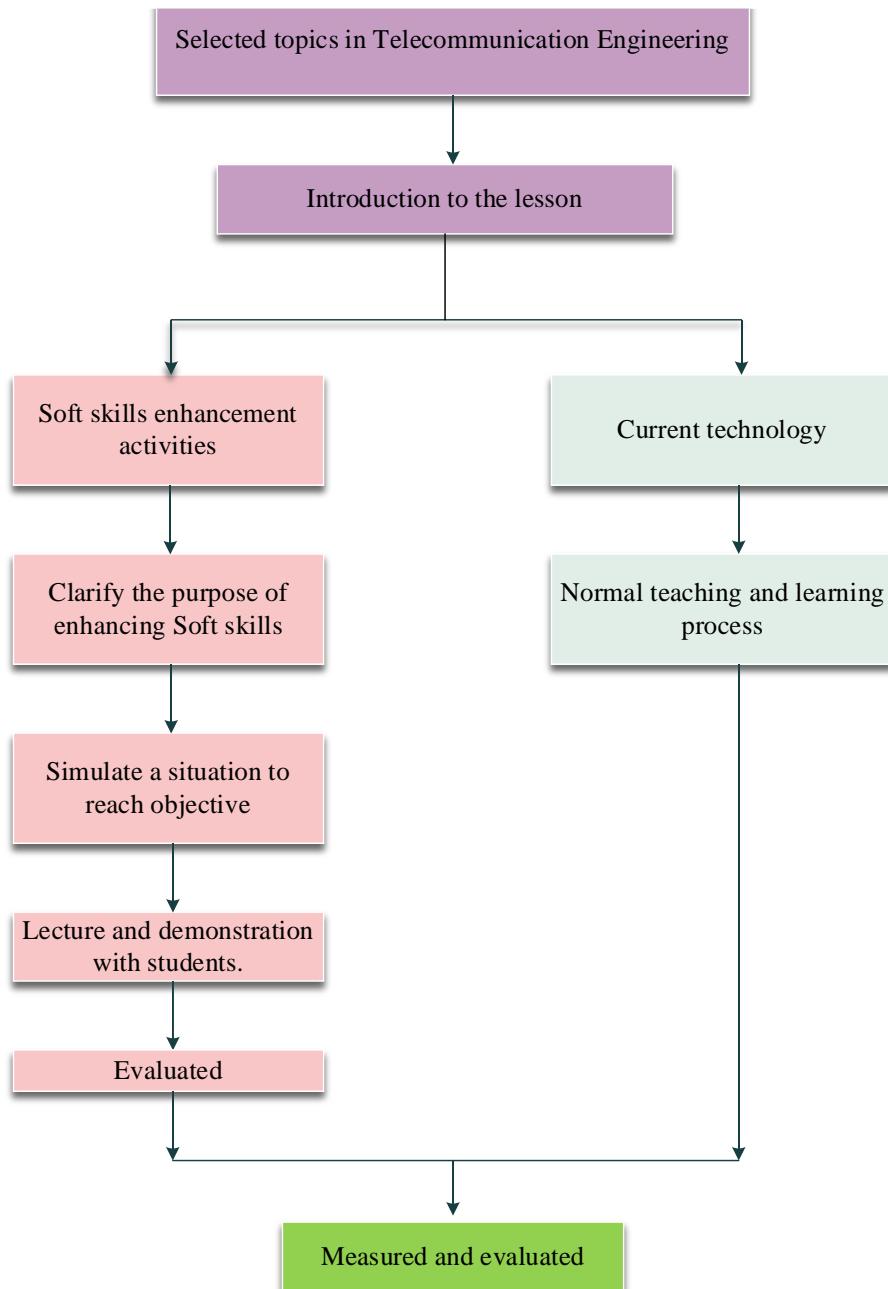
Figure 2. Teaching management for enhancing soft skills for students.
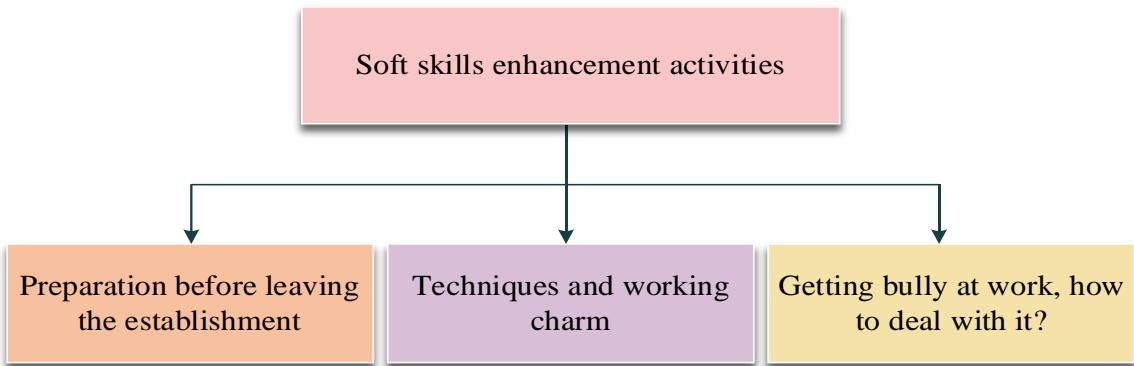
Figure 3. Activities for enhancing students in soft skills.

Figure 3 shows the activities for enhancing students in soft skills in all three activities that are described in week 2- 4, 1.5 periods/week as follows:

3.2.1 Preparation before leaving for the workplace

3.2.2 Techniques and charm of working

3.2.3 How to handle bullying in the workplace

All three activities have informed the purpose of the lecture and let students participate in the lecture to understand and see the value in enhancing soft skills.

3.3 Simulating the situations to reach the descriptive objectives and organizing a variety of activities such as questioning and dividing the students into groups to separate the situation or writing student experience etc.

3.4 Bringing the information from number 3 to discuss with students and pointing out the strengths and weaknesses of the described content.

3.5 After completing the activities, interview, and distribute questionnaires to evaluate the activities in three weeks.

5. RESULTS AND DISCUSSION

After completing all three activities, giving the interview, and distributing the examination divided into three areas which are lecturers, enhance soft skills, and benefits and uses of knowledge, the results are summarized of participation satisfaction assessment form in Table 1-3.

Table 1. Lecturer

Lecturer	Σ	N	$\overline{\mathrm{x}}$	S.D.	Interpretation
1. Preparation and readiness of lecturer	122	26	4.692	0.47	Very good
2. Expression of lecturer	124	26	4.769	0.42	Very good
3. Could explain the content clearly	124	26	4.769	0.42	Very good
4. Use appropriate and concise language	123	26	4.731	0.45	Very good
5. How lecturer answer questions?	123	26	4.731	0.45	Very good
6. Could create inspiration	118	26	4.538	0.64	Very good
Total			4.705	0.48	Very good

The results of the analysis from Table 1 show that 26 assessed students were satisfied with the lecturers. Overall, it is at a very good level. The arithmetic mean was 4.70 and the standard deviation was 0.48 ($\overline{\mathrm{x}}$ = 4.70, S.D. = 0.48) when analyzed individually. In order of averages from the highest, followed by the speaker's broadcast and being able to explain the content clearly, followed by using appropriate and easy-to-understand language and answering the questions of the lecturers.

Table 2. Enhance soft skills.

Enhance soft skills	Σ	N	$\overline{\mathrm{x}}$	S.D.	Interpretation
1. Students are aware of soft skills	126	26	4.846	0.36	Very good
2. Having more positive thoughts	118	26	4.538	0.76	Very good
Total			4.692	0.56	Very good

The results of the analysis from Table 2 show that the students who evaluated. Overall satisfaction in enhancing soft skills was at a very good level. The arithmetic mean was 4.69 and the standard deviation was 0.56 ($\overline{\mathrm{x}}$ = 4.69, S.D. = 0.56) when analyzed individually. In order of averages from highest to highest, followed by students' awareness of soft skills and positive thinking increased, respectively.

Table 3. Benefits and uses of knowledge.

Benefits and uses of knowledge	Σ	N	$\overline{\mathrm{x}}$	S.D.	Interpretation
1. Able to apply the knowledge gained in applying to work	123	26	4.731	0.60	Very good
2. Able to apply knowledge as a guideline for development progress	126	26	4.846	0.36	Very good
3. Being confident and able to use the knowledge gained	120	26	4.615	0.69	Very good
4. Benefit from participating in this event	125	26	4.808	0.40	Very good
Total			4.750	0.51	Very good

The results of the analysis from Table 3 show that the students who evaluated. Overall satisfaction with the benefits and uses of knowledge was at a very good level. The arithmetic mean was 4.75 and the standard deviation was 0.51 ($\overline{\mathrm{x}}$ = 4.75, S.D. = 0.51) when analyzed individually. In order of averages from the highest and the next, the knowledge can be applied as a guideline for progress and benefit from participating in this activity, respectively.

6. CONCLUSION

According to the results of the study of cultivating and developing students in soft skills of electronics and telecommunication engineering students, Faculty of Engineering and Architecture, Rajamangala University of Technology Suvarnabhumi, with activities to cultivate and develop students in the field of soft skills, these three activities are preparation activities before going to the workplace activities, techniques and charms at work, and how to deal with bullying in the workplace? The results can be summarized and discussed in each aspect as follows.

1. As a lecturer, the results showed that the students in electronics and telecommunication engineering those who have participated in the activities of cultivating and developing students in the field of soft skills. in all three activities are: Preparation activities before going to the workplace activities, techniques and charms at work, and how to deal with bullying in the workplace. The evaluation results are at a very good level. The mean was 4.705 and the standard deviation was 0.48 ($\overline{x}$ = 4.70, S.D.=0.48) because the instructors were prepared in terms of content, personality, the language used appropriately, and easy to understand. This resulted in the transfer of activities that presented activities for cultivating and developing students in the field of soft skills, which clearly focused on students preparing themselves before entering the workplace. The development of emotional skills or soft skills is an absolute necessity that must be included in every course. Soft skills have been emphasized [6]. Instructors in all courses guide or intervene in the development of soft skills. By balancing and promoting the teaching and learning, it approaches and enables students to develop emotional skills and soft skills to recognize themselves. Self-worth has a positive mindset solve immediate problems with consciousness happy working with others.

2. Soft skills instill and develop those who have participated in the activities of cultivating and developing students in the field of soft skills in all three activities are: The evaluation results are at a very good level. The mean was 4.692 and the standard deviation was 0.56 ($\overline{X}$ = 4.692, S.D. = 0.56). This is due to the activities of cultivating and developing students in the field of soft skills that the researcher has presented, focusing on students to prepare themselves before entering the workplace. The researcher presented an activity that raised student's awareness of emotional skills in a positive way affecting their lives. Working in an establishment coping with stressful situations and all students must hurry to adjust their attitude to be a positive person. There was knowledge about the development of students in three areas: 1. Cognitive Domain 2. Affective Domain, and Psychomotor Domain. The development of these three areas must be developed together with the lack of anything better, it will not result in the development of students.

3. Regarding the benefits and application of knowledge, the research results showed that the students in electronics and telecommunications engineering who participated in the activities of cultivating and developing students in the field of soft skills in all three activities were assessed at a very good level. The mean was 4.750 and the standard deviation was 0.51 ($\overline{X}$ = 4.750, S.D. = 0.51). This is due to the students applying the knowledge gained in the activities or adjusting the application to everyday life at home, school, or institution to progress in their careers with confidence.

In summary, the overall picture of the activities of cultivating and developing students in the field of soft skills, all three activities were assessed at a very good level. The mean is 4.717 and the standard deviation is 0.50 ($\overline{X}$ = 4.717, SD = 0.50) due to the benefits that are gaining attention in today's society and from the case in the social world. Information that is important for the development of emotional skills, soft skills of all students and youth in the 21st century must have to fulfill their work or daily life happily, divided into four areas. as follows [7].

1. Communication: Skills in communication and interaction with others, including public speaking skills.

2. Collaboration: The skill to work with others, which is related to leadership is the skill of being a leader knowing where to lead, and teamwork, the skill of working as a team with others.

3. Critical thinking: Critical thinking skills and problem-solving skills.

4. Creativity: Creative skills which will be used in work and problem solving.

Soft skills are the important factor for success that modern youth must have because soft skills are essential skills in today's labor market. Organizations or organizations have focused on soft skills in addition to hard skills. People around the world agree that people with high IQ alone [8]. It cannot be successful in working or running a business sustainably without continuous development of soft skills. Therefore, the new generation of smart people must have skills in both areas: good at work and good at both people. which is considered the ultimate desired personnel of every organization. Some scholars even call this skill that it is the potential in people management competency.

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A Review of Artificial Light Technology; Leds on in Vitro Cultured Plant Morphology and Physiology

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ABSTRACT

Light strongly affects plant anatomical, physiological, morphological, and biochemical parameters of plant growth and development. Nowadays, artificial light technology is popular in agriculture system especially in vitro culture system. In this review, we aim to give an overview of the impacts of artificial light technology, which are LEDs on in vitro cultured plant morphology and physiology. The outcome shows the knowledge of using artificial light to promoted plant growth and development and how they affected.

Keywords: Light; Artificial light technology; Plant morphology; Plant physiology

1. INTRODUCTION

Light is one of the most important factors that affect the developing plant growth and development. Since seeds are germinate, they need to be response to their light environment. The responses of plants to light sensing from its quantity (fluence rate), quality (wavelength, i.e., color), direction, and duration (photoperiod) [1], [2]. Artificial lights sources vary in intensity, duration and spatial distribution. The light emitting diodes (LEDs) technology popularly used as supplementary light has shown great advancement in protected cultivation. One of the greatest challenges for the LEDs as alternative light source for greenhouses and closed environments is the diversity of the way experiments are conducted that often makes results difficult to compare. Morphology and physiology of grown plants are regulated by various micro-environmental factors such as light, temperature, humidity and carbon dioxide [3]. Light (spectral quality, photon flux density, and photoperiod) is an important factor among these and it generally influences the overall growth and development of in vitro plants [4]. Generally used light sources for culture of plants are fluorescent lamps; some research and commercial laboratories also use metal halide, sodium or incandescent lamps. The spectral range of these lamps vary from 350 to 750 nm (as shown in Figure 1), which contains mixture lights and affect the growth of cultured plants. Recently, light emitting diodes (LEDs) have been developed and used as an alternative light source for plant culture system because of their wavelength specificity and narrow bandwidth and minimum heating [5]. Red and blue lights have the greatest impact on plant growth because they are the major energy sources for photosynthetic CO_2 assimilation in plants.
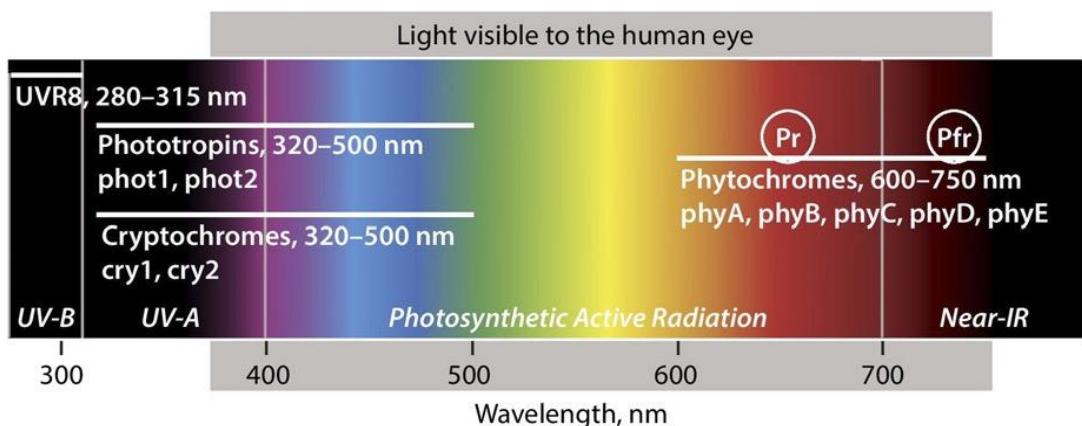
Figure 1. The range of wavelengths that are sensed by the main plant photoreceptors (phytochromes, cryptochromes, phototropins, and UVR8) allowing light-driven developmental adaptations (data from http://www.biologie.ens.fr/smdgs/spip.php?article57). [6]

2. EFFECT OF LIGHT QUALITY ON PLANT MORPHOLOGY AND PHYSIOLOGY

There are several reported about the light quality in micropropagation. [7] reviewed the use of blue and red LEDs has been commonly used for producers as these wavelengths are efficiently absorbed by the photosynthetic pigments as we known as chlorophylls, with red light being the most energy efficient in LED production. Both blue (420–450 nm) and red (600–700 nm) lights are absorbed by chlorophyll a (Chl a) which has its absorption peaks at 430 and 665 nm and chlorophyll b (Chl b) at 453 nm and 642 nm [8] (as shown in Figure 2. (A)). As the chlorophyll and nonchlorophyll pigments have different absorption spectra, the result is a composite absorption spectrum that is broadened such that a wider range of radiation is absorbed by plants [9] (Figure 2 (B)). The light scattering increases the probability of absorption drastically, which is demonstrated if a leaf is vacuum infiltrated by, e.g., water (as shown in Figure 2 (C)) [10]. The light absorption in leaves represents absorption in all pigments, including non-photosynthetic pigments. Since some of the absorbed energy will not be delivered to the reaction centers of the two photosystems, the relative quantum yield of photosynthesis (as shown in Figure 2 (D)) will deviate from the absorption spectrum of the leaf (as shown in Figure 2 (B)).
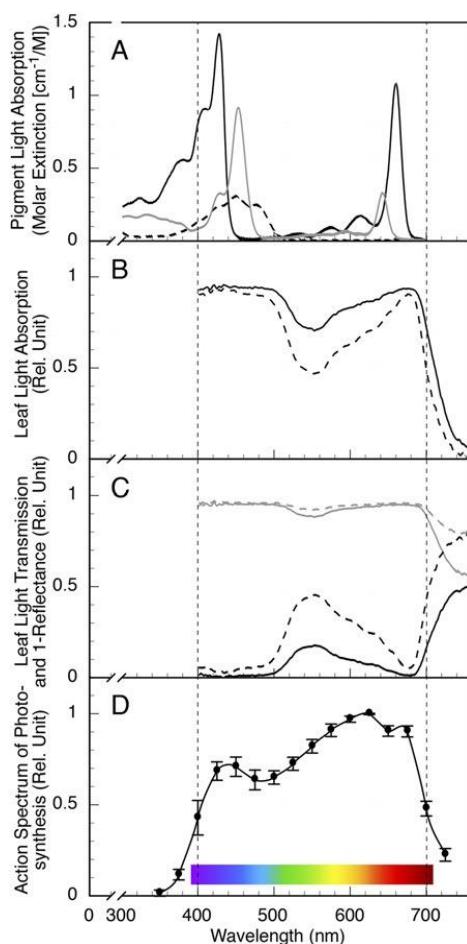
Figure 2. Spectrum for pigments and leaves. (A) Absorption spectrum of chlorophyll a (black line) and chlorophyll b (gray line) in diethyl ether, and beta-carotene (dashed line) in hexane based on data from http://omlc.ogi.edu/spectra/ PhotochemCAD/index.html. Other carotenoids like lutein and zeaxanthin have a similar absorption limit as beta-carotene [11] in the green range above 492 nm. (B) Light absorption in Chrysanthemum morifolium; fresh leaf (black line) and vacuum infiltrated by water (dashed line) to eliminate light scattering measured by a light integrating sphere (ASD Inc., Boulder, CO) and Avaspec- 2048 spectrometer (Avantes, Apeldoorn, The Netherlands). (C) 1-Reflectance (gray lines) and transmission (black lines) of the same fresh (solid lines) and vacuum infiltrated (dashed lines) leaves. (D) The relative quantum yield of photosynthesis of eight crop species (mean values ± SD) based on data from [12].

The influence of light quality on growth and development of in vitro grown Doritaenopsis hort was investigated. [13] Doritaenopsis hort plants were regenerate from leaf explants and supplied with four different light treatments; 1) fluorescent light (provided by white cool florescent lamps), 2) red LED (660 nm), 3) blue LED (450 nm), and red plus blue (1:1 photon flux density). The result showed that growth parameters were highest with plants grown under red plus blue light emitting diodes (LEDs). Leaf length was greater with the plants grown under red LED. Carbohydrate (starch, sucrose, glucose and fructose) and leaf pigment (chlorophylls and carotenoids) biosynthesis of the plants was significantly increased in plants grown under red plus blue LEDs compared to red or blue LED and fluorescent light treatments. This study suggested that the production of quality Doritaenopsis plants was possible by culturing the plants in vitro under a mixture of blue plus red light sources.

[14] They studied the effect of light quality on physiological transformation of in vitro Phalaenopsis 'Fortune Saltzman' seedlings. Phalaenopsis tissue culture seedlings were examined. They separated the seedling into three stages; stage I (seedlings of 1–2 cm in height with 1–2 leaves and 1–2 roots) tissue culture seedlings were grown under six different light qualities under a T5 fluorescent lamp: White, Red (610 nm), Red (658 nm), Blue (440 nm), Red (610 nm) + Blue (440 nm), and Red (658 nm) + Blue (440 nm). The result showed that after five months, cultured seedlings subjected to Blue (440 nm) treatment generated more leaves and presented higher levels of chlorophyll a, chlorophyll b, total chlorophyll, and carotenoid content. On the other hand, seedlings subjected to the Red (658 nm) treatment had longer stems and leaves and higher fresh and dry weights than those subjected to other treatments. Root quantities increased under Red (658 nm), Blue (440 nm) + Red (610 nm), and Blue (440 nm) + Red (658 nm) treatments. This clearly shows that to enhance seedling growth through commercial production, Red (658 nm) should be applied.

[15] They studied on the effect of light quality on leaf production and development of in vitro cultured plants of Alternanthera brasiliana Kuntze. Light quality experiments were performed in growth chambers equipped with Sylvania Cool 60 F20T12 fluorescent tubes to provide different light qualities: red light, green light, white light, and blue light. White light and darkness conditions were used as control treatments. The result showed growth parameters including specific leaf mass, thickness, and leaf density were lowest in plants grown under red light. Blue light induced the largest number of leaves/plant, and the largest thickness and area of the leaf blade. Green and red lights induced the smallest leaf areas. The thickness of the abaxial-face epidermis and spongy parenchyma of the plants was significantly reduced in plants grown under red light. The thickness of the palisade parenchyma and upper epidermis were significantly increased in plants grown under blue light, compared to the other fluorescent-light treatments. In the dark and under red light, the mesophyll was homogenous; and in the dark and under green light, the leaves were more compact. Under blue light, the cells displayed the characteristic palisade morphology. The results showed that the increase of a specific parenchyma type was related to a specific spectral band. This study indicated that Alternanthera plants have strong morphological plasticity induced by light. The results suggested that high quality Alternanthera can be achieved by culturing the plants in vitro under a combination of blue and red light.

The effects of different light qualities on rapeseed (Brassica napus L.) plantlet growth and morphogenesis in vitro was study by [16]. The light sources generally used for in vitro plant cultures are fluorescent lamps. The plantlets were exposed to 60 µmol m^{-2} s^{-1} photosynthetic photon flux (PPF) for a 12 h photoperiod under the following six different light qualities: fluorescent lamps (FL), monochromic blue light-emitting diodes (LEDs) (B), monochromic red LED (R), and three mixtures of B plus R (3:1, 1:1, 1:3) LED. The proliferation rate was greater in plantlets that were cultured under B light than those under FL. The differentiation rate, fresh mass, dry mass, concentration of chlorophyll a, soluble sugar concentration, stem diameter, root activity, stomata frequency and transplantation survival rate were greater in plantlets that were cultured under B:R = 3:1 light than under FL. The concentration of starch and the spongy tissue length were higher in plantlets cultured under R light than those under FL. The B:R = 3:1 LED light was suitable for rapeseed plantlet growth in vitro and can be used as a priority light source in the rapeseed culture system according to its differentiation rate, proliferation rate, growth rate, and transplantation survival rate.

3. EFFECT OF LIGHT INTENSITY ON PLANT MORPHOLOGY AND PHYSIOLOGY

Light provides the energy needed for growth, photosynthesis and may influence plant productivity and seedling survival. Different light intensity is a key factor in the field, which varies seasonally, diurnally and spatially [17]. Phalaenopsis orchids have large well-developed leaves to utilize maximum light energy and when kept under high PPFD leaves show rapid photo bleaching.

[18] They were studied about the possible relationship between the effects of different levels of light intensity and the changes of antioxidant properties, Malondialdehyde (MDA) level, Lipoxygenase (LOX) activity, protein content and photosynthetic process during short term acclimatization in Phalaenopsis. Six months old in vitro grown plantlets were exposed to low light (LL-60 $\mu molm^{-2} s^{-1}$), intermediate light (IL-160 $\mu molm^{-2} s^{-1}$) and high light (HL-300 $\mu molm^{-2} s^{-1}$) photosynthetic photon flux density (PPFD), respectively under controlled condition. Plantlets exposed to HL intensity had lower level of Fv/Fm ratio than the LL grown plantlets during acclimatization. Regarding antioxidants enzymes, Superoxide dismutase (SOD) activity increased in leaves with increasing light intensity but light stress had no significant effect in roots. dehydro ascorbate reductase and monodehydro ascorbate content activities increased in LL and IL but decreased at HL. The Catalase (CAT) activity increased in both leaves and roots with increasing light intensity. While guaiacol peroxidase activity increased in roots, peroxidase activity was not detected in leaves. No significant change in glutathione reductase (GR) activity has been found at IL and HL, though it decreased significantly at LL compared to in vitro grown plantlets. There was an increase in ascorbate oxidase activity in leaves of about 50% at HL compared to in vitro grown plantlets, whereas no changes in roots were observed. glutathione S transferase activity showed pronounced stimulation in both leaves and roots of the plantlets exposed to HL compared to in vitro grown ones. Total leaf protein content increased in light stressed plantlets compared to in vitro grown plantlets. Leaf protein and LOX increased during light stress compared to in vitro grown plantlets suggesting that LOX mediated lipid peroxidation contributed to the oxidative damage occurring in the study. These results suggest that increase in enzyme activities were an adaptive response of the plantlets to higher amounts of reactive oxygen species (ROS) generated during acclimatization under light stress.

The effects of in vitro environmental conditions, ventilation of culture vessels and light level, on water loss control and photosynthetic capacity of Castanea sativa during in vitro culture were studied by [19]. C. sativa microshoots were cultured in ventilated (V) and non ventilated (NV) vessels, using two photon flux density (PFD) levels, 50 and 150 μmol photons $m^{-2} s^{-1}$ (L50 and L150, respectively). The use of ventilation and the increase in irradiance improved the performance of the microshoots with respect to traditional in vitro culture of C. sativa (NVL50). Microshoots grown under VL150 showed an increase in stomatal density and improved their functional characteristics, showing a more elliptical shape and lower percentage of stomata opening. This paralleled a significantly lower transpiration rate and stomatal conductance. Increasing light level and using ventilated vessels increased the microshoots capacity to harmlessly dissipate excess absorbed energy, water use and photosynthetic activity, resulting in a greater production of new microshoots. These improvements during in vitro culture generate microshoots with anatomical and functional characteristics similar to those observed in seedlings, which could help reduce the stress observed during ex vitro transfer.

[20] They studied on Photosynthetic response of in vitro guayule plants in low and highlights and the role of non-photochemical quenching in plant acclimation. Guayule (Parthenium argentatum L.) is a hypoallergenic latex-producing recalcitrant crop. During in vitro regeneration, the growth and the photosynthetic response of guayule was strongly affected by light intensities. Chlorophyll a (Chl-a) fluorescence was used to study the photosynthetic responses of in vitro grown guayule plants under low light (100 $\mu molm^{-2}$ s^{-1}) and high light (1250 $\mu molm^{-2}$ s^{-1}). In high light (HL), the shoot length was reduced and fresh and dry weights were enhanced, contrary to low light (LL) plant response. Total chlorophyll (Chl) and carotenoid contents based on fresh weight or leaf area were reduced by about 50% in HL compared to LL. Although maximum efficiency (Fv/Fm) of photosystem II (PSII) in the dark, electron transport rate (ETR-I), and quantum yield of photosystem I(PSI) were unaffected, the electron transport rate (ETR-II), quantum yield of PSII and non-photochemicalquenching (NPQ) were ~78–88% higher in HL than LL. There were no significant differences observed in malondialdehyde (MDA) content during regeneration of plants in either HL or LL. The higher NPQ in HL grown plants than LL grown plants suggests that NPQ plays an important role in photoprotection during acclimation of guayule plants when exposed to HL.

4. EFFECT OF PHOTOPERIOD IN MORPHOLOGY AND PHYSIOLOGY

Photoperiod is indicating the length of day or presence of light for plants grown under LED at total absence of natural light. Naturally, plants use photoreceptor proteins of phytochromes or cryptochromes to detect length of light, as well as absence of light or darkness [21], [22]. Changes of photoperiod affect to plant physiology such as, seed germination, plant growth and yield, while flowering of some temperate plant species depends on critical length of night [23]. [24] They study the effects of LED photoperiods and light qualities on the growth and chlorophyll fluorescence of Cunninghamia lanceolata (C. lanceolata) in vitro culture plantlets. In this study, plantlets were exposed to 20 $\mu molm^{-2}$ s^{-1} irradiance for three photoperiods, 8, 16, and 24 h under the three composite lights, 88.9% red+ 11.1% blue (R/B), 80.0% red+ 10.0% blue+ 10.0% purple (R/B/P), 72.7% red+ 9.1% blue+ 9.1% purple+ 9.1% green (R/B/P/G), as well as white light (12.7% red+ 3.9% blue+ 83.4% green, W) as control. The results showed that: plant height, dry weight, rooting rate, average root number, length, surface area and volume, chlorophyll, and chlorophyll fluorescence parameters were significantly affected by photoperiods, light qualities and their interactions. Plantlets subjected to photoperiod 16 h had longer root, higher height, rooting rate, root number, and the higher levels of chlorophyll, chlorophyll a/b, Y (II), qP, NPQ/4 and ETR_{II} compared to photoperiods 8 h and 24 h, while Fv/Fm during photoperiod 16 h was lower than 8 h and 24 h. Plantlets exposed to R/B/P/G generated more root and presented higher chlorophyll, Fv/Fo, Y (II), qP, and ETR_{II} than W during photoperiods 8 and 16 h. Total chlorophyll content and ETR_{II} were significant correlated with rooting rate, root length and root volume, while Fv/Fm and ETR_{II} were significant correlated with plant height, average root number and root surface area. 16-R/B/P/G is best for growing C. lanceolata plantlets in vitro. From the result, the experiment can conclude that the effectiveness of photoperiods and light qualities using LEDs for micropropagation of C. lanceolata. The best plantlets were harvested under 16-R/B/P/G treatment. And there was a correlation between the growth and the chlorophyll and chlorophyll fluorescence of their leaves under different photoperiod and light quality.

5. CONCLUSION

Light is an important factor that affect the developing plant growth and development especially plant morphology and physiology. Currently, artificial light plays an important role in agriculture technology and in vitro culture system. Artificial light technology also showed a great advantage to promote plant growth and development. Nowadays new trend of agriculture such as indoor crops, plant factory or vertical farm are also use artificial light supplied to plants, like that from LED, can be achieved through the light quality, light intensity and photoperiod to fulfil photosynthesis and other plant physiological functions which related to increase the quantity and quality of crop production. This review aims to show the effect of artificial light; LEDs to plant morphology and physiology to people who would like to use them in agriculture field.

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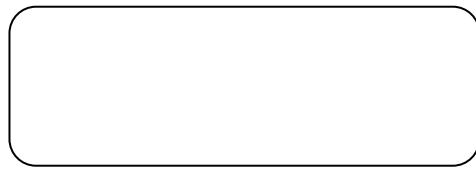
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1. Leaving 1 row before inserting the table and giving 1 row before writing the information for the table in details.

2. Uses "Table ..." at the left corner with font 12 bold inch.

3. Table name is in font 12 inches and if the table detail is longer than 1 row, it should be started with new row by the same starting column.

4. Using only in column table as opened the left and right alignments.

Table 1 (Table name is in 12 inches.)

| Title (12 bold inch.)	Title	Title	Title	Title
Content (12 inches.)	Content	Content	Content	Content
Content	Content	Content	Content	Content
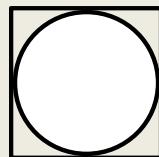
Figure 1 .... (Font is in 13 inches with in center column)

3.7 Discussion part in 16 inches.

At left column for contents. For first row in each paragraph, it has to give 4 word-spaces (font in 14 inches.)

3.8 Conclusion part in 16 inches.

At left column for contents. For first row in each paragraph, it has to give 4 word-spaces (font in 14 inches.)

3.9 Acknowledgement in 16 inches. Without putting number in front of topic (Font in 14 inches.)

No needs to put the number for this content (font in 14 inches.)

3.10 References title font in 16 inches.

    (Content font is in 14 inches.)

3.11 $\overline{X}$ **and Table Format**

    - Create your own table in column and Do Not Copy table form from other file sources.

    - Use $\overline{X}$ as only in this following size $\overline{X}$ (S.D.) ($\overline{X} \geq 3.50$) ($\overline{X} = 4.51$).

3.12 Sub title format (Example)

---

1. Title (ขนาด 16 หนา)

    1.1 Sub title (6 word-spaces in 14 font inches.)

        1.1.1 Second sub title (alignment as the first world of sub title in 14 font inches.)

            1.1.1.1 Third sub title

                (1) sub title of 1.1.1.1

                    (1.1) sub title of (1)

Paper preparing /Paper submitting for publishing in Journal of Industrial Education

For correction, perfection, and time saving, paper submission for publishing in Journal of Industrial Education is needed to follow as this guideline.

1.1 Printed and typed in A4 paper size for 6-11 pages with one column style. By using Microsoft Word for Windows 2007, it is highly recommended the word processing software that fits in the Journal of Industrial Education format guideline according to our time saving for paper proof and publishing.

1.2

1.3 The original or submitted paper must be only formatted as the Journal of Industrial Education printed format. **If NOT follows as directions**, <u>**the author is informed and the paper will NOT be stepped any forward.**</u>

1.4 Paper is needed to be clear in contents and pictures.

1.5 Paper is Not published or Not printed in any sources such as journal, conferences, so on.

1.6 The author is fully responsibility to prove the correction of any requirement of Journal of Industrial Education format.

1.7 Typing or writing journal application form and attach transfer receipt.

1.8 Filling and signing on form to submit industrial education journal article. The first name is the author name, then the second to sixth are advisor names and so on.

1.9 Preparing and submitting paper is noted as forms. URL/ http://www.tci-thaijo.org/index.php/JIE

    1.9.1 SCAN PDF FILE AND MICROSOFT WORD**(**.doc. or .docx.**)** to database and naming the files separately.

1.7 Competely fill out the member form of Journal of Industrial Education.

    Scan it, attach it to ThaiJo system, and post confirmed mail.

1.8 Competely transferred the member fee for Journal of Industrial Education.

    Scan it, attach it to ThaiJo system, and post confirmed mail.

1.9 Competely fill out the submitting form for Journal of Industrial Education with requirement in 1.6

    Scan it, attach it to ThaiJo system, and post confirmed mail.

1.10 For the preparing and submitting paper, please see the direction and guideline of Journal of Industrial Education as URL http://www.tci-thaijo.org/index.php/JIE (Guideline is also in website).

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② Paper submitting form: https://drive.google.com/file/d/1ZMWINlA5BjFiOqHHvP2KOZwbngA6c5Zq/view

③ Template **paper format**: https://drive.google.com/file/d/1J6955l2yCkoQRWuDAueun6C-RPBWcU5V/view

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