

# Exploratory Study of a Smart System Framework for Educational Process with Gamification: Case Study - Schools in Indonesia

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**Abstract:** Education in Indonesia is one of the sectors that is always considered by the government. The right to education is legally guaranteed for all children without any discrimination. Therefore, various methods have been carried out by each stakeholder, including trying to adapt multiple technologies in the learning process. Most of the information technology that enters developing countries, notably Indonesia, is still dominated by multimedia applications on mobile devices. Which not support all the development aspects of children's potential in the learning process. Some things have not been considered, such as lack of attention related to children's development of motor skill factors and social engagement. Through smart system technology that utilizes hardware as a part of the system as a whole, the system will include those factors that are not noticed in the learning technology that has been adopted today. This research has succeeded in producing a framework for the need to create a smart system in the learning process for Indonesian schools. Through exploratory studies, scientific studies have been carried out based on theory and direct observation of the multi-ethnic learning environment in Indonesia, so the proposed framework will undoubtedly be able to be a guideline for building a smart system.

## 1 INTRODUCTION

Education is an action related to giving guidance and knowledge from someone to someone else. Someone who gives knowledge is called pedagogue and someone who obtains the knowledge is called student. One of educational processes usually occurred in school. When the target of the educational process is a child, is called pedagogy. Broadly pedagogy explained how learning and teaching activities influenced by cultural values, social, and environmental conditions. It also supported by a strong theoretical and practical basis. So that the educational process between regions can be different, not least in Indonesia. As a developing country, Indonesia, the learning process is considered as a tedious activity and only targets cognitive enhancement. Most of the children who do the learning process in school (as one of the main things in the educational process), often considered as an unattractive process and they tend to avoid it. Whereas, childhood needs not only emphasizing cognitive but also motor skill and social skill.

On the other hand, playing becomes the activity that children like. Indirectly, children assume that the

more energy they spent physically, the more fun they will get (Rubin, 1982). Children love to play because they can create images on their minds to realize it to the world (Bateson, 2006). The activity creates an addictive effect and a feeling of wanted to do it more and more. Modern theories of play differ from classical theories in that they not only explain play's existence but help us understand its function in children's development. Several studies related to the educational methods have tried to utilize the aspects of a game so that education can also be fun. Many studies and modern theories related to learning, which states that learning is not only bound to how the results are at that time. It is correlated to the effects that appear from the development of the children (Mellou, 1994). In developed countries, the benefits of games that have addictive effects and challenges are gaining popularity in the educational process, how the educational transfer process can engross game procedures. Gamification is one of the liveliest topics to study because it binds the meaning of "game" that does not offer "playfulness" (Salen et al., 2004).

Reinforced by the observation results in developing countries' schools, for instance, Indonesia.

Schools that used technology in teaching and learning focus on the increase of intellectual or cognitive potential only. The learner success parameter only considers by the increase of the score results they got. Thus, it seems like it is too focused on extrinsic motivation (Filimonov, 2017). Proving that the benefits of the learning process using technology in a developing country is not efficient. Education should be able to utilize technology such as smart systems, both massively connected (the internet) or only local areas such as a school or class. A smart system is an approach that given by information technology to create a decent service. Originally IBM tried to provide a smarter planet paradigm, which would develop a system that could solve problems using information technology communication through reactive-way (Barile and Polese, 2010). When hardware technology comes into play, then motor skill and social engagement also increase, and it arises the intrinsic motivation. Children will have motivation during the learning process, not just only focus on the results and achievements.

Therefore, the objectivity of this research is how a framework for a smart system can help the learning process created by applying the principle of game or gamification. With a particular case study in Indonesian schools, incidentally, Indonesia is a multicultural country and still develop. Moreover, Indonesia has diverse demographic conditions. Those factors were affecting the adjustment of building the smart system.

## 2 APPROACH AND METHOD

To produce a framework related to smart systems that help the learning process, the development of a basic framework will be carried out. As seen in the Figure 1, the basic framework used in ADDIE consist of Analysis, Design, Development, Implementation, and Evaluation. Some researchers commonly use the ADDIE framework in developing a new and more specific learning framework (Peterson, 2003). ADDIE has a broad characteristic and manipulated movement. To establish a new framework for a particular field, then the ADDIE framework needs to be adjusted with its need. Thus, the stages that need to be done to develop this framework is conducting exploratory studies on several research topics that have been determined. The exploratory study emphasizes the conceptual theory results based on honesty, integrity, and transparency on a particular branch of knowledge (Gerring, 2001) (George et al., 2005). An exploratory study is a research to find and explore information and analyzing the relation between theories and knowledge found (Vakkari, 2003). The activities

could be literacy in books, international publications, and regulations made by agencies or legal organizations. Another scientific method related to other exploratory study is observation, with a direct view of the phenomenon of environmental issues, which will establish the evident authentically of the theory that is found (Wimmer and Dominick, 2013).

Stages	Procedures
Analysis	Identifying and collecting data as a benchmark for next stages.
Design	Designing system requirements by considering the previous analysis.
Development	Designing system requirements by considering the results of the previous analysis.
Implementation	Implement and deliver systems that have been developed for users / participants.
Evaluation	Evaluate whether there is any increasing specific factor in participants after using the proposed system.

Figure 1: System Mechanism Design.

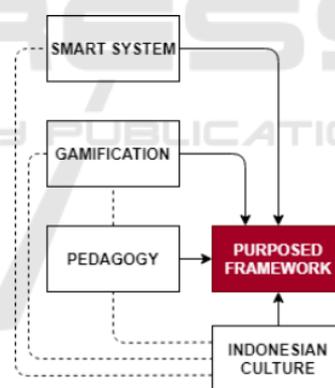


Figure 2: Research Literature Map.

The topics that will be explored are around smart systems, gamification, pedagogy, and Indonesian culture schools. A smart system is a system that can help to solve specific issues by utilizing technology, whereas gamification is a method of applying game elements in other fields. Because in gamification, there are different definitions between game and play, you can see the position of gamification towards "gaming" and "playing" in Figure 3. So then, it can be clarified that gamification offers a new learning style, where it applies the elements of the game into a nongame system.

These two things will be the solution to the learning process issue towards children or usually called

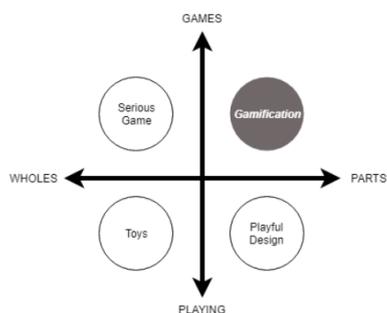


Figure 3: Gamification Position(Deterding et al., 2011).

pedagogy. Pedagogy refers to the practice of learning related to the study method of delivering intention towards children. Besides pedagogy, the culture of learning in developing countries will be formulated in the study. In this case, the observation conducted in Indonesia. It is known that culture and the environment influence learning. Hence, both pedagogy and the learning culture need to be reviewed according to the goals of this study, which create a framework for a smart system that utilizes gamification to support the learning process in schools. In addition, The relation between the topics can be explored in Figure 1. Furthermore, a mapping and explanation will be made for each finding on every step-in framework ADDIE. So that a new framework will emerge affiliated with smart systems for the learning process (case study: schools in Indonesia).

## 3 RESULT AND DISCUSS

This part will be explained about how the ADDIE framework has developed into a new framework, a framework that has been described with more specific requirements than general procedure explanation. Any findings from exploratory research on related topics mapped into a proposed framework that has helped provide a more detailed and particular framework for smart systems for the learning process. Furthermore, each stage of the proposed framework will be elaborated, which has contained a mapping of the results of exploratory studies conducted.

### 3.1 The Proposed Stage of Analysis

At this stage, a developer who uses this framework will trace the basic needs of the system to be built. This analysis section will be divided into two parts, namely, Learning Objectives Analysis and User Analysis.

#### 3.1.1 Analysis of Learning Goals

On the proposed framework, the goals of the learning process that has been analyzed divided into two groups, which are general learning goals as the mission and specific learning goals as the vision(Huang and Soman, 2013). General learning goals are statements that described expectations of the final conditions that will be obtained, while specific learning goals can be interpreted as the objectivity of the system to be built or a series of objects during the learning process. Thereby it will help the realization of the general goals. In other words, the specific learning goals must contain intrinsic motivation, and the general goals must bring up extrinsic motivation(Ryan and Deci, 2000).

#### 3.1.2 Analysis of Users Readiness

Users in the proposed framework are defined as human resources or brainware that uses the system(Insan et al., 2019). Some research related to technology readiness explains that readiness for the implementation of technology (including smart system) generally can be seen from three aspects, which are technology, organization, and environment(Tornatzky and Fleischer, 1990). The accomplishment of the adoption in a smart system depends on how the system can be calm towards the users(Ibanez et al., 2014), both on the pedagogue and the student. With the support of the constitution and government regulations (organization's aspect) throughout the education process in this country, it supports the use of technology and adequates the environment. It can be concluded that readiness analyzation is one of the right steps in developing a smart system.

Determine what needs to be considered in designing the system so that the delivery of the goals can be delivered well, by considering the results of the previous analysis.

#### 3.1.3 Material Design

Material design is intended to compile any content that will be prepared to be studied — derived from the goals to be achieved, which have been determined in the previous phase. In deciding the contents required standardized guidelines. If the application of material based on a competent curriculum, then it will be able to help each student to stay involved(Huang and Soman, 2013). It could be from books that have a clear syllabus, or other material sources that have been determined and recognized by specific organizations. Coupled with direct survey techniques for educational organizations, this can be an alternative for

determining the explicit content that will be used as material (Mathiyazhagan and Nandan, 2010) (McIntyre, 2011) (Simon et al., 1996) (Salant et al., 1994). For validating the substances that have been built can be strengthened by conducting personal studies such as interview towards the experts of the material (Alshenqeeti, 2014). Finally, the output of this phase is a list of the contents that will be delivered.

### 3.1.4 Gamification Design

Technically, the steps in this phase explain that the developer decides which gamification elements must be applied, of course, after going through the selection that matches the material to be included in the learning (Huang and Soman, 2013).

The materials are learning contents obtained from the material design. Learning Contents will be helped to be represented by gamification. Before designing what game elements will be chosen on non-game content, noted that there are several levels of these elements. The design of the game elements can be identified to 5 levels of abstraction development [deterding]. From abstract explanation has been made into specifics and details. The first one is interface design (Crumlish and Malone, 2009), the second is game design pattern (Bjork and Holopainen, 2005) and game mechanics (Taylor, 2009), the third is design principles and heuristics or 'lenses' (Mandryk et al., 2008), the fourth is conceptual models of game design units (Brathwaite and Schreiber, 2008) (Bernhaupt, 2010) (Fullerton, 2014) (Hunicke et al., 2004), and the last one is game design methods and design processes (Fullerton, 2014) (Belman and Flanagan, 2010). As seen in the table 2, explained that every stage of the elements has its contributions.

Notably, for elements of progression such as points, badges, and levels, it is better to be prioritized to be chosen in the design of gamification. The existence of these game elements can increase the competitive feeling found in each student (Nicholson, 2012). Even more, the leaderboard that shows the progress of each student can be seen by all participants and improve their social status. For other progression elements such as rewards, it can also provide motivation and get recognition of the time, effort, and skills students have. Because rewards and penalties are two sides of the same coin, which means rewards are an easy tool for motivation. Helping someone to make their own decisions about their actions without external control behavior will lead to better results (Nicholson, 2012). Eventually, when the game elements adopted in the learning process, it will enhance student engagement and aim to incorporate as many learning activities as possible (Mohamad et al.,

2017).

Level	Description	Items
Game interface design patterns	Representing the issue from the context and play a crucial role in designing and developing phase.	Badge, point, leaderboard, level.
Game design patterns and mechanics	Focus on how the flow of the system measured and ordered.	Time constraint, limited resources/ life time.
Game design principles and heuristics	Evaluative guidelines for approaching design problems or analyzing a design to realize system objectivity.	Enduring play, clear goals, variety of game styles.
Game models	Conceptual model from the game components or user experiences of the game.	challenge, fantasy, curiosity
Game design methods	Representing the process and practice on the development life cycle.	Playtesting, playcentric design

Figure 4: Taxonomy of Game Design Elements.

### 3.1.5 Learning Flow Design

Technically, a mapping over two results in the previous phase will be conducted. The selected game elements mapped to its relation with the learning content that has been designed. In a non-game adaptation towards game elements, three elements can be considered in representing learning material. The three elements are the mechanism, dynamics, and aesthetics (Zichermann and Cunningham, 2011) (Hunicke et al., 2004). Mechanism explained the connection of the goals and the selected game elements (also described in the previous phase).

Moreover, dynamics are related to an explanation of how game elements work and interact, so that will generate the flow of input and output from the learning process that the students face. For the aesthetics element, it is a representation of the description of the responses (especially emotional) that come up from students. For instance, if the level, challenge, and leaderboard are one of the elements that have been selected, then the dynamics element will be seen from how the material from learning content is represented

into various levels and with the emergence of different challenge variants at each level. Plus, if the elements are combined with badge or point, then each level will lead to a much more varied level of challenge. Furthermore, the leaderboard element is related to the achievements of each student. The leaderboard becomes a screen that able to see how far the level of the students can reach. The benefits of this leaderboard are the representation of the aesthetics element. Eventually, in this phase, the concept of learning flow will emerge if the gamification is being adopted. The output of this phase is the procedures management of learning contents in the form of flowcharts or steps that students will go through in the learning process (Fullerton, 2014)(Khaleel et al., 2016).

### 3.1.6 Smart System Design

Developing a system that has a "smart" paradigm needs cognitive abilities (Barile and Polese, 2010). Because smart systems are not only related to the implementation of the technology, but also the functional capabilities that they have. Functionality was able to analyze and make certain decision-making. Conceptually, the mechanism of the smart system divided into three, which are sense mechanism, actuating mechanism, and the processing mechanism of the data to produce the desired information(European Commission, 2011)(Akhras, 2000)(Yadav, 2017). Sense mechanism and actuate mechanism of the data are necessary to be designed because, in the definition, the system must be adaptive and aware of the environment. How the system takes data and provides action in response to the meaning of self-awareness was the reason why sense mechanism and actuate mechanism must be designed(Hammoudeh and Arioua, 2018). In sense mechanism and actuate mechanism needs to be designed concerning how each sensor and actuator used as a communication procedure. The smart system should have an integrated scheme in each topology that is built(Madni, 2008). So, every hardware, software, and humanware in this system will be able to interoperate with each other. Thus, the connection with the implementation for the educational process is that the system will be a "smart" assistant in presenting material, where the system will understand the needs of the goals in the first place. In the end, the system is built based on the right and accurate design which was able to reduce the waiting waste that may appear(Moon et al., 2018).

### 3.2 The Proposed Stage of Development

At this stage, execution and development were conducted based on the design documents that have been made previously. Determine what needs to be prepared to develop the system to realize the design results that have been produced already. In developing a system that has multiple environments, there are challenges, specifically related to time pressure in the developing phase.(Bievskas and nis Bievskis, ). One of the reasons that need to acknowledge that intelligent systems have complexity, thus allowing problems to arise during the development phase. Because not always a system that has pure computing is easier to use than systems that have complex computing((Yadav, 2017).

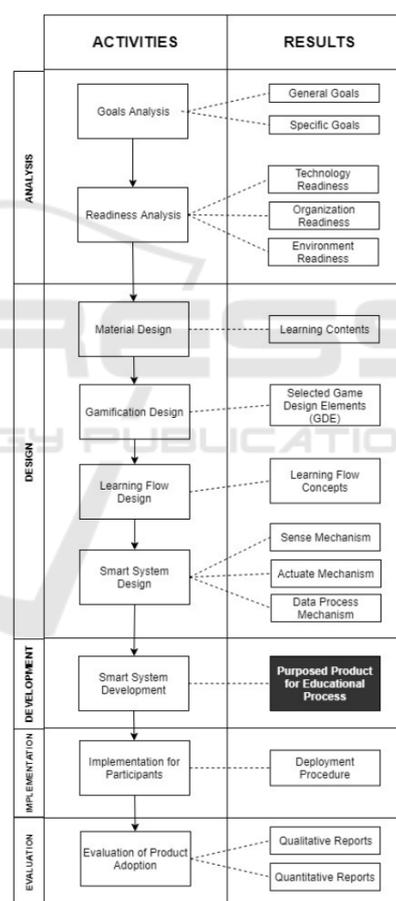


Figure 5: The Proposed Framework.

### 3.3 The Proposed Stage of Implementation

At this stage, the organization will implement the products produced from the previous development stage, generally by distributing the prospective users

who have been determined at the first stage (analysis phase). Considering developing countries such as Indonesia have multiple cultures that allow different needs during implementation, the distribution method can be adapted to the environment of the organization. Data generated at the Readiness Analysis stage should be a guideline in determining this distribution method. Each prospective user will have a general view of the situation when using it and will shape the user's experience of the proposed product (Harrison and Donnelly, 2011).

Eventually, the output of this phase is the procedure related to product deployment. Not only how this product reaches the organization (school), but it can be used based on the original propose-made. Other support outputs from this phase should be a companion product document or a document related to usage instructions (Bremer, 1999). Generally, user manuals have descriptive and narrative language that is cleared and detailed because the instruction document should present procedures and usage paths that must be easily understood for each function of the product.

### 3.4 The Proposed Stage of Evaluation

Data analysis divided into two phases, which are the quantitative phase and the qualitative phase. Evaluation techniques for the adoption of technology can use quantitative, qualitative, and its combination, which also known as the sequential explanatory design Method (Olds et al., 2005) (Teddlie and Tashakkori, 2003). Mixed methods research is considered legal, independent research designs in technical education that combine the strengths of both qualitative and quantitative (Olds et al., 2005) (Straus and Corbin, 1998) (Smith and Ellsworth, 1985). This selection needs to be adjusted to the initial goal of product development. Whether only seeing events based on the quantity, or seeing the quality, or pay attention to both. Technically, the quantitative method gets measured data about student activities. Then the data is analyzed statistically using parameters and nonparameters as needed.

On the other hand, qualitative methods use social approaches, usually with survey methods, precisely open-ended surveys that have been administered and analyzed to be explained numerically. The adoption of technology in the school environment, notably in Indonesia, places importance on a value parameter as an index of educational success. Then the quantitative method must be considered. Nevertheless, using both quantitative and qualitative methods could help to get answers to problems, it is better to do both evaluations.

## 4 CONCLUSIONS

From the exploration that has been conducted, a new complex and specific framework have developed and fulfills the needs of making a smart system that can be an alternative in the learning process. From the preparation process, which is analyzing process until the evaluation process, have work details to help to accomplish a system based on the initial requirements. The valid literature has approved any results obtained from exploration that has been carried out for reference. Therefore, the steps that exist in the reference framework become feasible to use. Furthermore, the next research has to prove that by following this proposed framework will create a smart system for the needs of the learning process in Indonesia. Then it is verified by seeing the results of the evaluation whether the resulting system does indeed provide positive results when adopted by the organization.

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