

Aesthetics of Interaction on Virtual Reality with Educational Games Content

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Abstract: The digital and virtual era creates a dependency between arts, science and technology. Knowledge and applications, currently, can no longer be separated, so there are overlaps between these concepts. In terms of interactive art, aesthetics no longer only arises because of its visual and sound beauty. This study investigates the diversity of aesthetic in virtual reality, especially with educational game content. This paper describes the aesthetic elements that occur in the experience of interaction through educational games. The case study of existing VR projects led this investigation of the aesthetics of interaction. The previous projects will be analysed for describing the aesthetics of interaction elements. We use the MDA framework (Mechanics, Dynamics, and Aesthetics) for study the learnable material as an element of aesthetic in virtual reality. Finally, we conclude that educational aspect potentially provides aesthetic elements in the play experience of the games with virtual reality technology.

1 INTRODUCTION

Virtual reality and digital games as part of interactive media cannot be separated from technology. The interdependence between art, science and technology provides its own advantages for interactive media. Interactive media becomes flourishing in the relationship between content, users and the technology that they use. Therefore, aesthetics no longer only appears as mere visual and sound beauty.

The aesthetics in the digital world of interactions gain more diverse by including other human senses. Moreover, feelings and communicative relations with the human side as well as artificial intelligence can also trigger the aesthetics of interaction. The aesthetics of interaction makes interactive media users get a distinct sensation of beauty. In addition, under certain circumstance the game player can be sucked into the virtual game world; this condition is often called immersion.

Educational games are often used as alternative learning in certain fields. And even in some conditions, the educational game is used to support the learning process at school. Most users of educational games give positive testimonials to the results of this alternative learning method. Basically,

with serious content, educational game users still feel immersion through these play experiences and other elements in the game world. On the other hand, educational games tend to emphasize learning material through game play rather than its visual elements. There are interesting things that pay attention from this research. The aesthetics elements of non-visual and sound have a potential to provide senses of satisfaction in playing. This study will focus on investigating the aesthetic elements that affect the immersion and play experience of the educational game.

2 LITERATURE REVIEW

2.1 Aesthetics of Interaction

Crawford (2003) illustrates the terminology of interactivity through a metaphor of reciprocal cycle relations between two people by carrying out activities listening, thinking, and speaking. The quality of interactivity depends on each act of listening, thinking, and speaking. Like a conversation cycle, when someone speaks, the interlocutor will listen, then understand the intent of the statement, analyze, synthesize and finally speak to react to the

opinions or arguments of the first person. This conversation occurs continuously in turn through the listening, thinking and speaking activities of each party. Finally it comes to the same understanding or agreed solution, this is the interaction metaphor according to Crawford (2003).

The terminology of listening, thinking, and speaking in the context of interactive technology can be explained through terms of input, process, and output, although it seems complicated to understand (Crawford, 2003). This elusive impression arises because we think from the point of view of the artists and designers; where artistic is born from the intuition and fruit of the work and design. The terms of input and output are part of the stages outside the artist's self, more precisely the terminology in the technical/ engineering field. The word of process itself in the field of interactive media also raises a lot of understanding. What process is meant? Does the process interact? Or is it the manufacturing process?

LeBlanc (2004) tries to offer a concept that is more easily understood through media of game; the approach is called MDA (Mechanics, Dynamics, Aesthetics). This approach will connect multi fields between technology, science and design. Let us begin understanding through the example of the game as software (Figure 1).



Figure 1: Game as Software (LeBlanc, 2004).

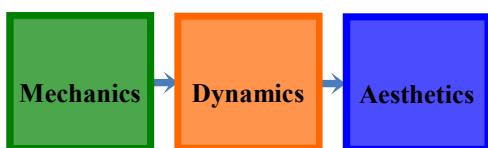


Figure 2: MDA Approach (LeBlanc, 2004).

LeBlanc (2004) proposes the MDA approach as a bridge between technology and design. In detail, it provides mechanical terms for programming code and game rules. Second, the dynamic term is to accommodate technical processes and interactive systems in the game. Finally, "fun" and technical needs are part of an aesthetic approach. In the world of aesthetic digital games, LeBlanc refines the term "fun" in eight types, among others (Hunicke et al., 2004):

1. Sensation (Game as sensory pleasure)
2. Fantasy (Game as imaginative but convincing)
3. Narrative (Game as a story or drama)
4. Challenge (Game as training against obstacles)
5. Fellowship (Game as a socializing container)
6. Discovery (Game as territory that needs to be explored)
7. Expression (Game as discovery/ self-actualization)
8. Submission (Game as entertainment / hobby)

We can use the MDA approach as a reference for aesthetics of interaction for develop games or other interactive media.

In his study, Costello (2007) also develops pleasure criteria into 13 types so that they could enrich LeBlanc's "fun" terminology, such as:

1. Creation (the pleasure of interacting with artworks)
2. Exploration (the pleasure of exploring something)
3. Discovery (the pleasure of finding or doing something)
4. Difficulty (pleasure with developing skills)
5. Competition (pleasure from the experiment reaches the final goal)
6. Danger (pleasure through fear or danger situation)
7. Captivation (pleasure by feeling another entity that has control or attraction)
8. Sensation (pleasure through the five senses response)
9. Sympathy (the pleasure of sharing emotional feelings)
10. Simulation (pleasure because of real life copies)
11. Fantasy (the pleasure to feel the fantastic creation of imagination)
12. Camaraderie (pleasure developing a sense of friendship)
13. Subversion (pleasure breaking rules)

According to some of those elements above, Wright et al. (2008) also formulates in other sentences that aesthetics of interaction need to focus on individual understanding, concerns, desires, aspirations, values, and user experience. Petersen et al. (2004) add that the aesthetic of interaction concept can be used as a way of conceptualizing interaction, gestural acceptance, emotional expression, and pleasant & spontaneous real interfaces. It means, the aesthetic of interaction is not only felt, however there is play experience inside it. A pragmatic approach to aesthetics of interactive system states that aesthetic is

closely related to the context, usage, and intermediate medium.

Kwastek (2013) states that interactive media must begin with active entities from several parties involved. Artists or designers are individual subjects and not just "the tailor" of the interaction systems. Therefore, the aesthetics of interaction should prioritize individual perceptions and interpretations. Perception and interpretation appear subjectively and cannot be generalized. The creator of interactive media still plays an important role in the aesthetics of his artwork. Artists will create proportions of interaction through design and programming as a form of system implementation by selecting, constructing, and uniting digital assets that have been prepared. Kwastek adds in the perspective of the users of interactive art, they feel that the beauty in interactive works is moments that are unthinkable and unidentified situation emerged outside of preconception. Creating interactive media is building an interactivity framework in the context of the process of using the intuition.

Kwastek (2013) also states that aesthetics in interaction projects can be affected by decision-making by interactive media users, even though the interaction is actually planned in advance. So in reality, users can experience immersion through their play experience and skip some interactions that are available by design. The emergence of real contradictions between the desire to admire artworks and the need to control those feelings are characteristics of interactive art. In other words, the absence of artists/ designers in the interactive media interaction process is recognized as part of the interactivity characteristics. Their role is only at the beginning of creating. The dynamics of interactivity are fully a process of interaction between the system and the user. Interactive project is built through gradual processes and iterations, where artists/ designers test potential interactions according to their imagination and design as a form of verification and possible modifications in these interactive media systems. It means the artists/ designers are the first users of their own works. Therefore, to get a more ideal verification, several test-plays are needed in the process of building interactive media by involving potential users or certain groups who have an interest in interactive media.

Blunck (as cited by Kwastek, 2013) suggests that a certain form of aesthetic experience is possible if we experience a situation not by truly experiencing "its sensual presence", but by "imagining it in its absence, imagining it sensually and in such a way as to direct it to presence of its aesthetic".

2.2 Narrative as Virtual Reality

In the digital world, opinions emerged regarding the use of virtual reality technology, including VR will replace reality; including the opposite of VR will not be able to replace reality, VR will question the concept of reality, VR will rediscover or explore reality, VR will enhance the user's mind, VR is a riskless pleasure so it can be considered immoral, VR will question the uniqueness between fiction - reality, etc. (Ryan, 1999). In his study, Ryan analyzed VR as a semiotic phenomenon and explored its implications for literary theory and textuality problems. Narratives play an important role in interactive media, as a result of the interaction plot and interaction experience depend on the storyline that was designed beforehand.

In VR technology, there is immersion and interactive elements that generated by computers. Ryan (1999) sees that this immersion and interactivity are characteristics of data used to create reality experiences through virtual reality. According to Steuer (as cited by Ryan, 1999), these two data characters will present the term telepresence; the condition where you feel the presence of environment that is developed virtually, rather than the real environment directly. Telepresence is related to presence, just as virtual reality relates to reality. Ryan describes that an interesting part of this interactive media is when it can transfer the concept of immersion and interactivity into a literary perspective. So the narrative has the potential to be applied textually into VR technology. This is related to interactivity, which is considered to have its own aesthetic value through post-modern theories. On the other hand, immersion is often ruled out as a form of illusionary aesthetic suspension from the reference to its use in the narrative. Therefore, the immersion has the power of the presence of reality (Ryan, 1999).

2.3 Immersion

According to Ryan (1999), immersion depends on clarity, where technological equipment has an influence in representing reality. In this case, immersion will be stronger when projecting a three-dimensional display, the illusion of depth through any space. Through VR technology, the boundaries of space are lost so users feel they are in the virtual world. Steuer (1992) states that there is a depth of information in VR media as a function of display resolution. Steuer also adds about the breadth of information as the number of sensor dimensions that are simultaneously displayed through media images,

sounds, sense of smell, and touch sensations. VR technology combines the diversity of media in a complete interaction experience.

Sheridan (as cited by Ryan, 1999) enriches Steuer's statement on immersion, where VR users must be able to explore the entire virtual world and understand it with various perspectives. Consciously the user "leaves" the real world and controls his senses to wander in virtual extraterrestrial life and even enters the inaccessible conditions in the everyday world. For instance, entering small spaces such as blood vessels or unidentified and isolated areas in the hemisphere of this earth. In other words, immersion is the blocking of the physical/ real world (Biocca, 1992). VR users will not succeed be immersed if their minds are still in the real world and still think that what is displayed in their eyes is the data produced by the computer. Computers in VR technology are actually just tools that process data and their presence is integrated in the system. This means that VR users do not communicate with the computer itself, but rather interact with the interactivity system through playing experience. This is reinforced by Lanier & Biocca's statement (as cited by Ryan, 1999) that VR users cannot see the computer anymore, because it has disappeared, there is only the users and their exploration experiences.

Another interesting part of VR technology, immersion also makes communication through language and words also disappear. This language is replaced by the action of physical movements using both hands and mouth to change content in VR and improvise spontaneously and quickly (Lanier & Biocca, as cited by Ryan, 1999). In the virtual world, to do an action or command is not necessary to symbolize a particular language. For example when building a fortress, in the virtual world the user directly creates the reality of the construction of the fort, without explaining the symbolic language about the defense building. This means that in interacting with the VR system, as a form of post-symbolic communication, communication is no longer needed in the form of language-bound descriptions and semantic use.

3 CASE STUDY

This paper uses two existing project as case studies of the aesthetics of interaction. The existing projects are SIMIGAPI and ASENG'S ADVENTURE: PECINAN.

3.1 SIMIGAPI



Figure 3: Main Menu VR "SIMIGAPI" (Tjandra, 2015).

SIMIGAPI is a VR project for volcanic eruption mitigation simulation (*Simulasi Mitigasi Gunung Berapi*). This project is a virtual reality application using head mounted display (Oculus Riff) with educational game content inside the system. SIMIGAPI has purpose to offer a joyful learning tool for children aged 7-11 years old. This application will educate them about volcanic eruption mitigation with fun experiences (Tjandra, 2018).

There are three level of SIMIGAPI based on the process of mitigation, which are introduction, preparation, and evacuation (Tjandra, 2015).

1. Introduction

This first level introduces eruption hazard areas, mitigation maps, and eruption situations using info graphics, animations and user interfaces.

2. Preparation (Indoor mission)

The users will see and listen to news from television and radio. Television, as a core media, can convey the news at the beginning of the volcano's status. There are local radio networks in disaster-prone areas that convey the current conditions of the volcano's situation. The users will find out the tools used to fill emergency bags. As shown in Figure 4, the tools are flashlight, foods & water, first aid kit, and goggles. The users are required to take these tools in preparation for evacuation.



Figure 4: Finding Tools in “SIMIGAPI” (Tjandra, 2018).

3. Evacuation (Outdoor mission)

In outdoor mission, players will be directed to check in at 8 points throughout their evacuation journey (Figure 5). The users will receive mitigation material through check points found along the way to the finish point containing prohibitions, information and instructions for mitigation evacuations. Figure 6 illustrates the GUI in each checkpoint. The goal is that users can be aware of certain situations that occur during evacuation in the field.

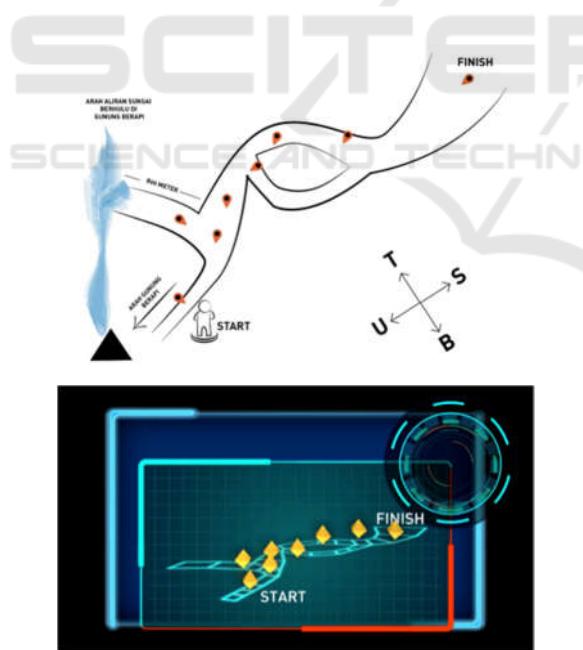


Figure 5: Check Points of “SIMIGAPI” (Tjandra, 2018).

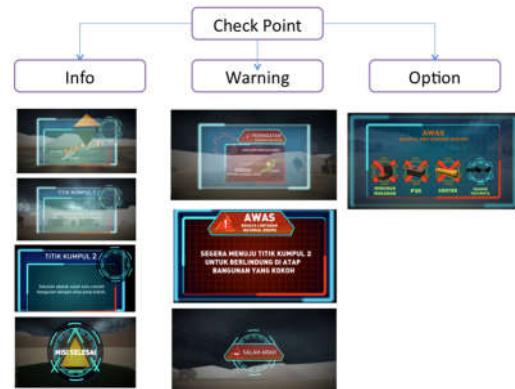


Figure 6: Schema of 3D GUI of “SIMIGAPI” (Tjandra, 2018).

3.2 ASENG’S ADVENTURE: PECINAN

ASENG’S ADVENTURE: PECINAN is a VR game application that developed for reintroducing traditional Chinese (Peranakan) food culture through new media. This project was developed on Android operating system and used on Samsung Gear VR. Basically, this VR game could be categorized as an educational game (H. Purnama & H. Wongso, personal communication, January 28, 2019).



Figure 7: Game World of “ASENG’S ADVENTURE: PECINAN” (Purnama, 2018; Marshal, 2018).

This project was led by phenomenon that Indonesian young people do not consider about traditional Chinese food. Most of them recognise Western food, however they do not know the food

that originated from Indonesia (Wongso, 2018). This game has target users are teenagers and young people, with age range of 16-21 years old, domiciled in Tangerang and Jakarta. In this project, players will act as a person who named Aseng, a food stall owner who dreams of becoming a royal cook.

Purnama, Wongso, Marshal (2018) describe the gameplay of the game, firstly, the player will choose the food that he wants to cook (Figure 8). Players will be faced to the tutorial level with the spring roll menu.



Figure 8: Menu Quest of “ASENG’S ADVENTURE: PECINAN” (Purnama, 2018).

Secondly, in the pre-cooking process, the player will collect cooking ingredients that can be obtained from the quest, as shown in Figure 9. If all the ingredients have been collected, the player will enter the cooking phase.



Figure 9: Visualization of The Ingredients Shop of “ASENG’S ADVENTURE: PECINAN” (Purnama, 2018).

Next in the cooking process, the player will be given a direction and follow the direction. Finally, when the food has been cooked, the food will be assessed and the player will get experience and game currency in the form of gold. This gold can be used to buy ingredients in the store, while the experience is useful so that players can cook food on the next level that has a higher of difficulty.

4 DISCUSSION

In discussion section, firstly, we will describe both of existing projects use MDA approach. The existing project will be explained in general concept of MDA

approach. And then analyze the element of aesthetics for both projects by identifying each component carried out the application of the MDA approach. Then those are reviewed to gain an understanding of the interaction aesthetics in the two projects. We focus on the users’ feedback who playing the VR educational games.

Discussion about aesthetics of interaction cannot be separated from human cognitive abilities. The aesthetics of interaction, in term of design, is a product of cognition. Norman (as cited by Preece, Roger & Sharp, 2002) distinguishes two cognition modes, which are experiential and reflective cognition. The creativity is one of result of reflective cognition. In addition, reflective cognition gains abilities to design and learning. He adds that both modes of cognition still need other aspect when we use in daily life, such as support of technology.

Norman also describes six cognition processes (as cited by Preece, Roger & Sharp, 2002):

- attention
- perception and recognition
- memory
- learning
- reading, speaking, and listening
- problem solving, planning, reasoning, decision making

According to Norman’s statement, we can explore the aesthetic of interaction more depth by making correlation between LeBlanc’s MDA approach and VR educational games. Especially, the relationship between senses, action, reaction, and technology.

4.1 MDA Approach for The Existing VR Games

We sum up some response of users test for both VR educational projects. The first summary, as described in Table 1, is MDA approach for SIMIGAPI project and Table 2 is a depiction of MDA approach for ASEG’S ADVENTURE: PECINAN project. We divide the description into four items, namely requirements, rules, designer’s task, users’ feedback. Each item will fill the mechanics, dynamics, and aesthetics elements. As declared before, the feedback of users test will employ the investigation of the aesthetics element. Mainly, discussion on the terminology of “fun” based on LeBlanc’s idea.

As mentioned in Table 1, in SIMIGAPI VR educational game, firstly the users feel learning something about the mitigation. Secondly, they are also felt fun by getting new knowledge. Thirdly, the users face new experiences on emergency response. The last, they are immersed into the simulation.

Table 2 describes that, by playing the VR game of ASENG'S ADVENTURE: PECINAN; first of all the users learn about cooking. Next, the users get freshly information behind the traditional food and its philosophy. Finally, they feel fun in the virtual world.

In the context of this case study, these games are built in mitigation scenario based on the narrative of evacuation from volcanic disasters and cooking scenario. The designers use volcanic mitigation materials and cooking tutorial as basis for developing narratives. It means, there are learning materials that are adapted into the narrative. So the narrative will be linked to the interaction plot to form a game scenario. As Ryan (1999) explained that narrative plays an

important role in determining interaction plots and play experience. We can conclude that offered learning material determines the interaction plot and play experience in the VR game.

Of course the VR game "SIMIGAPI" is providing an understanding regarding volcanic disaster mitigation through its game play. Similarly, the "ASENG'S ADVENTURE: PECINAN" project offers a process of learning to cook and get to know traditional Chinese food. So these VR games have the aim to provide an understanding of what is new and the knowledge that is not yet known. The suitability of the VR game development goals with the design must be validated.

Table 1: MDA Approach for SIMIGAPI Project.

	Requirements	Rule	Designer's task	Users' Feedback
MECHANICS	Software: C#, Unity, Autodesk 3DS Max, Adobe Photoshop Hardware: PC, laptop, Oculus Rift DK 1 (head-mounted display)	Ensure the function of hardware and software can run properly so that the interaction and response of play can be felt directly by the players.	Determine the technology of Oculus Rift as a gaming platform	<ul style="list-style-type: none"> Sometime get technical difficulty when HMD rotate to right and left Cabling on Oculus Rift DK 1 are suitable for children
DYNAMICS	<ul style="list-style-type: none"> Game play, scenario of mitigation, interaction plot Introduction, preparation, and evacuation 	Information → Action → Reaction → Feedback → Operation	Determine the game concept: volcanic eruption mitigation simulation	<ul style="list-style-type: none"> Making interaction with the VR game system Most of the users follow the scenario of mitigation
AESTHETICS	Senses: sight, hearing, touch Sensory: eyes, ears, hand Kinesthetic: movement of hand & head, clicking mouse	sensation, fantasy, narration, challenge, fellowship, discovery, expression, submission	Determine aesthetic concepts that can accommodate dynamic model, such as 3D assets, 2D illustration, audio, and animation.	<ul style="list-style-type: none"> The users learn something about mitigation. The respondents feel fun when knowing new information. The users get new experience about emergency response on volcano eruption. They feel immersed.

Table 2: MDA Approach for ASENG'S ADVENTURE: PECINAN Project.

	Requirements	Rule	Designer's task	Users' Feedback
MECHANICS	Software: C#, Unity, Autodesk 3DS Max, Adobe Photoshop	Ensure the function of hardware and software can run properly so that the interaction and	Determine the technology of Android as a gaming platform.	<ul style="list-style-type: none"> Using VR controller, sometime feel unpredictable

	Requirements	Rule	Designer's task	Users' Feedback
	Hardware: PC, laptop, Oculus Rift DK 1 (head-mounted display)	response of play can be felt directly by the players.		<ul style="list-style-type: none"> • There is technical limitation when doing hand movement as acts of cooking
DYNAMICS	<ul style="list-style-type: none"> • Game play, scenario of cooking competition, interaction plot • Pre-cooking preparation, cooking process, and assessment & reward 	Information → Action → Reaction → Feedback → Operation	Determine the game concept: cooking competition.	<ul style="list-style-type: none"> • The users practiced cooking by doing movement of their hand on the VR controller • Most of the users follow the scenario of cooking competition
AESTHETICS	Senses: sight, hearing, touch Sensory: eyes, ears, hand Kinesthetic: body gesture, movement of hand & head, clicking console/controller	sensation, fantasy, narration, challenge, fellowship, discovery, expression, submission	Determine aesthetic concepts that can accommodate dynamic model, such as 3D assets, 2D illustration, audio, and animation.	<ul style="list-style-type: none"> • The users learn something about cooking. • The respondents feel fun when knowing new information. For example, they freshly knowing philosophy of the food or story behind the traditional food. • They feel inside of the virtual world of the game

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Based on feedbacks from the user test, these two educational games can be stated to be successful in delivering the learning material, because between the design concepts and the final results are synchronous. Designer SIMIGAPI explained that SIMIGAPI VR game users get new knowledge related to volcanic disaster mitigation as well as information about evacuation and items that must be taken during an evacuation (Tjandra, 2015). Purnama & Wongso (personal communication, January 28, 2019) adds that the results of user test the ASENG'S ADVENTURE: PECINAN project provides positive validation as consistent as their scenario plan. ASENG'S ADVENTURE: PECINAN users newly just found out information after they played with this educational game. The scenario of how to cook a food can be learned through this game, including determining the ingredients of cooking, the use of cooking tools, and how to cook it.

According to those VR educational games, there is a similarity about the outcome of the game play. The goal of educational game development is achieved, which is learning process of something and

giving understanding of knowledge. Basically, game could be used as a learning media and a method for comprehend some fact and practical life in real experiences. A game could be a simulation of real things in ordinary life and also extraordinary activities.

Visually, the game environment leads the game users immerse to the virtual world. Most of the respondents of both games point out that the game assets help them to feel the aesthetics experiences in the games. This immersion also leads the gamers to feel the learning space as real as daily life, even though it is a virtual/ digital world. Some practices of playing games, the gamers do act - think to what they are faced in the game world and collapse all real life activity, as same as mentioned Biocca (1992) about blocking the real world as an immersion of the game.

According to this case study about educational game, there is still has an immersion even though it is a serious game and is not just entertainment media. In other words, game virtual world still has possibility to develop knowledge. At least, game players can understand to the substance that was modulated as

learning material and has specifically serious outcomes.

As conclusion of this subsection, we offer a modification of LeBlanc's MDA approach by adding a term "understanding", so there is nine aesthetics terminology of "fun" in educational games, such as:

1. Sensation (Game as sensory pleasure)
2. Fantasy (Game as imaginative but convincing)
3. Narrative (Game as a story or drama)
4. Challenge (Game as training against obstacles)
5. Fellowship (Game as a socializing container)
6. Discovery (Game as territory that needs to be explored)
7. Expression (Game as discovery/ self-actualization)
8. Submission (Game as entertainment/ hobby)
9. Understanding (Game as learning media)

4.2 The Relationship of MDA Approach with The VR Games

We provide a graphic that illustrates the relationship between the MDA approach and the two VR educational games. We take modification of MDA approach to analyze the relationship with both of VR existing projects. This illustration of the relationship (as shown in Figure 10) is formed circle and is not linear as founded by LeBlanc (2004). In our opinion, it is not linear because of interplay between MDA elements. It means mechanics element is not always the first starting point of the game development process.

In sophisticated era, technology is growing rapidly and can accommodate the demands of high-artworks. There is no more technological barrier for creativity. Consequently, in some cases, the project led by artistic concept and then decided which technology is being required to develop the game. In other cases, dynamics element can be trigger of the game project due to the point of interest, which is the interaction.

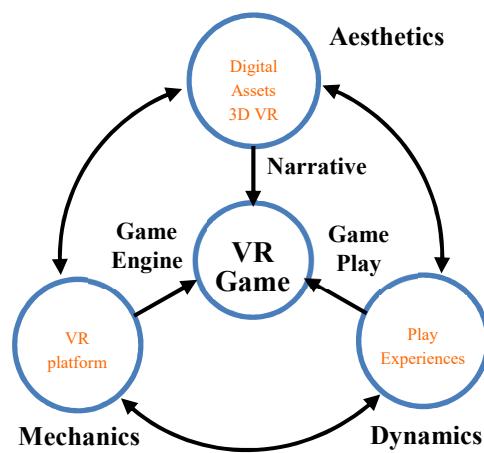


Figure 10: Relationship of MDA Approach with the VR Educational Games.

Figure 10 points out each relationship of MDA approach, such as:

1. VR platform represents mechanics elements, which the technology requirements (hardware - software) are integrated into a game engine.
2. Dynamics element is accommodated by interaction in the play experiences and then act as a game play for both VR educational games.
3. Aesthetics element is fulfilled by digital assets of VR games, for instance, 3D assets, audio, 2D illustration, and animation. All of the assets are being tied with narrative. This narrative leads the interaction plot; as a result, all of digital assets are integrated in the game scenario and the learning material.

As declared before, modified MDA approach conduct adaptable starting point to designing game. Each element of MDA can be leader of game development. Nowadays, technological support can adjusted to other elements compare to one decade ago that technology led dynamics element and then aesthetics element affected by the its dynamics component.

5 CONCLUSIONS

Based on the results of this study of the aesthetics of interaction on virtual reality with educational games content, we can conclude that educational material in these VR game, potentially could enhance the terminology of fun by adding new vocabulary in LeBlanc's aesthetics taxonomy, which is understanding. The understanding means that game

as learning media. So, there is nine “fun” terminologies in the aesthetics element of MDA approach for educational games.

Second summary, in current digital age, MDA approach supposes to be more dynamic and flexible due to increasingly sophisticated technological developments. The MDA approach is not linear again, however there is more adoptable to the game design concept.

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