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Mobile Game Based Learning to Develop Ethical Decision Making Skill of Novice Volunteer in Disaster Response

Didin WAHYUDIN[1,3*], Shinobu HASEGAWA[2,1], Tina DAHLAN[3]
[1] *School of Information Science JAIST, Nomi-Ishikawa, Japan*
[2]*Center for Graduate Education Initiative JAIST, Nomi-Ishikawa, Japan*
[3]*Indonesia University of Education, Bandung, Indonesia*
*didin.wahyudin@jaist.ac.jp

Abstract: Manyresponses of catastrophic natural disaster did not perform properlyto an appropriate standard. This often occurred when first responders were involved, especially novice volunteer who did not have the accurate decisionmaking skill. One of the main issues is the lack of regular training to develop such skills. It has been pointed out that exercise of the non-technical abilities, such as decision-making has an enormous impact on effective disaster response.However, some researchesshow that there are difficulties to conduct live practice for the disaster situation similarly. In addition, the novice volunteer cannot receive maximum advantagesfrom live training due to feedback limitation where reflection from actual circumstances is required to improvethose skills.The purpose of this research is to design a mobile game based learning (mobile GBL) for developing such skills. First of all, we conducted a preliminary survey to assess the awareness of the ethical decision-making skill of the novice volunteer from high school and university organizations in Indonesia. We asked these respondents to answer three categories of questions encompassed six components of moral intensity. We also interviewed some experts from the official search and rescue (SAR) organization in Indonesia to confirm first responder requirements. Based on these preliminary surveys and interviews, we have designed a training system called Magnitude which enables the novice volunteer to develop their ethical decision making skill at all times during official disaster management training inside and outside of class, and expect them to improve their performance in disaster response activities.

Keywords: Mobile Game Based Learning, Ethical Decision-making Skill, Novice Volunteer, Disaster Response.

1. Introduction

Indonesia is geographically located within the areas that have been victims of catastrophicdisaster effectsfrequentlyso-called "the Ring of Fire', that is,the Ancient Australia-Indian Continent, the Pacific Ocean Floor, and the Eurasian Plate. These areas are at risk of natural disasterspersistently, such as, earthquakes and tsunamis, landslide, flood and violent eruptions, which can be devastating. In December 26, 2004, a destructive earthquake with 9 of Richter scale strikes Aceh, a province in Sumatra Island, Indonesia. More than 165,708of people reported dead and missing and affected an estimated $5 billion in economic destruction.Awkwardly, this disaster is not the last disaster striking Indonesia. Several disasters were caused thousands of people died and lost, damaging public vital facilities and requiring persistent recovery.

Many facts on disaster responses in Indonesia show that these activities are still sporadically performed. It must be admitted that many of the actions undertaken aim to decrease the impact of the risks posed by the disaster. For example, disaster rescue training for Boy Scouts and youth member of Red Cross Society. However, a volunteer must be trained as much as possible in order to have broad knowledge of disaster response. In other words, the volunteer should be able to conduct training programmes independently to increase their skills.It is argued that decision-making in emergency response is a vital skill for first responders. The decisions can impact the capability of response agencies to do their work (FEMA, 2010).

This research aims to contribute an alternative to the existing volunteer training system.

Furthermore, the research endeavours to supply a mobile game based learning (mobile GBL) to develop decision-making skills, especially ethical decision-making skills in natural disaster response, with high motivation and playful learning.

2. Literature review

2.1Decision-making skill in natural disaster response

A natural disaster is an event or series of events that pressure and disrupts the lives and livelihoods caused by natural factors leading to the emergence of environmental damage and loss of property, physical and psychological impact and personal calamities. Occasionally, we have to face a disaster situation that becomes a portion of daily live. Anyone can be affected by it involving an earthquake and tsunami, flooding and a landslide, or other life-threatening disasters.

Disaster response is a series of activities carried out immediately at the time of disaster. These actions are to deal with the negative impact comprising the rescue and evacuation of casualties, fulfillment of basic needs, protection of refugees, etc. The importance component in emergency response period including ease of access in the deployment of human resources, such as, expert first responders and volunteers, equipment and logistics; ease of access in the form of commands and command system; emergency response command post; emergency field command post, and emergency operations plans. However, disaster response and rescue are sometimes unprepared. The short time span of disaster response necessitates the utilization of all resources and requires accurate decision-making (Carrillo et al, 2011). Decision-making is a process of determining the best decision from a number of alternatives to perform activities in the future.

One key issue in the preparation of disaster response is training for decision makers and emergency responders in dealing with the catastrophic circumstances. Particularly, it has been highlighted that the exercises of the non-technical abilities, such as, situation awareness and decision making have a tremendous effect on successful and effective disaster response and management. The ability to distinguish present and probable difficulties can positively affect the victims (FEMA, 2010). Sinha was studied the influence of experience in decision making of firemen (Sinha, 2005). The research shows that experience is one of the main factors for accurate decision making followed by education and training.

2.2 Ethical decision making

The problems facing social and humanitarian actions such as disaster first response are many and frequently require selecting a choice between contrary options. Decisions made on a moral basis may have critical impacts on the societies. James Rest's in Lincoln (Lincoln, 2001) described that ethical decision making is a combination of four stages, including (a) Moral sensitivity (moral awareness) is aptitude to distinguish a moral issue in a situation. (b) Moral judgment is conveying and calculating moral reasoning when selecting possible solution on the moral problem. (c) Moral motivation (moral intention) is selecting a choice with high intention which representing a different value of moral decision. (d) Moral courage (moral action) is an ability respecting to a moral intention in personal act. However, process of making an ethical decision will face to a failure if the decision maker did a failure at any step of these components.

Furthermore, Jones (Jones, 1991) explains six components of moral intensity influencing all stages of ethical decision making described by Rest's (Lincoln, 2001). These components are essential in the process of ethical decision-making. (1) Magnitude of Consequence, which is defined as the sum of the harms (or benefits) affecting the victim by a moral act. (2) Social Consensus, which is defined as the degree of social agreement that a proposed act is ethical (or unethical). (3) Probability of Effect, which is defined as the probability of the harms or benefits caused by the act. (4) Temporal Immediacy, which is defined as a period between the ethical act and the effects of the action. (5) Proximity, which is defined as sense of closeness of social, cultural, psychological, or physical intimacy between the actor and victims. (6) Concentration of Effect, which is defined as the number of people affected by a given magnitude of harms or benefits.

2.3 Mobile GBL and related work

Serious games have been fostered in the education field for a long time, such as, in the domain of personal training in military, business and emergency. It is offer a situation with minimum cost that can impress learners to explore many choices in a virtual setting. For example, training for management of disaster and emergency using Play2Train, a virtual learning in Second Life environment. Hewitt, Spencer, Mirliss, and Twal (2010) stated "virtual world can provide an engaging, learning-intensive alternative to face-to-face scenario exercises". Such game also delivers the direct advice affecting the learners can receive suggestion to change their action immediately (Caird-Daley, Harris, Bessel and Lowe 2007). Metello, Casanova, Carvalho (2008) applying serious game techniques to simulate the situation of emergency. The authors designed a simulation engine presenting some situation of emergency through serious game. In this system, they implemented real disaster data using techniques of geographical information system and dynamic modelling.

Increasing of mobile technology motivates scholars and researchers to stimulate learning technique using a mobile device. Mobile learning provides a beneficial of blended formal and informal learning properties. Because mobile devices have small size, it provides the main affordance of mobile learning which learners can carry the system anywhere and use it for training activities ubiquitously (Churchill and Hedberg 2008). Another affordance of such system is a mobile games implementation that it can directly suitable into the desired learning situation. Klopfer (2008) described "mobile games provide many opportunities to consider the game play thoughtfully, discuss it with others, and reflect on its significance, without requiring substantial investments in game-play time". To sum up, learners can engage in mobile games for a few minutes a day or week, and it is enable learners to grasp educational subjects within playful learning independently.

3. Preliminary Research

3.1 Interviews

We conducted some interviewsby visiting some disaster experts in National Search and Rescue Agency Chapter Bandung (BASARNAS) and the other disaster experts from Non-Government Organization (NGO) experienced in disaster response activities. Many of them were experienced in disaster response activities, such as, Aceh earthquake and tsunami in Indonesia 2004, China earthquake, Sendai earthquake and tsunami 2011 and the other disaster activities around the world. This was very valuable phase to confirm the requirements of the system. All of information from expertise might classify the position of the system in the domain of volunteer training. From all of the interviews, we gathered many conclusions answering following questions:

What are common mistakes and difficulties for novice volunteers?

- Strong spirit but less skill; the majority of the volunteers who worked to help disaster response come from communities. Many of them only rely on the spirit of unprepared. Confusion maybe happened when working in the disaster area, ifthey do not have appropriate skills.
- Do not care about rules; in some case, many volunteers especially novice volunteers work as disaster response without sufficient expertise. This condition is not only causing threat their safety but also disrupting disaster response process.

What are fundamentalcriteria's of disaster first responders in Indonesia?

- Getting multi skills; the volunteers should have many skills due to limitation of disaster response resources. If they master these skills, they can work in a variety of disasters. For example, a volunteer should have competences on diving so he/she can take action in flooding disaster. On the other hand, he/she may also have climbing skill, which he/she can tackle landslide evacuation.
- Knowing the culture and environment; Indonesia is a big country, which has many cultures and islands. The volunteers considered doing disaster response activity in Indonesia requisite to know diversity of cultures and area that has potential disaster. Moreover, if some day disaster occurs in that area, theymight adapt to with the situation quickly so they will be able to carry out emergency response duties with the best performance.

Relating to decision making skills, what are the requirements?

- Strong analysis; the volunteers should have critical thinking to analyze problems occurred in disaster field. This is an important point of view from experts related to common problems belongs to novice volunteers in decision making.
- Good behavior; on disaster response, a volunteer will find a lot of issues requiring immediate decisions. Sometimes the problem is more related to ethical matters. He/she who has the good behavior would be very easy to make a decision.

How to improve volunteers' skills?

- Regular disaster simulation; Disaster simulation should be conducted frequently in scale of Family, School, and Community. This regular simulation will build instinct to take instant response to solve problems occurred in disaster striking.
- More practice, it is important for volunteers to practice as much as possible. More practice will improve and maintain their skill recurrently, so he/she can keep the skills until disaster happened.

3.2 Surveys

To identify the importance of the system, we organized a preliminary survey. We distributed the questionnaires to measure the understanding of the novice volunteers' ethical decision-making skills. We selected a number of the novice volunteers from high school (HS) and university (Univ.) organizations in Indonesia. Using questionnaires to collect demographic data, we divided the respondents into two categories, that is, experienced and inexperienced volunteer.

The first group, as shown by table 1, consisted of eighteen volunteers who had been part of the organization for more than 2 years. Some of them had actual volunteer experiences in flooding and landslide disasters and also had many practice in emergency and rescue, such as, triage, wall climbing, and scouting. Table 2 describes another group comprised of fourteen volunteers who joined less than 1 year ago. This group was a newcomer in disaster and emergency voluntary. They did not have any experience in training and real situation of disaster and emergency. Main reason for categorizing the respondents was that we could compare the comprehension about moral aspect on ethical decision-making.

Table 1: Features of experienced volunteer

N	Educational Background		Sex		Age (year)			Member Experience (year)		Experience in training (times)				Experience in Disaster Response	
	HS	Univ.	M	F	14-17	18-20	21-23	1-3	>3	1	2-3	>3	Never	Yes	No
18	10	8	11	7	9	7	2	12	6	0	10	8	0	2	16

Table 2: Features of inexperienced volunteer

N	Educational Background		Sex		Age (year)		Member Experience	Experience in training (times)				Experience in Disaster Response	
	HS	Univ.	M	F	14-17	18-20	< 1 year	1	2-3	>3	Never	Yes	No
16	6	8	12	2	6	8	14	0	0	0	6	0	14

3.2.1 Questionnaire

We provided eighteen questions contained scenario example of ethical problems. Those divided into three categories, which each category enclosed six components of the moral intensity influencing all phases of ethical decision-making. We sent these to a psychologist to review the questions in psychology point of view. It was highly necessary to assess the questions to determine whether the scenarios covered ethical matters.

The first category had scenarios that must be answered with disagree. For example, a question

contained a Probability of Effect. “Floods hit a suburb of South Bandung, Indonesia. There is a collapsed bridge under which a dead boy trapped. Mr. Pandu, a novice volunteer, is eager to cross the river to evacuate the boy, without wearing a life jacket”. In this scenario, we knew that a victim trapped under the collapsed bridge was dead, so it was not too urgent to evacuate immediately. The volunteer should understand the basic principle of disaster response to prioritize his personal safety before rescuing the victims.

The Second category must be answered with agree. We modified questionnaire above as follow: “Floods hit a suburb of South Bandung, Indonesia. There is a collapsed bridge under which a little boy trapped and unconscious. Mr. Pandu, a novice volunteer, is eager to cross the river to evacuate the boy without a life jacket”. In this modified scenario, we knew that there was a little boy trapped under a collapsed bridge. He should take a risk to cross the river with swift currents to evacuate the boy. We could identify that the victim was unconscious, so we had an opportunity to save his life. If evacuation finished immediately, we could save the victim from the effect of the river current.

The last category contained the open question reflecting three conditions: Do, Do not, and Confusion. For example, “Mr. Pandu is a special person on the disaster response team. He has a lot of skills not owned by the others team members. One day when a catastrophe disaster occurred, as a member of advanced disaster responder team, He is asked to go into the disaster areas soon. At the same occasion, he also has the responsibility to care his family members, including his sister and his beloved mother who suffered injuries caused by the disaster. What is the best decision between two options?” In this scenario, the respondents needed deeper thinking than previous questions. We knew that Mr. Pandu faced into two dilemmas. If he decided to take care his family members, there were a lot of problems appeared in disaster response. His expertise was necessary for accurate action and quick response. However, if he decided to go with his job and left his family, there was also a problem. Psychologically, he intended to help in advance his family, and it would cause interruption of his concentration in first response activity.

3.2.2 Results

Data collected from category one, and two of the questions did not show the difference between two groups. Experienced and inexperienced respondents possessed the tendency to answer questions with closely similar result. For example, for a following scenario of Concentration of Effect: “After a devastating earthquake occurred, a tsunami hits Pangandaran coastal. Mr. Pandu is a novice volunteer. He is also a victim of this disaster. His home was collapsed, and he lost his mother. He heard valid information that his mother is in a medical center. He decided to meet her, but at the same time, Mr. Pandu found a family with four family members lived near his home was injured. After he had seen his mother, he knew that one of family members of his neighbor was died”. Most respondents, as visualized by figure 1, could identify this situation clearly and answer the question correctly.

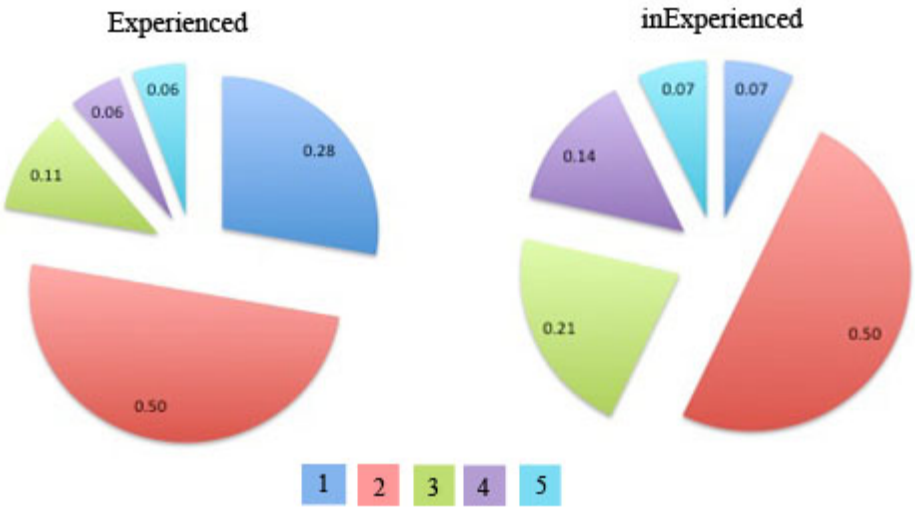

Figure 1.Results of question category one contained scenario of Concentration of Effect (1. Strongly

disagree, 2. Disagree, 3. Neither Agree Nor Disagree, 4. Agree, 5. Strongly agree)

Table 3 shows the result of the last category of questions.The most of experienced respondents answered the question correctly, andonly few of them faced to confusion. It explains that the experienced respondents understood the problems clearly, so they made the right decisions. However, the majority of inexperienced respondents were confused when making their decision.

Table 3: Data collected from the third question category

Question (Moral Aspect)	First Group			Second Group		
	Respondent = 18			Respondent = 14		
	DO	DO NOT	CONFUSED	DO	DO NOT	CONFUSED
1. Magnitude of Consequence	12	6	0	2	4	8
2. Social Consensus	12	5	1	3	6	5
3. Probability of Effect	13	2	3	5	1	8
4. Temporal Immediacy	11	5	2	5	2	7
5. Proximity	15	3	0	4	3	7
6. Concentration of Effect	13	4	1	2	3	9

4. Magnitude model

4.1 Ethical decision making in Magnitude

Ethical decision making is critical aspects of successful and efficient disaster responses. In such case, six moral factors usually appeared during the responses. However, most of the novice volunteers have difficulties to solve disaster issue specifically in the process of making an ethical decision because of unclear understanding of these factors. Hence, ethical decision making in Magnitude is a significant concern of the research.

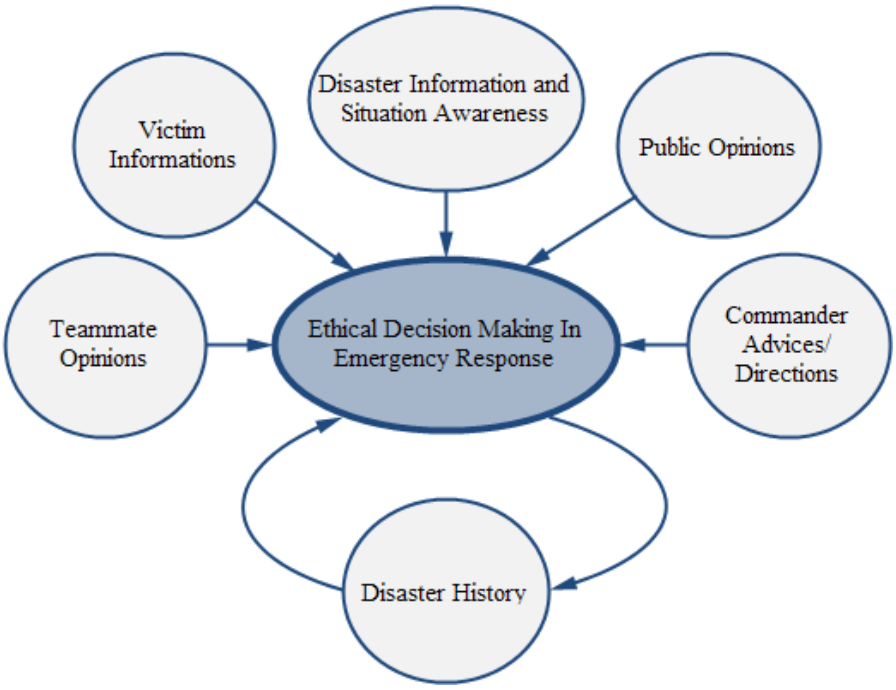

Figure 2: Ethical decision making model in Magnitude

To establish the best ethical decision making, we implemented the six moral aspect into some actions which the learners should collect much information as shown in figure 2. (a) Victim

information is complete data including the number of victims, illness, and social background. (b) Disaster information is disaster scale and type. (c) Situation awareness is knowledge of the circumstances that will be occurred later. (d) Public opinion is public comments and responses on the action that has been done. (e) Commander direction is all advices from disaster response leader related to responses stages. (f) Teammate opinion is a comment or judgement from the other members of the team. If the learners get confusion after comparing these aspects, they may search many similar disaster cases in the database of disaster histories. This database will guide them to have a wide-ranging of knowledge of past disaster.

We identified there are two unique factors of moral aspects i.e., Social Consensus and Proximity. Learners who have different preferences and social background, such as, culture, religion and the other social aspect will have a different angle to view issues related to these factors. For example, a learner comes from a rural area where the distance between one places to another is very far apart, may talk to the other (victim) loudly. However, another learner from an urban area may speak to the other with a soft voice. This example explains the differences between decision making and ethical decision making. In ethical decision making, social background and behavioural of the learners are dominant. Regarding of these differences, the system should supply multi parameter rules to assign the values, which are acceptable by all of the learners regardless of learners' background. We design an artificial intelligent (AI) module as a part of an ethical decision making plugin for Unity3D game engine. It supports the system to engage the learners distinguishing moral aspects clearly on the process of making an ethical decision.

4.2 Framework

There are many researches that aim to utilize serious games in the domain of decision making skills. For example, The Human Factors Integration Defence Technology Centre, Canfield University, UK, studied the system for training decision-making skill in the military using serious games on a PC (Caird-Daley et al, 2007). However, none of the significant researches focused on improving ethical decision making skill.

Using mobile devices, on the other hand, volunteers can acquire non-technical skill of disaster response regularly. It can be used not only during official class of disaster response training but also be played and practice in other places at all times. However, most technical skill exercise in disaster response should be conducted in the outside area where outbound training facilities needed. For example, volunteers will attend some comprehensive training, such as, High Angle Rescue Technique, Jungle Rescue, Collapsed Structure Search and Rescue (CSSR) and Water Rescue (Sanubari 2009). Hence, training manager could integrate this system into actual training curricula to fulfil the necessity of non-technical skill experience, which such skills preparation is expensive and risky to establish. In addition, increasing of mobile technology due to decreasing of mobile device price. Smith (2013) reports statistical data of smartphone ownerships in United States that around 79% of the teenager and young adult (age 17-24) has smartphone. Mobilemonday (Rao 2011) published a report of mobile trend in Southeast Asia. It is show that smartphone ownerships in Southeast Asia include Indonesia tend to increase in the future. Both survey results encourage us to exploit mobile game based learning for developing very necessary skill in disaster response. In summary, mobile GBL benefits from the novice volunteers, interaction with his/her environments in order to accumulate knowledge, with high levels of motivation for learning.

Prensky (2001) defined many genres that have the potential to support the learning of decision making skill. Based on his argument, the proposed game called Magnitude combines various genres that support learning these skills, including simulation, strategy, and role-playing. We plan to develop the system using unity3D, a mature game engine on the market. Use of the existing game engine admits this research to focus on developing the framework for providing learning content. On the server side, a system administrator (training manager) can create game scenarios described in the following section, and collect and analyse assessment data. On the client side, a player can update the level of the game, generate a dynamic game level, and send the assessment result to the server. We provide a mobile application, which have a function to manage the system. Research also developed some additional module to fulfil system necessities, such as, create an authoring interface for deploying the game levels and scenarios constructed by training manager. Figure 3 shows the design of the mobile GBL framework for developing ethical decision-making skill in disaster response.

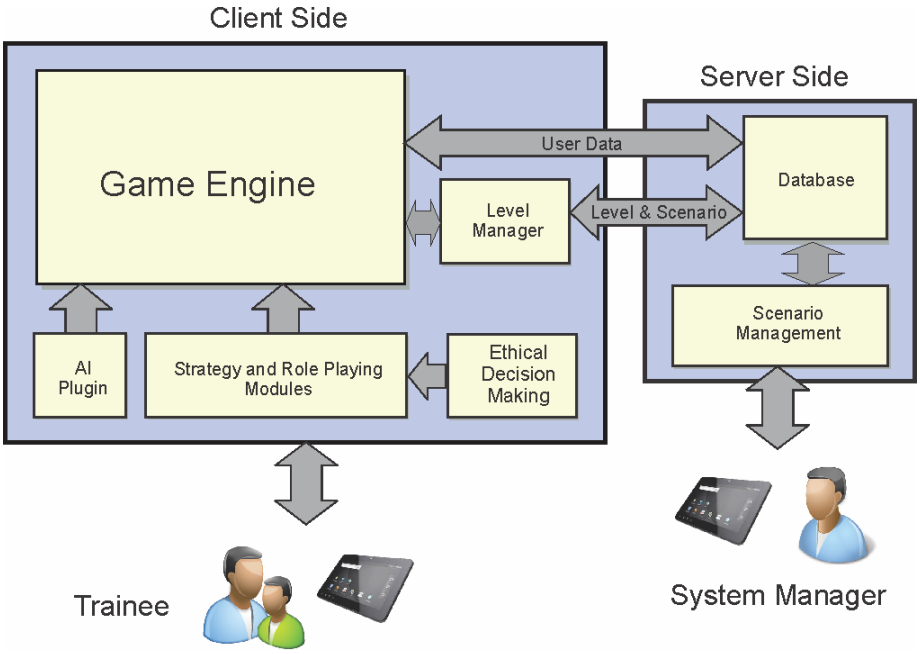

Figure 3: Magnitude Model

4.3 Example scenario

The game seats its learner in disaster response situation. Learner will be asked to play the role of a member of the disaster first responder team. At starting level of the game, player may receive information from virtual character that has the role as a disaster commander. Player has a job to distinguish the type and impact of the disaster. Player should identify disaster data, such as, the affected area and disaster type include earthquake, tsunami, landslide or the others type. Afterward, he or she should be able to choose the equipment that will be used in action. As a member of first responder team, it is essential for the player having the skill to choose respond aids to make sure that their activities in first response will be done efficiently. It is also necessary to pay attention to the safety aspect of his actions.

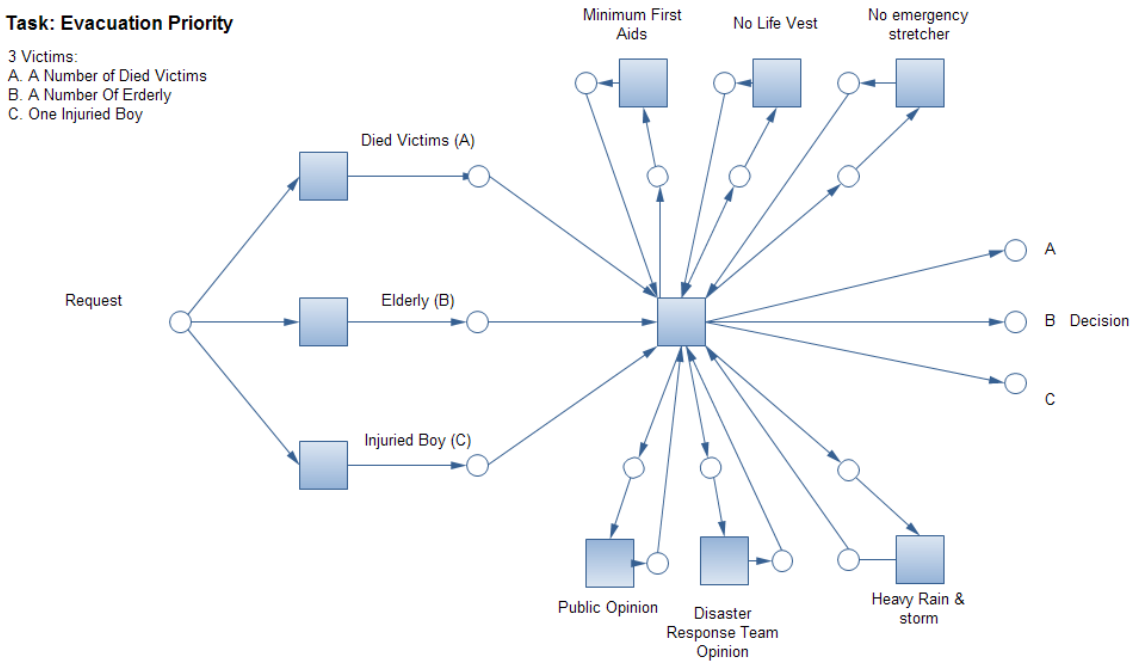

Figure 4: Design of Example Scenario Using Petri Net

Game mechanic will continue to a selective situation of disaster environment. For example, situation when floods disaster hits a suburb of a city. This scenario measures the learner understanding of ethical matters in disaster response; that is Concentration of Effect and Probability of Effect, when making a decision. Figure 4 shows the design of example scenario using Petri net (Araújo, Roque 2009). As a volunteer, a player has a duty to rescue the victims spontaneously. There is a collapsed bridge under which a little boy with head injuries is trapped. The player should find complete information about the bridge structure, victim's information and his condition. He or she may gather reports from news highlights in game user interface. The news highlights inform to the player the statistical report of river current level, weather prediction and some information from witnesses. In this case, the player will be confronted into two conditions. First, he/she should cross the river to evacuate the body, without wearing a life jacket. This action may risk his/her safety. If suddenly the river overflows very fast, it causes not only losing the opportunity to rescue the victim but also making problems for his/her own safety. Second, he/she can wait until the other volunteers arrive with a life jacket, but this may result in loss of the victim's life. In near place, there are a number of elderly who suffer low body temperature due to bad weather. He/she needs blankets as soon as possible to cover their bodies from the cold wind. It is also significant to evacuate the elderly victims immediately. Finally, the player will be faced to a condition, which there are a number of the dead victim found on riverbanks. It is also necessary to evacuate the corpses quickly to prevent massive disease.

Gathering much information from such resources is very necessary for the player to analyse how to make the best decision. There is much information, some of them are informative, and it may guide the player to make a comprehensive consideration, but the others perhaps contain hoax and junk information. By the contrasting information from a reliable source and others, the player will be forced to build widespread analytical thinking. To prioritize one of these choices, the player needs the competence of critical thinking and problem solving to make the best decision. If he/she confuses to make the best decision, he/she can ask virtual character about pros and cons of each action. He/she also can search many similar situations in the previous disaster database to study how these problems resolved. After the player finishes a level of the game, the game mechanics will be continued to select another game level systematically.

5. Conclusions and future work

Many researchers have recommended a number of development methods and game models for learning. However, there has not been a mobile game based learning focused on improving ethical decisionmaking skill in disaster response. Furthermore, this research provides contributions to the field of mobile GBL by (i) providing directions for future research based on learner necessities; and (ii) contributing to the original model of natural disaster response training to improve ethical decisionmaking skill. Future work will focus on the development of the system and evaluation ofitsusefulness.

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