Mobile Serious Game Design for Training Ethical Decision Making Skills of Inexperienced Disaster Volunteers

Didin Wahyudin*** and Shinobu Hasegawa***

(Received 11 June 2015 and accepted in revised form 14 December 2015)

Abstract This paper presents the design and development of a mobile serious game (SG) named MAGNITUDE for training inexperienced disaster volunteers. First, we present interviews with disaster experts to clarify the issues in disaster work and to identify the required criteria for volunteer workers. Second, we explain the survey we did to investigate the subjects’ awareness of ethical issues in a disaster situation. The survey involved 64 subjects, classified into two group, i.e. experienced (Ex) and inexperienced (Ix) who were in high school or the early years of university. The results of the survey showed that the Ix group had less awareness of ethical issues than the Ex group. Based on this finding we have been developing MAGNITUDE to harness its training potential. This SG is envisioned as encouraging Ix volunteers—who usually come in the early periods of disaster response work as spontaneous volunteers—to improve their soft-skill of making decisions ethically.

Keywords: mobile serious game, ethical decision-making, inexperienced disaster volunteers, disaster response

1. Introduction

A natural disaster interrupts the lives and livelihoods of people affected by natural events and is accompanied by environmental destruction and loss of live and property, physical and psychological effects, and personal catastrophes. Anyone can be impacted by a natural disaster, which includes landslides, floods, earthquakes, tsunamis, volcanic eruptions, or other serious calamities.

However, the response phases to such disasters are very complicated. In addition, the decisions in disaster response have to be made in a very short period of time and often without appropriate information. To eliminate the impact of a disaster, several teams should work in a cooperative and articulate manner as much as possible to carry out the response actions. Thus, decision-making is essential to all disaster work, both in terms of mission success and also the safety of volunteers and equipment.

One key issue in the preparation of disaster response is training of volunteer disaster workers who respond early to deal with the catastrophic circumstances. Specifically, it has been highlighted that the proper exercise of non-technical abilities such as situation awareness and decision-making has a tremendous effect on successful and effective disaster response and management.

This paper presents the design and development of a virtual environment for training ethical decision-making in disaster response. The rest of the paper is structured as follows. We first summarize interviews with disaster experts to confirm the required criteria for volunteers. Then, we describe our survey to identify subjects’ awareness of the ethical issues in disaster response scenarios. The survey involved 64 subjects in high school or the early years of university who had joined humanitarian-related organizations. The survey results showed that the magnitude of consequence (MC), probability of effect (PE), and concentration of effect (CE) provided dominant factors of moral intensity that differentiated the experienced (Ex) and inexperienced (Ix) groups. In a real situation, the ability to recognize and to anticipate the effect of disaster work is very important; thus volunteers should take into account these aspects. Based on the survey results, we have developed MAGNITUDE, a mobile first person role-playing game (RPG) for training of ethical decision-making in disaster situations. It can be used to improve volunteers’ soft-skills, especially related to MC, PE, and CE. We conclude that there is enormous opportunity to use the developed game to achieve this purpose.

---

*School of Information Science, JAIST, Japan
**Electrical Engineering Department, UPI, Indonesia
***Research Center for Advanced Computing Infrastructure, JAIST, Japan
2. Decision Making in Disaster Response

Disaster response is a set of activities carried out instantaneously at the time of a disaster, dealing with the unexpected impact from the rescue and evacuation of casualties, fulfillment of basic needs, protection of refugees, etc. However, disaster response and rescue teams are sometimes unprepared. The short time span in which disaster response must be made necessitates the utilization of all resources and requires accurate decision-making that is a process of determining the best decision from a number of alternatives to perform future activities. The ability to distinguish present and probable difficulties can positively affect the victims. Thus the process of making an ethical decision will face failure if the decision maker fails at any step of these components.

Jones explains six components of moral intensity that are essential in the process of ethical decision-making: (1) Magnitude of Consequence (MC), which is defined as the sum of the harms (or benefits) affecting the victim by a moral act; (2) Social Consensus (SC), which is defined as the degree of social agreement that a proposed act is ethical (or unethical); (3) Probability of Effect (PE), which is defined as the probability of the harms or benefits caused by the act; (4) Temporal Immediacy (TI), which is defined as the period between the ethical action and the effects of the action; (5) Proximity (PX), which is defined as the sense of closeness of social, cultural, psychological, or physical intimacy between the actor and victims; and (6) Concentration of Effect (CE), which is defined as the number of people affected by a given magnitude of harms or benefits.

However, the majority of responders coming in the early period of disaster response work are spontaneous volunteers. They do not have enough experience associated with non-technical skills, especially ethical decision-making. Hence, they require training in such skills. On the other hand, many research findings have noted that live training is hard to organize, and it has been argued that inexperienced responders will not improve their skills from live training as much as an expert. This may be due to the feedback limitation in identifying a given situation from typical events. Thus, a virtual environment could be used to overcome this weakness.

3. Preliminary Research

3.1 Interviews with Disaster Experts

It is generally known that when a major disaster occurs volunteers will come. They provide vital contributions to the disaster work phase to immediately reduce the impact. As a lesson learned from past disaster work, we have found that most of the volunteers that came in the early periods of disaster response are community responders. Usually they are inexperienced and they work in the disaster as spontaneous volunteers with little planning beforehand. As a result, other problems such as safety-first issues occur; and the situation has often been described as a disaster within the disaster. In addition, they have been found to be more vulnerable to getting post-traumatic stress disorder symptoms compared to professional responders.

We interviewed three disaster experts from the National Search and Rescue Agency (BASARNAS) and non-government organizations (NGOs) that took part in many disaster responses. The purpose of the interviews was to grasp the experts’ experiences that corresponded to the issues that occurred in disaster response. The interviews were a very valuable tool to verify the volunteers’ criteria and requirements. We summarized the main points of the interviews as follows.

- Inexperienced volunteers have a strong spirit but fewer skills. The majority who have worked in disaster response are spontaneous volunteers from communities. Most of them only rely on their spirit and are unprepared. Thus, confusion may happen when working in the disaster area if they do not have appropriate skills.
- Volunteers do not care about rules. Typically, spontaneous volunteers do not have sufficient expertise. If they make a mistake due to their limitations, the effect of their action not only causes a threat to their safety but also disrupts the disaster response process.
- Volunteers need to be aware of the diversity of cultures and environments in areas where disasters may strike. When volunteers are aware of the diversity, if someday a disaster occurs in one of those areas, they will be able to adapt to the situation quickly and they will be able to carry out emergency response duties effectively and safely.
- Volunteers should demonstrate good behavior. They will find a lot of issues that require immediate deci-
sions, and sometimes the issues are related to ethical matters. For these reasons, they should be able to adapt to the standards of the community impacted by the disaster wisely.

To eliminate some problems and to achieve good skills for spontaneous volunteers, the experts emphasized that regular disaster training and simulation were necessary. Engaging in regular simulation would foster the necessary instincts to respond instantaneously in disaster situations. Through recurrent training and simulation practices, volunteers would be able to increase and maintain their skills until an actual disaster happened.

3.2 Survey

3.2.1 Research Questions, Subjects, and Hypothesis

The objective of this survey was to investigate the subjects’ awareness of ethical considerations in disaster situations by measuring the importance of moral intensity components. To achieve the research goal, we defined the main research questions as follows. (1) How are the subjects aware of the ethical consideration in the disaster situation? (2) Are there any differences in the subjects’ awareness based on whether they are inexperienced or experienced? From the answers to these questions we expected to have empirical evidence of potential volunteers’ awareness that would be used for designing the MAGNITUDE game.

The survey obtained data from subjects in high school and the early years of university. The two educational backgrounds were selected to get subjects who were members of youth organizations, such as Scouting and Red Cross, and adventure clubs. We considered them as potentially spontaneous volunteers in disasters because some of them had trained in technical skill exercises.

With regard to measuring the awareness of the subjects to ethical dilemmas in disaster response situations, we hypothesized that experienced persons would oppose general unethical statements. Furthermore, to accumulate the dissimilarities between experienced and inexperienced persons’ views on various disasters response issues, we assumed that latter would have less awareness and understanding of the ethical dilemmas.

3.2.2 Questionnaires

In order to collect quantitative data from the subjects, the following questionnaire sets were used. In questionnaire set 1, we asked a number of demographic questions, including the subjects’ gender, age, years of education, and length of membership in a humanitarian aid organization.

In questionnaire set 2, we provided two categories of ethical scenarios. They were adopted from ethical scenarios that focused on emergency situations. The subjects were asked to designate their agreement or disagreement with some statements on a five-point Likert-type scale. The first category reflected negative statements as the following example that formed the PE Component.

“Heavy rains flooded almost all of South Bandung suburb. There was a collapsed bridge that trapped a little boy. At the same time, the flooding caused swift river currents. Mr. Pandu—an inexperienced volunteer—was desperate to cross the river without a life jacket to evacuate the victim. When he reached the location, he found the boy had stopped breathing and was dead. After that, the river current flowed even more swiftly, and he was trapped with the dead boy”.

In this scenario, we learned that the victim trapped under the collapsed bridge was dead, so it was no longer urgent to evacuate the boy immediately. The subjects should understand the basic principle of disaster response is to prioritize their safety before rescuing victims. However, to measure the subjects’ ability to distinguish ethical issues in different situations that contradicted the previous one, in the second category, we changed the condition of the statement in the first category. As such, the subjects were encouraged to analyze a broadened possibility of issues that might occur in disaster response work.

“Heavy rains flooded almost all of South Bandung suburb. There was a collapsed bridge that trapped a little boy. His leg was fractured. At the same time, flooding caused swift river currents. Mr. Pandu—an inexperienced volunteer—was desperate to cross the river with a life jacket to evacuate the victim”.

In the modified scenario, the subjects should take the risk to cross the river, even with the swift currents, to evacuate the boy. The victim was injured, but they
had the opportunity to save his life. If the evacuation was completed quickly, they could save the victim from the flooding.

Questionnaire set 3 contained some open-ended questions reflecting the ethical intention that the subjects would take when a specific action happened. The importance of providing such open-ended questions was to allow the subjects to provide answers that they chose without forcing them to select from concrete options. Their responses were coded into three anchored scales: i.e. ‘would [take the action]’, ‘would not [take the action]’, and ‘unsure’. The following question is an example from the questionnaire set 3.

“Mr. Pandu was a member of an advanced disaster response group that had the job to investigate the post disaster situation immediately. At the same time, he also had the responsibility to take care of his family members including his sister and his beloved mother who were injured in the disaster. Which is the better decision between the two options?”

3.2.3 Procedure

The survey involved 64 subjects from high school and university who belonged to the Scouts and the Indonesian Red Cross. At the beginning, the subjects were asked to complete questionnaire set 1 for demographic data. Then, they were asked to rate their opinion for the first and second categories of questionnaire set 2. Before continuing to rate both categories, we described the example situation in the disaster area. Finally, the subjects were asked to answer questionnaire set 3, and then we evaluated their opinions more comprehensively.

Statistical Analysis: Descriptive statistics including means, standard deviations, and actual ranges were reported for the following study variables: age, gender, and years of affiliated humanitarian experience. Furthermore, Pearson’s chi-squared test was used to determine the differences between experienced and inexperienced groups. All statistical procedures were performed at α=0.05 (2-tailed statistics).

3.3 Findings

3.3.1 Response to Questionnaire Set 1

The purpose of this survey was to investigate the bearing of observed moral intensity upon the subjects’ ethical awareness. Regarding gender of the subjects, 74% were males (n=47) and 26% were females (n=17). The subjects’ age ranged from 15 to 20 years old (mean=16.5, SD=1.22). The percentage of subjects that had been a member of a humanitarian organization for more than two years was 45% (n=30). The remaining 34 subjects (55%) had been a member for less than two years. We regarded the subjects who were part of an organization for more than two years as being in the Ex group. A number of them had actual volunteer experiences in flood and landslide disasters, and also had much practice in emergency care and rescue, such as triage, wall climbing, and scouting. We regarded the remaining 34 as belonging to the Ix group who were novices in disaster and emergency voluntary service, and they did not have sufficient experience in training or in real disaster situations.

3.3.2 Response to Questionnaire Set 2

We performed chi-squared test for both categories of questionnaire set 2. Table 1 shows the results of the first category: statements SC and PX provided a p-value >0.05. We could, therefore, confidently claim that there was an equal comparison of Ex and Ix scoring in each nominal category. Hence, the results indicated that between Ex and Ix groups there was not a serious problem regarding awareness of such ethical components of moral intensity. Conversely, the chi-squared tests of the statements MC, PE, TI, and CE gave a p-value <0.05. We therefore believed that there were unequal proportions of Ex and Ix scoring in each nominal category.

Table 2 shows the results of statistical analysis for the statements of the second category. The results of the chi-squared test for statements SC, TI, and PX indicated that scoring in each nominal category for Ex and Ix groups was similar (p-value >0.05). Hence, we thought there were no significant differences between both groups. In contrast, the results of the chi-squared test for statements MC, PE, and CE gave a p-value <0.05. These statements provided a significant difference between the Ex and Ix group responses. From the survey results of questionnaire set 2, we determined that subjects had trouble identifying the effect of such actions. However, as Jones noted, ‘moral intensity is expected to play a major role in the recognition of moral issues and, hence, in the actual engagement of moral
### Table 1. Statistical Analysis of Negative Statements of Moral Intensity (First Category).

<table>
<thead>
<tr>
<th>Statements</th>
<th>Subject Groups</th>
<th>Response</th>
<th>Chi-squared test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnitude of Consequence (MC)</td>
<td>Ex</td>
<td>0 1 2 17 10</td>
<td>6.0696 2 0.0481*</td>
</tr>
<tr>
<td></td>
<td>Ix</td>
<td>2 5 5 17 5</td>
<td></td>
</tr>
<tr>
<td>Social Consensus (SC)</td>
<td>Ex</td>
<td>0 1 3 13 13</td>
<td>4.3439 2 0.1140</td>
</tr>
<tr>
<td></td>
<td>Ix</td>
<td>0 4 5 13 12</td>
<td></td>
</tr>
<tr>
<td>Probability of Effect (PE)</td>
<td>Ex</td>
<td>0 2 2 14 12</td>
<td>8.1016 2 0.0174*</td>
</tr>
<tr>
<td></td>
<td>Ix</td>
<td>1 2 8 16 7</td>
<td></td>
</tr>
<tr>
<td>Temporal Immediacy (TI)</td>
<td>Ex</td>
<td>0 4 3 20 3</td>
<td>6.2957 2 0.0429*</td>
</tr>
<tr>
<td></td>
<td>Ix</td>
<td>1 10 5 15 3</td>
<td></td>
</tr>
<tr>
<td>Proximity (PX)</td>
<td>Ex</td>
<td>0 6 2 16 6</td>
<td>5.8240 2 0.0544</td>
</tr>
<tr>
<td></td>
<td>Ix</td>
<td>0 7 10 13 4</td>
<td></td>
</tr>
<tr>
<td>Concentration of Effect (CE)</td>
<td>Ex</td>
<td>0 2 4 17 7</td>
<td>6.7594 2 0.0341*</td>
</tr>
<tr>
<td></td>
<td>Ix</td>
<td>2 7 8 15 2</td>
<td></td>
</tr>
</tbody>
</table>

*p<0.05, **<0.01

### Table 2. Statistical Analysis of Positive Statements of Moral Intensity (Second Category).

<table>
<thead>
<tr>
<th>Components</th>
<th>Subject Groups</th>
<th>Response</th>
<th>Chi-squared test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnitude of Consequence (MC)</td>
<td>Ex</td>
<td>2 17 4 7 0</td>
<td>7.0395 2 0.0296*</td>
</tr>
<tr>
<td></td>
<td>Ix</td>
<td>2 10 3 12 7</td>
<td></td>
</tr>
<tr>
<td>Social Consensus (SC)</td>
<td>Ex</td>
<td>1 17 3 8 1</td>
<td>2.7222 2 0.2564</td>
</tr>
<tr>
<td></td>
<td>Ix</td>
<td>0 14 3 12 5</td>
<td></td>
</tr>
<tr>
<td>Probability of Effect (PE)</td>
<td>Ex</td>
<td>3 20 4 3 0</td>
<td>11.0194 2 0.0041**</td>
</tr>
<tr>
<td></td>
<td>Ix</td>
<td>2 10 12 9 1</td>
<td></td>
</tr>
<tr>
<td>Temporal Immediacy (TI)</td>
<td>Ex</td>
<td>6 14 2 8 0</td>
<td>5.4144 2 0.0667</td>
</tr>
<tr>
<td></td>
<td>Ix</td>
<td>1 16 10 7 0</td>
<td></td>
</tr>
<tr>
<td>Proximity (PX)</td>
<td>Ex</td>
<td>2 16 2 10 0</td>
<td>4.0166 2 0.1342</td>
</tr>
<tr>
<td></td>
<td>Ix</td>
<td>1 13 7 13 0</td>
<td></td>
</tr>
<tr>
<td>Concentration of Effect (CE)</td>
<td>Ex</td>
<td>6 17 2 5 0</td>
<td>8.3050 2 0.0157*</td>
</tr>
<tr>
<td></td>
<td>Ix</td>
<td>2 12 7 11 2</td>
<td></td>
</tr>
</tbody>
</table>

*p<0.05, **<0.01
decision-making processes instead of, or in addition to, other decision-making schemata'. Thus, there is significant evidence that volunteers should pay attention to all components of moral intensity. If the volunteers fail to recognize the effect of their action, it can cause a crucial negative impact in the future not only for the victims but also for the community and themselves.

### 3.3.3 Response to Questionnaire Set 3

With regard to the open-ended questions in questionnaire set 3, Table 3 shows the results of the statistical analysis. The chi-squared tests for the subjects’ responses to statements Q1, Q2, Q4, and Q5 gave $p$-value <0.05. Therefore, we concluded that there were significant differences between the Ex and Ix group responses to the statements. Moreover, the chi-squared tests for statements Q1 and Q5 ($p$-value <0.01) indicated that both statements showed a strongly significant difference between both groups. On the other hand, $p$-value >0.05 for the chi-squared test for statement Q3 indicated that both groups had similar responses. The largest difference between Ex and Ix groups was the number of Ix subjects that gave the response of ‘Unsure’ for all statements. This meant they were sometimes confused in selecting responses compared to the Ex subjects. Thus, we could assume that the Ix subjects had difficulties making decisions.

### 3.4 Discussion

This survey sought to examine the subjects’ awareness of moral intensity of ethical scenarios in disaster response. The results presented in Section 3.3 strongly supported the conclusion that there was a significant difference between Ex and Ix groups. Moreover, the results of the statistical analysis for both categories in questionnaire set 2 showed that Ix subjects had less awareness of ethical scenarios. In addition, we noted that PE and CE provided dominant factors of moral intensity that differentiated the Ex and Ix groups. In actual disaster response work, both PE and CE are related to the consequences of the volunteers’ acts. Thus, we believe that both moral intensity components should be improved by training based on a real disaster. On the other hand, the statistical analysis results for questionnaire set 3 indicated that Ix subjects had difficulties in making decisions.

The findings described within this survey indicate that in different ethical contexts, subjects in groups of different experience will differ according to what factors of a moral situation will distress their ethical (or unethical) behavior. Therefore, the most important consequence that emerged from this survey is the need to accurately recognize ethical decision-making behavior between Ex and Ix groups. Thus, the subjects need to be aware of how different groups gauge the moral intensity of an ethical situation, and how these insights could suc-

<table>
<thead>
<tr>
<th>Questions</th>
<th>Subject Groups</th>
<th>Response</th>
<th>Chi-squared test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Would Act</td>
<td>Wouldn’t Act</td>
</tr>
<tr>
<td>Q1</td>
<td>Ex</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Ix</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Q2</td>
<td>Ex</td>
<td>20</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Ix</td>
<td>14</td>
<td>10</td>
</tr>
<tr>
<td>Q3</td>
<td>Ex</td>
<td>21</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Ix</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td>Q4</td>
<td>Ex</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Ix</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Q5</td>
<td>Ex</td>
<td>25</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Ix</td>
<td>17</td>
<td>8</td>
</tr>
</tbody>
</table>

* $p$<0.05, ** $p$<0.01
cessively impact their ethical decision-making behavior.

The overall findings from this survey indicate that throughout the ethical decision-making process, a number of the Ix subjects had problems recognizing the overall harm caused by their actions. Consequently, if the objective of training is to both foster and encourage ethical decision-making behavior, subjects should be cognizant of the severity of the consequences caused by an unethical action. Moreover, for issues of low awareness of moral intensity, it may be possible to encourage ethical decision-making by increasing their understanding of the negative consequences associated with an undesirable action. In Section 4, we explain the proposed game based on this survey conclusion.

3.5 Limitation

We note the limitation that the sample size for this survey was considerably small. The study also was biased due to the influence of culture, demography, and way of thinking of the subjects. So, the findings may point to a different conclusion for the similar survey with subjects of different backgrounds. To overcome this drawback, we suggest the ethical questionnaires be sent in as general cases that can cover a wider scope of subjects without dependence on such factors.

4. MAGNITUDE Design

4.1 Overview of Using Serious Games for Training

The use of digital games for learning purposes can raise learners’ satisfaction and promote education at an appropriate level because games have the capability of grasping learners’ attention by creating an enjoyable impression in learning\(^{(11)}\). Digital games take advantage of the important role of learning through games by facilitating learners’ ability to engage and participate in conditions that would otherwise be terrible to be involved in. The games will expand their benefits further if they can involve the learners in all situations.

Moreover, some researches have found evidence that training or learning using games is more effective than traditional ways, for example, medical subjects were learned in a game\(^{(12)}\). There is also evidence that disaster training in the classroom has a major weakness, i.e., lack of realism of the disaster environment. Providing realistic simulation, is not only expensive, however, it is also undesirable to reproduce the chaos of the situation. Hence, such shortcomings can be replaced by a serious game world that can mimic the real environment of disaster situations. As such, players learn solutions to wrong doing which is not permitted in real life.

Nowadays, the number of serious games (SGs) has increased rapidly. They have been fostered in education for a long time. SGs provide simulation with the behavior of a real environment, and they can engage player-learners in order to familiarize them with a situation\(^{(13)}\). SGs are known to be promising methods for training in different subjects, including nursing\(^{(14)}\) and surgery\(^{(15)}\). In the domain of disaster or emergency training, some research studies have developed SGs on various platforms and for several purposes. In Table 4, we compare three SGs that focus on emergency training, i.e., Disaster READiness through EDucation (DREAD-ED)\(^{(16)}\), Advanced Medical Post (AMP)\(^{(17)}\), and Emergenza\(^{(18)}\). According to this comparison and evidence of a related study, none of those studies to develop SGs encouraged skill development of inexperienced volunteers when making ethical decisions in

<table>
<thead>
<tr>
<th>SG Name</th>
<th>Target Learners</th>
<th>Learning Focus</th>
<th>Gaming Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>DREAD-ED</td>
<td>Decision makers at command and control rooms</td>
<td>Communication among staff for crisis management</td>
<td>PC-based simulation game</td>
</tr>
<tr>
<td>AMP</td>
<td>Emergency policy makers</td>
<td>Vehicle and patient scheduling, and staff and material planning for a mass casualty incident (MCI)</td>
<td>Web browser game based on JAVA Applet running on either a PC or tablet device</td>
</tr>
<tr>
<td>EMERGENZA</td>
<td>First aid personnel</td>
<td>Clinical decision support and medical training systems</td>
<td>Desktop virtual environment and natural interaction using Kinect.</td>
</tr>
</tbody>
</table>
disaster response work. Hence, we were prompted to develop a SG for such skill training as an alternative to current volunteer training techniques.

On the other hand, widespread use of mobile and portable devices in education has encouraged progressive revolutions in ways of learning. They provide a benefit for blended formal and informal learning properties. Because mobile devices are small, they also provide the main advantage of mobile learning, that is, learners can carry the systems anywhere and use them for training activities everywhere\(^{19}\). Another advantage of such systems is that mobile game implementation is directly suitable to the desired learning situation. Klopfer\(^{20}\) claimed that ‘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’. In summary, learners can use mobile games for a few minutes daily or weekly, and learners can grasp educational subjects within individual playful learning.

### 4.2 Ethical Model in MAGNITUDE

Ethics has been defined as the study of the general nature of morality and specific moral choices that are made by people. An ethical dilemma is a condition where a person—who is responsible for making a decision—encounters many different possibilities. They have many ethical choices, but they cannot select all of them. The ethical dilemma makes the decision-making process more difficult than others. However, a game is suitable for training awareness of ethical values in a disaster responder by embedding ethical game play\(^{21}\). By doing so, learners have to consider moral dilemmas in different behaviors. They can do anything related to these behaviors without worrying that their actions will harm others as in real life.

Ethical decision-making is a critical aspect of successful and efficient disaster responses. However, most inexperienced volunteer responders have difficulties in solving disaster issues. Specifically, difficulties often come up in the process of making an ethical decision because of an unclear understanding of these factors. Consequently, it is necessary that inexperienced volunteers are aware of ethical issues in disaster work.

To provide an ethical dilemma in the game, we have embedded the six components of moral intensity (Figure 1) into the game narrative by which learners should collect this information. The following are explanations of MAGNITUDE elements that contain specific components of moral intensity\(^{7}\).

- **Victim Information** consists victim data regarding the number of victims, illness or injury suffered, and social background. MC and PX components might be included in it. Furthermore, learners must know certain information about victims to distinguish which victims need immediate help.
- **Disaster Information** consists of data about the type, scale, location of the disaster, and knowledge of the circumstances. The elements consist of PE, CE, and TI. By having this information, learners can estimate which actions in disaster response could potentially affect the environment or community in a short or long time period.
- **Commander Directions** are all instructions from the disaster response commander related to the response stages. The commander is responsible for managing and directing the response process. It is important to keep the action plan process on track because the longer the process goes, the more difficult for the commander to set up the next step.
- **Public Opinions** are comments and responses that come from the community and victims regarding the action that has been carried out.
- **Teammate Opinions** are comments or judgments from other members of the team. As a part of social collab-
orative teamwork, each member of the disaster response team has his or her own rational thinking. Some of them have supporting arguments, whereas others dispute the learners’ analysis.

Commander Directions, Teammate Opinions, and Public Opinions are MAGNITUDE elements that contain SC. However, our survey results for the MC, PE, and CE components showed that Ex and Ix groups determine them differently. MAGNITUDE takes this into account to encourage Ix subjects to be aware of these components. As shown in Figure 1, these components are distributed in Victim Information and Disaster Information; thus, the game narrative addresses both elements of MAGNITUDE.

4.3 MAGNITUDE Architecture

Some game genres can potentially support learning of decision-making skills(22). Hence, MAGNITUDE combines two genres to achieve the research goal, i.e. simulation and role-playing. By applying the simulation genre, MAGNITUDE imitates diverse types of disasters in an artificial environment. MAGNITUDE simulates post-disaster settings where disaster volunteers face infrastructure breakdown, social chaos, and governmental disruption. On the other hand, the general appeal of implementing a RPG genre is to encourage the development of learners’ abilities to confront non-player characters (NPCs) with ethical conflicts MAGNITUDE was developed using Unity3D, currently one of the popular game engines. Use of the existing game engine allows us to focus on developing game play. Figure 2 shows the architecture of MAGNITUDE, which consists of two sides: the training manager and the learner sides.

On the manager side, we have designed the game to allow the training manager to create new game scenarios using an authoring interface. It provides a function to configure the game environment including type of disaster, number of tasks, and type and number of NPCs involved. This side will also create a dialog editor so that the training manager can write new conversations between learners and NPCs. In addition, the training manager has the authority to collect and analyze the learning progress data using analytic tools. Therefore, he or she can evaluate the objective of established game scenarios.

On the learner side, the learners can update the level and narrative of the game, and send the assessment results to the cloud. Each game session will be recorded in a data log and stored in a database in the cloud. It includes information on the date and time that the session was played, their responses, which questions were attempted, how long it took them to answer those questions, their score, and event and position of the

Figure 2. MAGNITUDE Architecture.
learners’ navigation. The data log is used to track learning progress and analyze learning outcomes. MAGNITUDE is implemented by C# scripting in Unity3D. In the current development, it is available for iOS and optimized for iPad 4. With the power of this game engine, further development will cover all types of iOS and Android devices. The MAGNITUDE components are described below.

- The Simulation Component is a set of Unity classes intended to simulate the disaster environment.
- The RPG Pattern and Ethical Components are a set of rules that consist of an established RPG pattern. The patterns are applicable to delivering ethical game play by being embedded with the six components of moral intensity.
- Narrative manager is a set of finite state machines (FSMs) for handling game flow.
- The Artificial Intelligence (AI) component is a set of behavior trees to control the NPCs.
- For the authoring interface, we designed a mobile application so that the training manager-author is able to construct new game scenarios and add new conversation to the dialog system. All necessary game assets such as character model, pre-build terrain, dialog creator, etc. have been prepared when the authoring application was installed. The training manager-author just defines the new scenario configuration that will be saved in the JSON format data. The configuration file will be sent to the server when completed. To install the new game scenario, learners just need to download the configuration file, and then the game app on the learner side will extract it into the new levels of the game. The authoring app also has the capability to show the learning progress of the learners. The learner’s data is retrieved from the cloud and then it saved in a local SQLite format and presented in an analytics tool.

4.4 MAGNITUDE Narratives and Scoring

There is evidence that the narrative is an important game element. The narrative encourages learners to have an emotional connection to the story. Beside, the functions of the narrative in the game: informing learners about the next actions to be completed, and prompting learners about what they have already completed. Reeve(23) has described some research studies that have explained narrative forms for SGs, i.e. Linear Traditional, Branching, Parallel Paths, Threaded, Dynamic, and Implied Narrative

According to the above explanation, the MAGNITUDE game combines the linear traditional and branching narratives(25). Using the linear traditional narrative, the learners follow the narrative from the initial level to the unlimited level. This means that MAGNITUDE will have new game levels as long as the training manager, using the authoring system, can generate new scenarios to challenge learners. Each level contains a set of quests that represent the diverse types of disasters. By implementing the branching narrative in each quest, learners can prioritize their actions. They can start by choosing the easiest quest in each level and follow the main game flow based on the objective of the educational aspect.

SGs have one significant feature with regard to the in-game evaluation of learners’ performance which is feedback. Positive feedback satisfies proficiency and autonomy needs, and it is formidable to raise long-term motivation and play, whereas negative feedback motivates learners to repair poor short-term performance. In MAGNITUDE, this feedback is given to learners based on their ability. Indeed, learners’ learning progress is measured from the Character Points that learners are awarded when they overcome obstacles and complete the quests. It is an incentive given to them as a result of their activities that are appropriate to the acquisition parameters. Thus, if the Character Points reach a certain value, the level of character will go up. Character Points are determined by a combination of the following factors.

- Success Point is a score given to learners if they show success criteria to overcome a difficulty or to solve a problem.
- Social Point is a score given to learners by members of a response team, victims or a community. For instance, if an NPC is satisfied with the learners’ action, it will give them Social Points and vice versa.
- Failure Point is an undesirable score given to learners if they make a mistake that causes the task not to be finished.
- Teammate Point is the score indicating satisfaction of the members of the response team when learners accomplish collaborative work.
4.5 Game and Learning Mechanics of MAGNITUDE

Based on the survey results that MC, PE and CE were significant factors in distinguishing the Ex and Ix groups, we decided to deploy the game events with regard to emphasizing these components. Learners are asked to play the role of a volunteer, which is part of the disaster team that responds early in the disaster. The learners are tasked with the objective to respond to disaster issues spontaneously. MAGNITUDE gameplay starts to guide the learners to understand limited information about the disaster situation by the game introduction. Further, they are invited to discuss things with the main NPC (Commander) as shown in Figure 3, who introduces the objective of the quest and directs the flow of its completion.

In an initial task, learners should recognize type, impact and scale of the disaster, and also ethical considerations about conducting disaster response. In the learning domain, this initial step is to warm up them to consider their duty as disaster responders. As shown in Figure 4, the mechanics continues to the main feature of ethical gameplay that involves them in many tasks emphasized in MC, PE, and CE. How many tasks will be imposed to the learners depends on their level. For example, in the entry (novice) level, the game quest only exposes 12 tasks, for instance they requested to rescue an injured victim and to identify how many victims need to be evacuated. The task objective is given to them in the first meeting, and they will be involved in a discussion with the requesting NPC. Thus, they can observe and analyze the possible ways to satisfy the requester’s need. Each task represents one component of moral intensity, i.e., MC, PE, or CE. But sometimes all of these components emerge in such tasks. That can be seen in a rescue request from a mother of an injured boy whose leg is trapped by a collapsed structural beam in their house. Learners should be aware of the MC, PE, and CE components.
considerations. In the example case, the injured boy needs to be evacuated because of loss of a lot of blood. But, to remove the structural beam, heavy equipment is needed, but it is impossible bring that immediately to the scene. Learner-players must take responsibility and choose either to amputate the boy’s leg or wait for the equipment, which is very risky for the boy’s life.

Furthermore, every task has a different time constraint, hence they should be aware of the time limitations. The faster a learner completes this task, the higher the number of success points that can be obtained. However, beside the success points, learners will also achieve social points. These points depend on the personal traits of the requester NPC. The importance of such instant feedback is to keep learners engaged in the game narrative. In addition, as described in the RPG pattern for MAGNITUDE^{25}, the type of NPCs depends on the task objective. For example, if an NPC that is involved in the task is a teammate, the NPC type is dynamic. Personal traits are changeable depending on the learners’ action. At one time, the NPC will assist the learners’ action; at another time perhaps this NPC will interfere with their action. Nevertheless, to complete the task, learners are obligated to collect necessary information and to find appropriate resources. Either a task is complete or incomplete; the task evaluation examines their action. If the involved NPC feels that its need was satisfied, it will give the learners a subjective social point. In the final gameplay, the main NPC will be reengaged with the learners in a comprehensive discussion to examine the learners’ achievement in performing their duties. In this way they get the final score for the current quest. This end of the process also gives them a conclusion according to the quest objective introduced in the starting phase.

5. Conclusion

This paper presented interviews and findings of a preliminary survey measuring ethical awareness of inexperienced volunteers. From the interviews, we gathered a lot of useful information about volunteer requirements. The results of the survey indicated that there was a significant difference between experienced and inexperienced volunteers when facing ethical dilemmas. From the preliminary survey findings, we concluded that there is a huge opportunity to provide an alternative learning environment to improve the ability of inexperienced volunteers for making ethical decisions. Therefore, we have developed game-based learning to facilitate this goal. Using MAGNITUDE, learners employ a dialog system to get comprehensive considerations of the impacts of their actions. As a virtual training environment, MAGNITUDE can give learners immediate feedback so they can repair their performances instantaneously. For example, if their actions do not meet the six components of moral intensity, they get a negative response from the NPCs associated with the role of such NPCs, such as disaster team members, victims’ families, and the community. In contrast, if the actions fulfill the moral intensity components they collect positive rewards from the NPCs. Thus, learners improve their awareness of ethical issues posed in the disaster response situation. Furthermore, they can select the best option for making ethical decisions in a real life disaster situation instinctively.

We believe that MAGNITUDE, which we named to philosophically reflect the earthquake disaster scale, can improve learners’ skills from novice to expert like the magnitude scale in an earthquake event. The game is expected to contribute to particular training methods for disaster responders, especially for community responders, as part of a preparedness program for disaster management.

As a final point, we expect to polish the framework and to add more quests that cover all types of disasters through the dynamic level generation approach. We plan to organize an experiment to validate the learning effectiveness of the developed game. In this experiment, we also plan to gather data of game analytics for tracking learners’ progress, such as a navigation log of the game environment, log of events, and log for scoring and reward evaluation. By collecting such data, we plan to be able to distinguish the diversity of the learners based on gaming activities. Furthermore, it is also necessary to investigate learners’ perspectives of training ethical decision-making using a mobile serious game. We expect that such data can categorize learners’ achievement based on their gaming experiences.

References
MOBILE SERIOUS GAME DESIGN FOR TRAINING ETHICAL DECISION MAKING SKILLS OF INEXPERIENCED DISASTER VOLUNTEERS


(23) Reeve, C.: “Narrative-Based Serious Games”, Serious Games on the Move, pp. 73–89 (2009).


Didin Wahyudin received his Masters degree in Game Technology from Institut Teknologi Bandung, Indonesia. He has experience to involve in disaster response in Indonesia. Currently, he is a PhD student at School of Information Science JAIST Japan focusing on research of mobile serious games for training of disaster responders.

Shinobu Hasegawa received his B.S., M.S., and Ph.D. degrees in Systems Science from Osaka University in 1998, 2000, and 2002 respectively. He is now an associate professor in the Research Center for Advanced Computing Infrastructure, Japan Advanced Institute of Science and Technology. His research areas include support for Web-based learning, game-based learning, language learning, and community based learning.