

## Implementation of Emergency Management Exercises as Alternate Reality Games – Students’ Perceptions

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**Abstract**—Emergency management exercises could be carried out as simulations or serious games, as they allow for infinite replications in which participants can make mistakes without negative consequences. Alternate reality games (ARGs) offer a model for interactive networked narratives based on realistic and immersive emergency scenarios, and possibilities for collaborative problem solving with peer-to-peer communication. The aim of the paper is to analyze and discuss students’ attitudes towards the implementation of an emergency management exercise as a game inspired by ARGs, comprising a virtual crisis management exercise system. The study on which the paper is based was conducted using a qualitative approach together with a literature review and a thematic analysis of university students’ answers to an evaluation questionnaire, following their participation in a virtual exercise with an ARG design. The findings suggest that ARG concepts have a potential in emergency management training and could be tested with rescue services staff, also across national borders. Realism should however be increased and additional ARG concepts added.

**Keywords**—alternate reality games, emergency management exercises, immersive games, serious games, virtual crisis

### 1 Introduction and aim

In the field of emergency management, exercises are often based on dramatic scenarios such as forest fires and flooding disasters. It may be preferable to carry out such exercises virtually, either as simulations or as serious games. One argument for implementing the exercise scenarios as games is the possibility of infinite replications in an environment that offers motivation and allows participants to make mistakes without any serious negative consequences [1]. Important standard criteria for emergency management exercises are realistic scenarios with immersive narration that involve collaborative problem solving and peer-to-peer communication.

In common with other serious learning games, emergency management exercises ought to have specified learning outcomes that are intrinsically integrated into the narration and the gameplay [2][3]. Emergency management exercises have a tradition of collaborative exercises, in which the aim is to practice and to evaluate the collaboration

between different stakeholders in the field of emergency management [4][5]. Furthermore, emergency management exercises are transboundary and involve many actors such as firefighters, police, medical units, and decision-makers across geographical and organizational borders [6][7].

The Gaining Security Symbiosis (GSS) project has been a joint venture between the Mid Sweden University and the Nord University in Norway since 2011. The overall project objectives are to contribute to increased security for residents and visitors in the border regions and to gain new knowledge about the nature of the cooperation between risk and crisis actors in Sweden and Norway. The project members have been responsible for arranging several emergency exercises and have observed and evaluated others.

Emergency exercises have been criticized for being too predetermined, for refraining from uncertainties that characterize real situations, and for being too narrow in scope, as they have focused primarily on the response phase of emergencies and the provision of training only for professional responders [8][9]. Furthermore, scenarios have tended to oversimplify the complexity of many of the parallel activities that take place in real emergencies [10][11]. Accordingly, the wider aim of this paper is to examine the design of a game-based system for emergency exercises that address the aforementioned criticisms. Specifically, we analyze and discuss students' attitudes towards the implementation of an emergency management exercise inspired by alternate reality game (ARG) concepts.

## **2 Background**

The border between Norway and Sweden extends from 59°N to 69°N and is 1630 km in length. It passes through sparsely populated and mountainous terrain, following the mountain range that runs through the Scandinavian peninsula. At a latitude of approximately 63°N, within the counties Trøndelag in Norway and Jämtland in Sweden, the mountains give way to open terrain, farmland, and villages in the vicinity of the border.

The region that comprises the 12 border municipalities of Jämtland (5) and Trøndelag (7) has a long history of contact and collaboration. However, in the field of emergency management the municipalities share the challenge that resources are widely dispersed. The combined area of the municipalities is 52,920 km<sup>2</sup>, which is larger than the area of Switzerland, yet in 2020 the population was only 83,330, resulting in a low population density of 1.6 inhabitants per km<sup>2</sup>, and the population has been decreasing during the last 20 years [12][13]. The area is popular with tourists; it hosts a leading winter ski resort at Åre (Sweden) and the world heritage site of Røros (Norway), but due to the declining numbers of inhabitants there is a struggle to maintain the preparedness levels in the region.

To compensate for sparse resources, stakeholders like emergency response organizations at both county level and municipality level have pushed for transboundary cooperation on emergency preparedness and response. As a result, it has been routine for personnel from each country to collaborate with personnel from partner organizations

on the other side of the border and to conduct emergency exercises together. However, due to the current COVID-19 pandemic there have been restrictions on cross-border traffic in 2020 and 2021. One of the measures of the GSS project has been to construct an exercise system that allows Swedish and Norwegian personnel in the border region to conduct joint emergency management exercises from their workplaces.

Exercises have been organized in the form of a scenario with a simple basic structure. The participating stakeholders have responded to one situation or event at a time specified in the fixed scenario manuscript and have dealt with a set of events in a linear order, during which their communication and decisions have been logged and tagged with information about timing and which participants were involved in the communication [11]. The method has also been used to record and systematize emergency communications during larger exercises, as part of the evaluation of those exercises. One such exercise was the Inter System Interoperability for Tetra-TetraPol Networks (ISITEP) [14] exercise in 2016, in which the Norwegian and Swedish TETRA emergency communication systems were connected for the first time, which was found an important measure to strengthen cross-border collaboration during an emergency response [15].

The recorded communication from the ISITEP exercise in 2016 was analyzed to identify the individual communication threads and their content [11]. Contrary to the hypothesis that analyses should increase understandings of emergency response phases, the findings indicated that the concept of phases does not apply well to adding realism and immersiveness to the exercises. It was possible to track distinct activities within the exercise and to identify their start and termination. However, the activities did not take place in an orderly sequence. Except for a distinct phase in which the alarm was raised, it was difficult to structure events sequentially. Therefore, emergency management and emergency management training need to be modified to enable distinct activities to be tracked [15].

### **3 Immersiveness, presence and flow in games**

Participants in emergency management and crisis management exercises benefit from being faced with realistic, if unlikely, events. In the third iteration of the GSS project, one of the work packages has been to build an emergency crisis exercise system for remote participation based on ideas from video games and traditional crisis management exercises. For participants to become engaged and involved in the prepared scenarios in the exercises requires a degree of immersion in the virtual crisis management that is enacted during the exercise [11].

In general, when people use computers to carry out tasks such as online meetings or video calls over a prolonged period, or when they play video games on computers, consoles, or handheld devices, they typically become immersed to the extent that they either feel ‘lost’ in whatever they are engaged, or they feel a ‘connection’ with it. As described in [16] and [17], immersion and presence do not always occur but the likelihood of them occurring is higher if certain characteristics of the users, the games, and the software are present.

Immersiveness in games in general, and video games vary due to several unique factors. One factor is how the game draws the player into the imagined game world to induce a sense of ‘presence’ in that world. The precise definitions of ‘presence’ and ‘immersion’ have been the subject of considerable discussion since their introduction into descriptions and analyses of video games. The term ‘presence’ was originally used in the context of telemedicine [17] and relies heavily on the metaphor of mental transportation between geographical locations. It may also apply to the use of networked services to allow users to be present in a virtual conference or meeting. By contrast, in the context of video games, ‘immersion’ refers more to the mental processes involved in game play. Since game play involves teleportation into and within virtual worlds in which the player is thinking, solving problems, and imagining things, either of the above-mentioned terms seems appropriate.

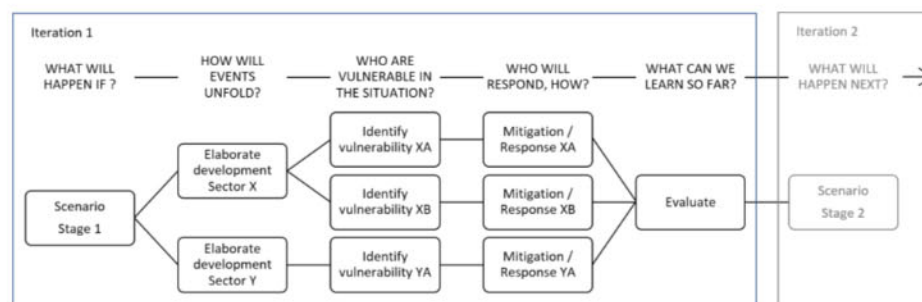
The following conditions have been listed [17] as necessary to create a sense of immersion in video games: (1) the conventions of the game must match the user’s expectations, (2) there must be meaningful tasks for the player to do, and (3) there must be a consistent game world. These three conditions need not co-exist in equal measures, but they are all needed for users to become immersed in the game experience. There are also some conditions that need to be in place related to playing a game before immersion can be expected to occur. According to [18] these are: (1) the user must know the user interface, (2) the user must know how to use the controls or to navigate with the given hardware, and (3) the user must know how to read and interpret the displayed information in the system. However, as pointed out in reference [19], the future of immersiveness may not be the high-resolution formats and big screens, but narratives skillfully presented on everyday devices.

It has been proposed that the absolute presence of a full set of nine dimensions is necessary to qualify as flow in game analysis [20]. Originally, it was suggested that flow in games was characterized by the following: balance between skills needed to perform an activity and the activity’s demands; clarity of goals; merging of action and awareness; immediate and unambiguous feedback; concentration on the task; perceived control over the activity; loss of self-reflection; distorted perception of time; and intrinsic motivation toward an activity [20][21]. A discussion exists as to whether flow is an ‘all-or-nothing’ experience in which all the criteria for flow needs to be present or whether flow can occur when only a subset of the criteria is active [22].

## **4 Method**

The study on which this paper is based was conducted with a qualitative approach involving both a literature review and an analysis of university students’ answers to a evaluation questionnaire relating to a virtual emergency management exercise. The literature study was based on search strings containing ‘emergency management’ and ‘alternate reality games’, used separately and combined with a Boolean AND. The findings from the literature review (presented in the preceding two sections) were used as a filter for the analysis of the questionnaire answers.

Evaluation questionnaires were distributed to master’s students following their participation in a virtual emergency management exercise. The exercise had an ARG-inspired design based on our earlier research [11]. As part of the exercise, 12 students answered a questionnaire with 16 questions relating to their perception of a proposed crisis scenario. The process for that part of the emergency exercise is outlined in Figure 1. After the exercise, each student answered a set of three questions to enable a quick evaluation of their immediate reactions to the exercise format and scope. Data from the questionnaires were analyzed inductively in a thematic analysis. The analysis was carried out in a systematic procedure, as outlined in [23], to find patterns and themes essential for achieving the research aim.



**Fig. 1.** Framework for repetitive practice of exercising emergency response management, Adapted from [11]

The virtual exercise was conducted according to an informal practice based on questions that allow different stakeholder groups to explore vulnerabilities associated with hazardous situations, which from their respective perspectives may ensue from a scenario, and to elaborate the responses that each vulnerability calls for [11]. The questions were as follows:

1. What will happen if ...?
2. How will events unfold?
3. Who are vulnerable in the situation?
4. Who will respond and how?
5. What can we learn so far?

First, a scenario was presented to the students who participated in the exercise. The scenario was a potential flooding event. Second, each participating stakeholder group had a reasoned discussion about the situation to investigate the potential development of that situation as relevant for the sector the group members represented. Third, based on their assessment of the situation for their respective sectors, each group elaborated on the vulnerabilities, understood as susceptibilities to harm [24], that were relevant for their sector. Fourth, each group identified the responsibilities that existed in the situation and determined alternative or complementary courses of action that could mitigate or alleviate the imminent situation. Fifth, and finally, during a joint evaluation, the re-

sources, the operation, and the collaboration needed to manage the situation were identified, and most importantly, the resource gaps, inoperativeness, and barriers to collaboration that could have worsened the situation. See Figure 1 for the framework for how the exercise proceeded.

## **5 Findings**

In this section, first the findings from the questionnaire are presented separately, followed by a subsection with the results from the literature review.

### **5.1 Student survey**

Although the students had little time to prepare and familiarize themselves with the concept of alternate reality games, they entered the alternate reality of the scenario, took a firm grip of the situation on basis of the role they had been assigned, and performed good analyses of how the situation could have developed and what measures should have been implemented. Some of the students expressed that they found it stimulating to be challenged in a subject area that was new to them and that all aspects of the virtual exercise were of interest, from preparing for the exercise to responding to the scenario and the technical implementation.

The students appreciated the structure of the exercise, which was based on a standardized set of questions that they were required to answer. The questions are the same type of questions as any organization will have to answer to respond effectively to a scenario, as seen from each participating sector’s point of view: How might events unfold? Who are vulnerable in the situation? Who will have to respond and how? After each participating group had considered and responded to all questions, all groups met and discussed the first response iteration and what learning points could be taken from that part of the exercise. Subsequently, adjustments were made to the original scenario on basis of the discussion. The modified scenario, representing the next emergency stage, formed the basis for the next iteration [11].

The students expressed that in addition to practicing response strategies, the approach formed a basis for wider discussions on the vulnerabilities associated with hazardous situations. Each question initiated a brainstorming session that opened for several different developments of the original scenario, which also made it clear to the students that any given situation can have many outcomes. The students wanted the possibility to have discussions with persons representing other sectors during the iteration, to have a second opinion. However, the demand for exchange of views was accommodated in the joint evaluation after the iteration.

On the negative side, the students argued that more thorough preparations before the exercise, as well as more time to discuss matters and make decisions during the exercise, would have resulted in better outcomes from the discussions and ultimately better decisions. The scenario in the exercise was based on the geography of a real but anonymous municipality, which appeared fictional to the students. Also on the negative side, but a most interesting finding, was that the participants wished to see more rather than

less realism in future virtual exercises. A concrete example was the wish for built-in game maps to have a higher degree of real-world detail.

In connection with the final evaluation, the students called for a comprehensive final presentation of the entire exercise, from the perspective of the representatives of the different sectors involved in the exercise and for the development of the entire scenario.

## **5.2 Literature study**

As described in the ‘Background’ section, immersion is an important characteristic of virtual emergency exercises and serious games. Realism and immersion have been identified as important components to stimulate engagement and quality learning outcomes in serious games [25][26][27]. An issue pointed out in reference [28] is that training exercises involving small-scale individual task in highly controlled environments could decrease realism and immersion. According to reference [29], research studies have found that complex and costly emergency management exercises do not always result in quality learning outcomes and applicability. Compared with emergency exercises with serious games, the alternate reality games (ARG) genre is an interesting, lean, and cost-efficient alternative.

Alternate reality games should involve problem solving and encourage players to participate in an emerging collective story that leads to the formation of social groups. As the term implies, players enter an alternate reality but one in which the purpose is to create a storyline that infiltrates real life. Furthermore, the involved gamers should be active participants and part of the story [30]. Active participants who could modify the game scenario during the gameplaying could add value to emergency management exercises. Another interesting concept in ARGs is to have a storyteller or a ‘puppet master’, with the role of guiding players in different directions as the game scenario develops [30][31]. The puppet master could have various roles in an ARG and both place obstacles to create dilemmas and act as a facilitator by providing clues for problem solving.

The ARG genre has its roots in the entertainment field, but ARGs have since been used in educational contexts with promising results. In addition to the identified motivational effects of games, ARGs have been found suitable for collaborative problem solving with a graded challenge, whereby players can choose their starting level and how to scaffold their gaming journey. Finally, the idea of building on basic existing technologies in ARGs [32][31] seems interesting for the development of lean and dynamic emergency management exercises.

## **6 Discussion**

The students’ responses indicate that a high degree of realism in the proposed scenarios is vital for the participant’s engagement, attention, and participation during the exercise. This indicates a correlation with the desire for achieving immersion and presence during the exercise reported in this paper. The students were presented with a very short description of a possible exercise scenario and were asked to elaborate on it. For



some students, the task made them aware of their lack of competence to participate in the exercise with what they perceived as necessary expertise.

The students expressed a binary polarity regarding preparations prior to the exercise. Some wanted more information and training in using the system, while others liked the challenge of learning during a time-limited exercise. At the most basic level, our results show that thorough preparations result in better outcomes and those realistic scenarios result in higher precision in the participants’ responses. Those who make general decisions based on general scenarios will not be accommodated in such exercises.

The evidence that developments during an exercise are better characterized as a process in which many parallel activities take place at the same time, rather than as an orderly sequence of emergency phases, made us reconsider the structure of the exercise system and abandon further work on the existing linearly constructed model. Furthermore, the COVID-19 pandemic has made it clear that all groups in society, not just the emergency response professionals, are important for dealing with major crises. Furthermore, research has shown that in many cases lay people’s understanding of the situation in which an emergency ensues will be superior to that of the professionals, and that when the professionals make use of this knowledge their responses will be more effective [8]. Based on a review of exercises, it has been argued [9] that the exercise concept should be developed to include the preventive and recovery phases, and that actors with diverse backgrounds need to be included in exercises.

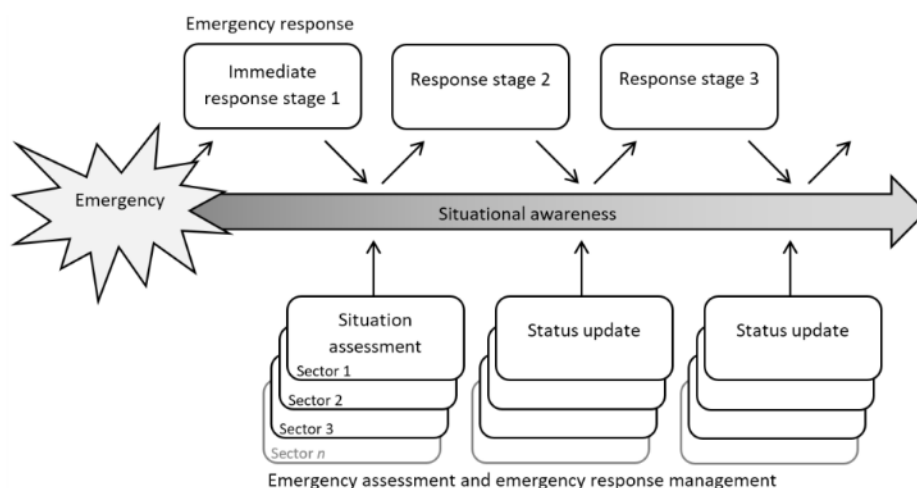
The virtual exercise system reported in this paper was constructed on the premises that crisis management is about decisions, communication, and coordination of several clearly separate but parallel activities, and that learning from exercises will be improved through post-exercise access to each response activity and communication related to each activity. The possibility to discuss what happened and what decisions were made during the exercise must be ensured. Furthermore, it is necessary to have the possibility to explore issues and measures that apply to mitigation, preparedness, response, and recovery within the framework of the exercise. These are premises that deviate from most exercises that have a linear structure. Finally, real events include both professional actors and lay people, and it is common that lay people are important in solving the challenges of crisis events. Therefore, exercises must be adapted for participation by professional actors and lay people. Most often, only representatives of professional organizations participate in emergency exercises. However, responses can be more effective if representatives of other sectors engage in the situations and exercise response too [8][9].

On the continuum between costly high-end realism simulations and oversimplified cheap games, ARGs appear as a realistic alternative to vitalize existing emergency management exercises. In this field it is important to have a design that challenges players to engage in real-worlds tasks instead of multimedia-rich fantasy game worlds. In common with emergency management exercises, ARGs are artefacts that should be designed to get more out of participants’ real life, as opposed to fantasy games that are played to escape reality. The ARG genre involves several elements that stimulate learning, such as realistic and immersive narration, problem solving, and peer-to-peer communication [33]. The combination of an updatable scenario-driven game structure in ARGs [34] and the potential of acting as virtual platforms for collaborative learning



[35] makes the ARG concept a promising source of inspiration for extending the design of digital emergency exercises. Additional advantages of exercise structured as ARGs are that its design is suitable for distributed implementation and that exercises can be carried out asynchronously.

Repetition of the procedure that was tested for this paper allows for exploration of sequences of situations, the second based on the outcome of first iteration and so on (Figure 2). The scenario for a further iteration could, in line with ARG principles, be adapted to the outcome of the previous iteration. Repetition of the practice resonates with proactive methods for emergency management [36] but with the important difference that more sectors than in the professional emergency response apparatus are involved. Conventional exercises tend to involve only the organizations that are trained to respond immediately in the case of an emergency and that have professional management staff that make the assessments and decide which measures to take. However, in many situations, effective response will require the involvement of professionals from more sectors and lay people.



**Fig. 2.** Proactive method for emergency management, Adapted from reference [36, p. 154]

The way to end a virtual exercise will have to be more thoroughly prepared and executed than was the case in our first test and preferably built into the system. Even for a system with low resolution regarding scenario detail and geographical precision, given an appropriate design it may be possible to map and visualize the disposition of resources and communication between the different participating sectors, especially for the purpose of visualization and analysis in a final joint evaluation.

## 7 Conclusions and future work

About virtual exercises, our main finding is that thorough preparations result in better outcomes and that realistic scenarios result in higher precision in the responses. Participants who make general decisions based on general scenarios will not be accommodated in such exercises.

Emergencies are always situated – they happen somewhere. Our findings indicate that hypothetical scenarios are not a way forward. The students found it difficult to determine the vulnerabilities as well as the potential responses in a fabricated context. They wanted the incidents to be located on a real map and to affect a real population.

The ARG idea of gamers as active participants updating emergency management scenarios is interesting and something that could be orchestrated as gaming iterations, including collaborative evaluations for modifications of the original scenario. Considering the promising findings from our study, the natural next step should be to increase the realism in game details and to implement more ARG concepts. An approach to increase engagement and participation in remotely managed and organized exercises must also aim for participants to become immersed in the problems while feeling present in an organization with a common goal. Furthermore, it would be interesting to test the revised game version with rescue service staff on both sides of the border between Norway and Sweden.

## 8 Acknowledgment

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