Fostering student participation in disaster risk reduction through disaster video games

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ABSTRACT

The *Sendai Framework for Disaster Risk Reduction 2015–2030* (Sendai Framework), the New Zealand *National Disaster Resilience Strategy* and the *Australian National Strategy for Disaster Resilience* fully integrate the concept of education into the overall goal of disaster risk reduction (DRR). While the links between the two overarching strategies could be more significant, especially considering the social construction of disasters, the flexibility offered by both curricula to how teachers approach the subject allows for a stronger inclusion of DRR activities. While it is acknowledged that children are greatly affected by disasters, the perspectives of children are often the least heard and included in DRR. Research into the use of disaster video games as learning tools brings together the perspectives of teachers and students to consider how to foster children's participation in DRR and support the aims of the Sendai Framework. This paper summarises a video game research project using three series of case studies. This process has led to genuine and meaningful outcomes based on the needs of teachers and students and offers a potential pathway to address gaps in policy and practice to reduce the risks associated with disasters.

Introduction

The Sendai Framework encourages a broad range of stakeholders, from government officials to local people at risk, to pool their knowledge and understanding of disaster risk to design inclusive policy and practice. While the Sendai Framework refers to the importance of education for reducing disaster risk throughout, Petal (2007) and Luna (2017) concur that DRR formal education remains largely top-down, with bottom-up perspectives (from teachers and students) lacking. Teachers are explicitly missing from the Sendai Framework, the *Australian National Strategy for Disaster Resilience* (Attorney-General's Department 2011) and also many Sendai Framework-inspired national policies like the New Zealand *National Disaster Resilience Strategy* (Ministry of Civil Defence and Emergency Management 2019). Nonetheless, the Australian national strategy has two mentions of schools; one for understanding risk by including risk reduction knowledge in education programs and another to empower individuals and 'communities' to exercise choice and take responsibility by having school programs actively encourage volunteering. Contrastingly, New Zealand's national strategy does not explicitly mention schools in any of the 18 specific objectives outlined to achieve the overarching goal of the strategy. However, under the enabling, empowering and supporting community resilience section (p.31), schools are fleetingly mentioned as one possible component of a community to action foundational resilience efforts. Such policies do little to indicate how to design these educational programs to achieve the intended aims for DRR.

The *Australian Curriculum* and the *New Zealand Curriculum* share similar aims for young people to become lifelong learners, promoting values, capabilities and competencies (ACARA 2019). While the *New Zealand Curriculum* is an outcome-based curriculum, the *Australian Curriculum* takes an integrative approach (ACARA 2019; Moss, Godinho & Chao 2019). Both provide flexibility in implementation to allow schools to tailor what they teach for the local context and students' needs.

New Zealand and Australia are exposed to a range of hazards, including natural hazards, biological hazards and anthropogenic hazards. Problematically, while disaster awareness and DRR is a national priority, students can complete their education without being exposed to disaster preparedness in schools (Johnson 2011, Selby & Kagawa 2012). However, teachers are expected by current policy, teaching practices and curricula

to help students to reduce their vulnerabilities while enhancing their capacities.

Selby and Kagawa (2012) comment that teachers and school leadership will generally refer to their national education authority for information and guidance (i.e. the Ministry of Education). The Australian curriculum incorporates disaster and DRR concepts from foundation to Year 10 (ages 5-16) through the learning areas of science, social science, technology and languages, including Auslan (Australian sign language). Senior secondary geography students focus on risk identification and management concerning DRR concepts of prevention, mitigation and preparedness. Though the misnomer 'natural' disaster is found within the Australian curriculum, the inclusion of disaster and DRR terminology indicates there are efforts by the national authority to support the delivery of DRR within the national curriculum.

Contrastingly, an analysis reveals that the *New Zealand Curriculum* does not explicitly define disaster or DRR anywhere. Learning units like the level 3 cross-curricula learning unit 'We Will Rock You' also contain outdated terminology like the use of 'natural' disaster in comparison to current academic literature (Kelman 2018). In addition, the content studied by senior secondary geography students in NCEA (National Certificate of Educational Achievement) is heavily hazards focused with limited consideration to the social dimensions of disasters. While the Ministry of Education embraces the 'What's the Plan, Stan?' resource developed by education consultancy Educating NZ on behalf of the New Zealand National Emergency Management Agency, they do not proactively reinforce this initiative that provides schools, teachers, students (Years 1–8, ages 5-13) and parents with the support to develop the knowledge and skills to prepare for natural hazards (Selby & Kagawa 2012). Johnson (2011) advocated that the Ministry of Education should play a significant role in supporting disaster education with a nationally implemented outcomes-based strategy to help students receive the necessary exposure to disaster education (Selby & Kagawa 2012). Selby and Kagawa (2012) also comment that a DRR curriculum calls for active, interactive and action-oriented learning with connections to local experiences.

This paper summarises a disaster video game research project built on three series of case studies. Desk research identified relevant video games both 'serious' and mainstream, assessing their main features and potential to inform learning about disaster and DRR. Secondly, three 'serious' disaster video games (Earth Girl 2, aka Earth Girl Tsunami, Sai Fah – The Flood Fighter and Stop Disasters!) were trialled with school students and teachers in Hawke's Bay, New Zealand to understand their concerns and priorities. Finally, insights gathered from the trials informed a larger project involving the video game Minecraft, deemed more appropriate by the students than the trialled video games to learn about disaster and DRR. Ultimately, the inclusion of video games within the curriculum offers not only an innovative teaching approach for teachers but also serves as a valuable tool for practitioners and researchers.

Reviewing 'serious' disaster video games for learning about disaster and DRR

DRR scholars, practitioners and educators propose video games as an innovative teaching method to engage students in learning about disaster and DRR. 'Serious' games refer to games designed for education rather than entertainment (Abt 1970). Theoretically, video games can be connected to constructivist learning theory. As such, video game design aligns within the player's zone of proximal development, referring to the gap between what learners can do without help and what is achievable with guidance and assistance from a more knowledgeable other (Schunk 2012). Video games provide players with 'scaffolding' to support the player through the zone of proximal development to overcome the presented challenge(s) (Loparev & Egert 2015).

To understand the benefits of using video games within the classroom, one must understand how students approach video games both inside and outside of the classroom environment. Since people typically play video games for entertainment, it is essential to consider how video games can and are being used by educators to foster student learning (Dezuanni & O'Mara 2017). Solely focusing on game content is therefore inadequate when considering the possible contribution of video games to learning within a classroom and school environment. In simple terms, video games comprise several components being game content, game mechanics, the skills players need or can build through gameplay, player motivations for initial and continued gameplay and the social interactions players experience inside and outside the game environment (Gampell & Gaillard 2016, Gampell *et al*. 2017). Therefore, video games are not only engaging tools that align with learning theory but also offer opportunities to connect to the education curriculum.

A plethora of researchers, international organisations (e.g. UNESCO, United Nations Office of Disaster Risk Reduction), governments (Canada), non-government organisations (e.g. Save the Children, Christian Aid) have developed numerous educational disaster video games. These video games convey disaster and DRR messages, including portrayals of hazards, vulnerabilities, capacities and DRR (prevention, mitigation and preparedness). Table 1 provides a non-exhaustive list of disaster video games that connects 'serious' disaster video games to concepts of DRR. Disaster video games from non-government and other organisations are often one-off deliverables developed for a specific project. Research to consider the usefulness of these video games as valuable tools is limited. Significantly, scepticism for whether disaster video games could build disaster awareness in players will be maintained without research to support the beneficial opportunities for learning available.

Table 1: Disaster risk reduction content analysis of educational disaster video games.

		Disaster Risk Reduction													
		Prevention				Mitigation			Preparedness						
		Use of man-made structures	Land-use regulations	Basic need and services provision	Engineering design	Engineering techniques/ hazard resistant construction	Environmental policies	Public awareness	Disaster risk analysis	Early warning systems	Stockpiling equipment and supplies	Coordinated evacuation	Emergency operations	Public information	Training and field exercises
Educational Disaster Games	Beat the Quake	X			X	X			X						
	Before the Storm														
	Build a Kit										X				
	Citizen Ship			X											
	Disaster Master			X		X		X		X	X	X		X	X
	Disaster Watch	X						X	X			X	X		
	Earth Girl								X	X					
	Earth Girl 2/Earth Girl Tsunami	X			X	X		X	X	X		X		X	X
	Earth Girl Volcano	X			X	X		X	X	X	X	X	X	X	X
	Earthquake Response			X							X		X		
	FloodSim	X	X	X	X	X	X	X	X	X	X		X	X	
	Hurricane Strike!	X			X	X			X	X	X	X		X	X
	Inside the Haiti Earthquake								X		X		X		
	Monster Guard			X					X		X	X			X
	Quake Safe House	X			X	X			X						

Source: Adapted from Gampell & Gaillard (2016)

Methodological approach to examine disaster video games within the classroom

Research reveals that teacher and student involvement is lacking in the video game development process, as are disaster survivors (Gampell & Gaillard 2016). This lack of involvement indicates that 'outsiders' are designing and developing these games without necessarily considering nor addressing the actual needs of the target audience (Gampell & Gaillard 2016). Significantly, Gampell, Gaillard and Parsons (2019) conceptualised and used a methodological approach reflecting the principles of constructivist learning theory and aligning with the participatory and playful nature of video games.

This project was conducted with 171 students from two intermediate school classes (Years 7–8, ages 10-13) and seven high school classes (Years 9–13, ages 12-18). In addition, two workshops were held with social science teachers from around New Zealand at the New Zealand Social Sciences Conference in 2017 (SocCon17) and 2019 (SocCon19). The suggested approach, built upon participatory toolkits, allowed for flexibility to fit local needs and requirements. Other teachers can reproduce this approach in their own classrooms. This research received ethics approval from University of Auckland Human Participants Ethics Committee (#017988).

Within a classroom setting, students were given video game access during the lesson on an appropriate device (i.e. laptop, tablet, iPad). For these particular trials, three 'serious' disaster video games (Earth Girl 2 aka Earth Girl Tsunami, Sai Fah – The Flood Fighter and Stop Disasters!) were used based on a hazard fitting the local context. Teachers and researchers selected the specific video game played ensuring the video game aligned with their lesson plans and connected to curriculum expectations. Students worked on individual devices or with a partner; two players per device was preferable if playing together. Students had autonomy over the gameplay process. There were no other guidelines except to play the video game. As such, students could decide whether they played the tutorial or not as well as the game difficulty or hazard scenario.

Gameplay should occur with minimal facilitator interference or rules governing the process. This approach stimulates a learning environment where students self-regulate their learning and actively engage in gameplay. Students could collaborate to achieve the game objectives. Students considered some classmates to be more knowledgeable others, providing support and advice to their peers. Students also considered the teacher a more knowledgeable other. However, interactions between the teacher and the student rested with the student. Such interactions support the students by providing advice and minor demonstrations that allow students to observe and replicate the teacher's actions.

Following gameplay, students participated in a carousel group activity to allow for the co-construction of knowledge through social interaction (Schunk 2012).

In this case, the carousel activity focuses students on topics such as hazards, vulnerabilities, capacities and DRR, including prevention, mitigation and preparedness in the local context. Teachers played a facilitation role. They could help students unpack their ideas to be added to the flipchart without explicitly directing the students to a specific response. The carousel activity was chosen to allow students to discuss and provide responses in a group setting to align with constructivism. Students recorded information on flipcharts using text and pictures. The flipcharts were photographed at the end of the session as a record.

Such activities require a debrief, allowing students to draw verifiable conclusions based on classroom perceptions. This helps students consolidate their new information in a public setting (Joplin 1981). Students were given control of the debrief. They read aloud the comments written on the flipcharts that lead to a participant-regulated discussion to critically reflect on the information, interact with and question each other. This helped to limit facilitator and teacher-directed conversation except when elaboration was required. Teachers could emphasise specific points or patterns from the carousel if students had difficulty unpacking their responses.

This research approach used a combination of tools to facilitate a process where the usually absent perspectives of the participants (teachers and students) could be brought to the forefront. For teachers, this process allows student perceptions and understandings to be collected. These can be used in subsequent classes to build from or as a reference for students later.

Current contributions of disaster video games in the classroom

Table 2 summarises the findings reported from classroom trials with students, perspectives from the supervising teachers in the classroom and teachers' perspectives from SocCon17 and SocCon19. Teachers involved in classroom trials and in both SocCon workshops made valuable contributions to how video games can be used within the classroom. Overall, the findings indicate that teachers and students share similarities in what they perceive to be necessary aspects of a video game for the classroom. Significantly, the data collected comes directly from the intended audiences of 'serious' disaster video games rather than from outsiders making assumptions about what teachers and students need. Video games developed for learning in the classroom require a dialogue with teachers and students to identify rather than assume their needs. This information builds a greater understanding of what teachers and students require so that practical, appealing and useful disaster video games can foster disaster and DRR awareness among school students.

The findings suggest that video game sessions should not be one-off activities but should allow students to test their skills and experiment with new knowledge

through multiple gameplay sessions. Importantly, prior video game experience and familiarity should not be assumed. Time for 'pure play' increases player comfort, allowing skill development and understanding of the game mechanics and rules. Gameplay sessions should allow time post-gameplay for students to debrief their experiences in a group setting. While video games are preferred to reflect aspects of reality, unrealistic portrayals (i.e. in Earth Girl 2, babies crawled to evacuation points, wheelchair users went upstairs) encourages discussions about the social dimensions of disasters. Some mainstream video games incorporate academic research into the game world. Mainstream video games like Assassin Creed Origins and Assassin Creed Odyssey, have educational game modes that remove certain game mechanics like 'combat' while introducing 'tours' for players to explore various dimensions of ancient Egypt and Greece. Mainstream video games could prove an effective method for learning too.

From research to practice: Minecraft as a disaster and DRR learning tool

The insights and perspectives gathered from teachers and students directly informed a subsequent project using Minecraft to foster children's participation in DRR (Le Dé *et al*. 2020). As teachers and students are frequently left out of discussions regarding disaster risk education, even though they should be regarded as critical stakeholders, the research team emphasised their inclusion alongside the local emergency management group in a co-designed process to inform the development of the area's emergency plan. It was important that both teachers and academic researchers worked together to build a lesson plan with targeted learning objectives that could align with the curriculum and the local context rather than imposing outsider assumption and perspectives upon the teachers and students.

The rationale for using Minecraft stemmed from students indicating they commonly played Minecraft, and therefore, they were highly familiar with the video game. In addition, Minecraft could address several requirements as outlined in the previous research findings. Minecraft allows cooperative play within the same game environment and can reflect real-life situations. The mainstream popularity of Minecraft (having sold 176 million copies worldwide over ten years) indicates the game's ability to motivate and engage students, while also having underlying educational advantages.

A geo-referenced 3-D Minecraft game world of the local Maraekakaho area, developed by researchers, contained geographical features such as roads, buildings and rivers served as the base layer for students to plot local hazards, vulnerabilities, capacities and DRR actions identified in the prior participatory activities. The finished Minecraft game world could be modified to reflect local hazards like flooding. This provided students with realistic visualisations of potential hazards within their local surroundings.

Three classrooms of approximately 20 students (Years 5-8) each played within the geo-referenced

Table 2: Perspectives and ideas of students and teachers about integrating video games into the classroom, categorised by group.

Students	Students and teachers	Teachers
Text-heavy games (i.e. Stop Disasters!) are less motivating and leads to information overload.	The video game should be highly engaging, interactive and fun.	Video games, as teaching tools needs to occur in the context of specific curricula area.
Voice-overs should be included in narrative-driven games (i.e. Sai Fah) to provide interactive, visual and aural stimulation and engagement.	The video game needs to be collaborative, cooperative and competitive to encourage social discussion and evaluation of approaches.	Students are focused on playing the game, therefore do not realise they are learning about DRR.
Video game feedback is useful to show areas of improvement – but does not indicate whether the student has achieved the necessary skills to tackle harder challenges	The video game should be easy to use – clear objectives, purpose, instructions and tutorial.	Video games offer both teachers and students opportunities to develop 21st century skills.
	Realistic content and relation to real-life case studies – show the consequences of player (in)action to better translate and apply knowledge/ skills to reality.	Transform teaching and learning practices by allowing students to engage in contents and contexts at higher levels.
	Video games cannot substitute for a teacher or traditional teaching practices.	Able to be used offline, online and across devices.
		Ability to encourage problem-solving and thinking (and vice versa).
		Foster partnerships not seen in the everyday classroom.
		Ability to foster school-home-community engagement.

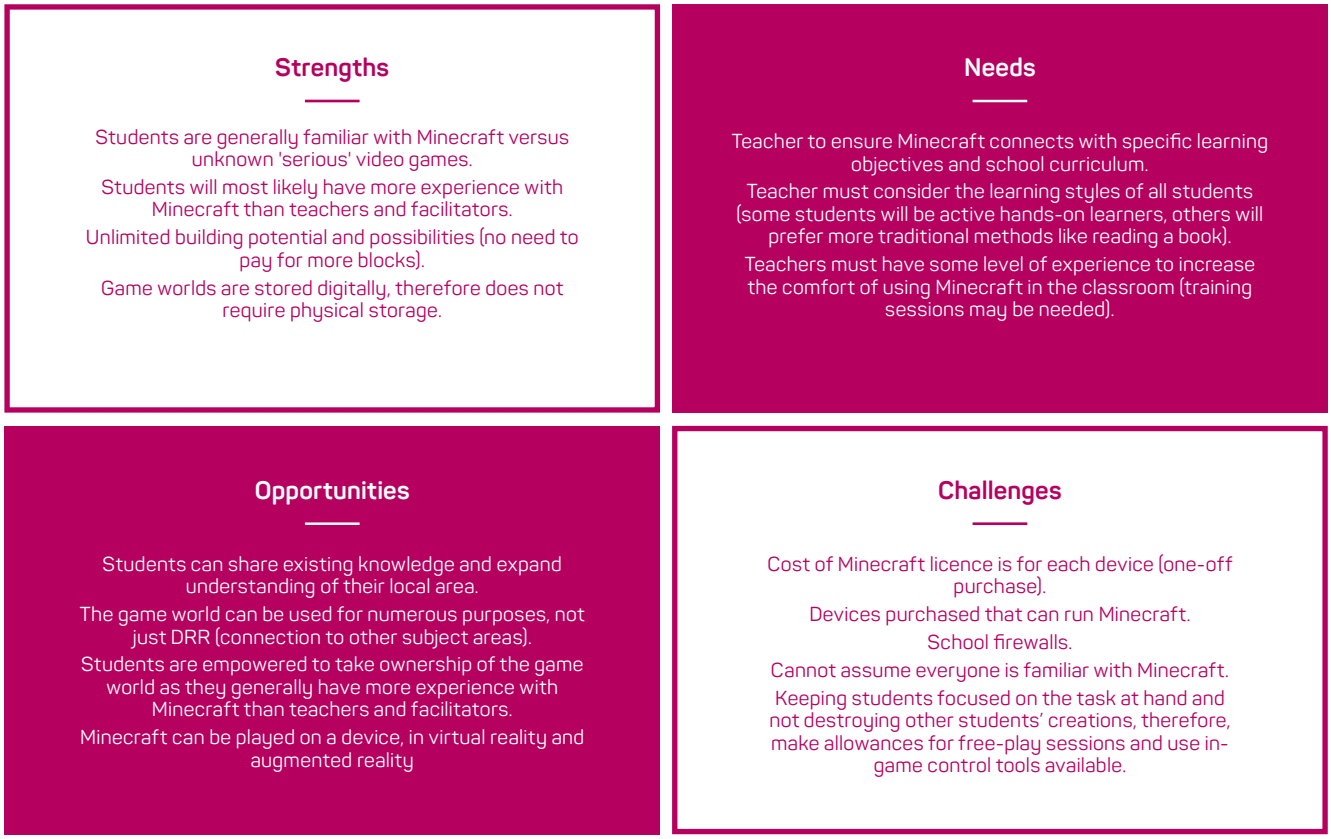

Figure 1: Strengths, Needs, Opportunities, Challenges matrix of lessons learnt.

Minecraft world for 90 minutes. Students were given complete control over the gameplay process. Within their classroom cohort, students designed a key, or legend, to indicate how various hazards, vulnerabilities, capacities and components of DRR would be identified. Students designated specific bricks or even used in-game signs with written information upon them to show what they had built and associated category. Students decided what they included in the game world. Many focused on aspects close to the school, their homes and included local features like the memorial, woolshed and restaurant. Students used information they had recorded in earlier preliminary scaffolding lessons via several participatory activities, such as one-word, carousel and participatory 2-D mapping to check what may be missing from the game world, the approximate locations or to check what they had categorised as hazards, vulnerabilities and capacities.

Students debriefed all activities to allow discussions on the overall process. These discussions highlighted the students' unique perceptions of hazards, vulnerabilities and capacities that adults may not have been aware of or had previously considered (i.e. the capacities of the swimming pool complex to provide toilets, showers and a substantial body of water). These discussions helped students contribute their ideas to the community resilience plan, fostering a platform for students to hold a dialogue with teachers, parents, practitioners and policy-makers. Teachers and researchers also debriefed after each session, discussing the outcomes of the session, reviewing the plan for the next session and discussing any alterations that should be implemented. Overall, the use of Minecraft to foster student learning about disaster and DRR is in its infancy. Figure 1 presents an overview of some of the lessons learnt in the form of a Strengths, Needs, Opportunities and Challenges matrix.

Figure 1 shows several opportunities for using Minecraft as a tool to foster participation in learning about disasters and DRR. A significant advantage of Minecraft is the one-off cost to purchase the game that allows unlimited building potential compared to other methods using physical materials. Additionally, the game world can be backed up to a hard-drive or to cloud storage after each session, resulting in a number of world save states.

For a teacher unfamiliar with using video games, Minecraft may be considered complex, but students will possibly have more knowledge and experience than the teachers or facilitators, helping the students take ownership over the process. Educators can use in-game mechanics to maintain a sense of control within the Minecraft world, like teleporting players to specific areas of the world or removing players from the game.

The Minecraft world can be continually updated with information from various subjects. This process enables an integration of other subject areas of the curriculum and connectivity between subjects and students' understandings of the world. With future iterations of Minecraft including Minecraft Virtual Reality and augmented reality mobile game Minecraft Earth, learning can transcend and make connections between the

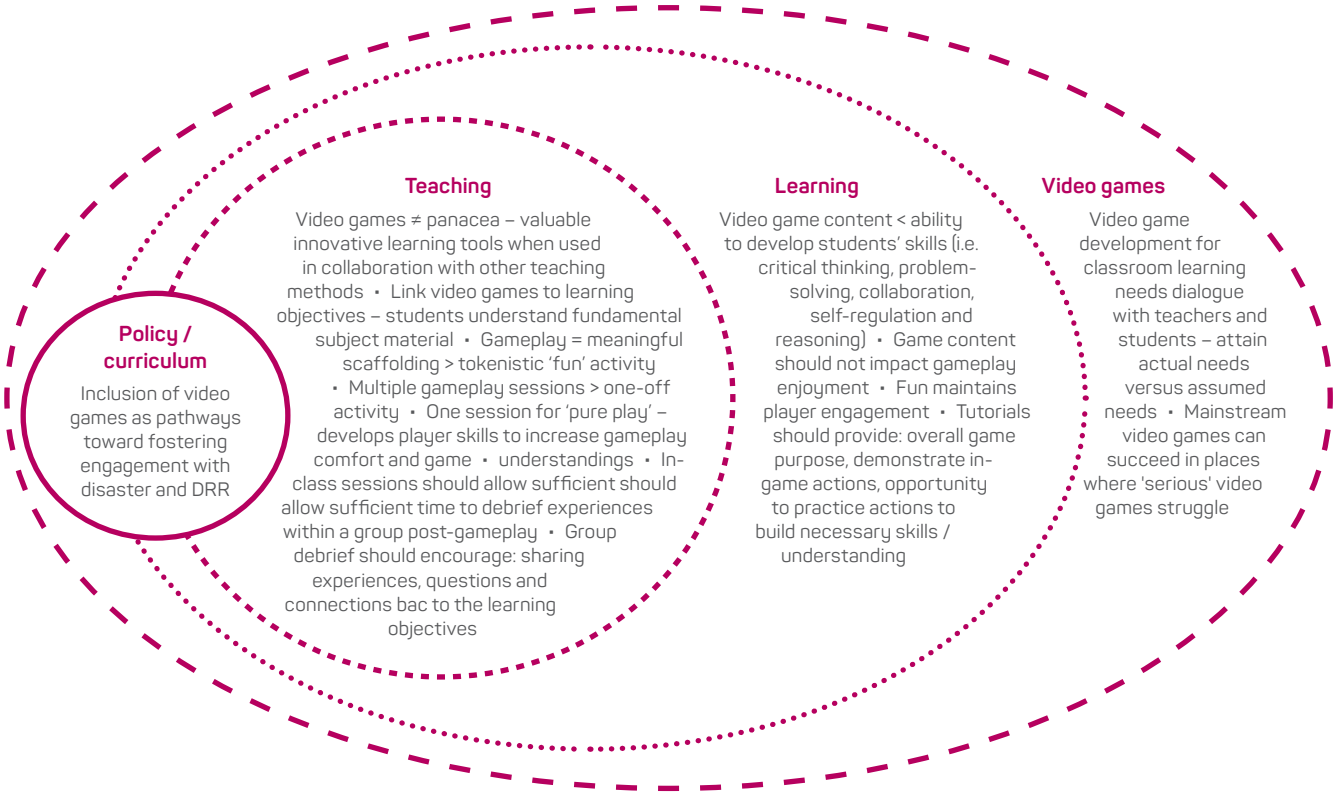

Figure 2: Recommendations for disaster video games in the classroom.

classroom environment, home and even lead to Minecraft field trips using augmented reality.

For the advancement of learning: recommendations for bridging the gap

The Sendai Framework, New Zealand's *National Disaster Resilience Strategy* and the Australian *National Strategy for Disaster Resilience* encourage the development of children's understanding of disaster risk. However, to foster the genuine participation of children as DRR leaders and change-makers, a reconfiguration of the existing educational framework may be required to better consider and integrate DRR in a meaningful way. Scholarship highlights the need for education authorities to take proactive and leading roles in supporting DRR initiatives in schools (Johnson 2011, Selby & Kagawa 2012). To shift thinking and discourse around the complex root causes of disaster, both the nature and consistency of messages could be delivered to students through the curricula (Chmutina *et al.* 2017). To address gaps within curricula, a collaborative and inclusive effort by stakeholders could include consistent messaging, understandings and the use of terminology that can be implemented by educational authorities.

Video games can become valuable teaching tools for teachers, and in collaboration with other tools to encourage participation, can be a potential pathway towards building greater awareness surrounding disaster and DRR. Academics and practitioners, among others, who wish to use video games to spread specific disaster messages and build disaster awareness must realise that video games are not merely products or activities for educational purposes. Significantly, the gaming process underpins the viability of using video games for learning rather than the belief that directly engaging with a 'serious' video game will foster learning. As such, existing 'serious' disaster video games are often unable to achieve the outcomes made possible by a mainstream game like Minecraft. Hence, video games cannot be developed as a deliverable disassociated to the needs of the target audience just to satisfy a checklist. Nor should a video game be used within a classroom because it is considered an innovative approach to learning. Instead, a process inclusive of all stakeholders can appropriately assess needs, which can lead to genuine and meaningful learning outcomes.

Reflecting on the research conducted into the learning potentials of disaster video games, Figure 2 provides several recommendations instilled from teachers and students to help inform decision-makers regarding the implementation of a DRR curriculum. Figure 2 attempts to broaden current perspectives to consider how video games and the process of gaming can help support not only the aims of national curricula, the Sendai Framework and other national policies, but also serve as engaging teaching and learning tools. As such, using video games to support formal education can also enable

opportunities to transcend and make connections between the classroom, home and in the local context.

Video games should not be considered a panacea to bridging the gap between policy, curricula and teaching practices but as one possible pathway to address current gaps. Moving forward, attention and consideration should be given to acknowledging and promoting video games as an example of a learning pathway in policy and curriculum, developing resources that are inclusive of stakeholders to support teachers using video games in the classroom (video game, lesson plans, suggestive teaching approaches) and developing video games to foster and encourage students to engage with disaster and DRR versus detracting from engagement with a focus on content.

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