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"Risk Management Can Actually Be Fun" - Using the Serious Cards for Biosafety Game to Stimulate Proper Discussions About Biosafety

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Abstract. As part of a Dutch Science Foundation project called T-TRIPP, the authors developed the serious game Cards for Biosafety. The aim of Cards for Biosafety is to let young biotechnology researchers learn more about biosafety. Analyses of workshops with researchers from the biotechnology domain as well as results of interviews with several biosafety officers clearly indicated the need for such a serious game with a focus on educational learning. Cards for Biosafety is a physical (also playable online on Tabletopia) round-based card game and playable with up to eight players. The game itself consists of scenario, risk and measure cards, and the task of the players is to choose risk and measure cards that fit the scenario explained by the facilitator at the beginning of each round. To test the efficiency of Cards for Biosafety as a learning tool, the authors conducted two online-workshops with twelve participants. The results of these sessions have not only shown that Cards for Biosafety is a well-designed game, but also a successful game to achieve the intended learning goal. In addition, the authors recognized that 'fun' is an important element in the game which leads to 'learning' in a very effective way. Future research should focus on the role of such positive states in serious games and their influence on learning outcomes.

Keywords: Biosafety · Biotechnology · Cards for Biosafety · Covid-19 · Game design · Learning goals · Self-reflection moments · Serious games

1 Introduction

The Dutch T-TRIPP (Tools for Translation of Risk Research into Policies and Practices) project is part of a National Biotechnology and Safety research programme, and it aims to design and develop interactive and innovative tools to give biotechnology stakeholders a platform to interact with each other. Serious games can be an important part of such a platform, because of advantages, such as providing a safe and interactive environment for the participants [1]. Therefore, the decision has been made to develop such a game. To identify the problem this game should address, the authors followed the IDEAS approach [2]. In general, IDEAS consists of four steps: **i**nterviews with subject-matter experts, **d**iscussion round(s) with **e**xperts, Moscow **a**nalysis [3], and participatory game**s**torm

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sessions. In a first step, all project partners of the T-TRIPP project conducted six interactive and gamified (online) workshops (each with max. 4 participants) in June 2020 with researchers (Principal investigators, Postdocs and PhD's) from different projects of the Biotechnology and Safety programme to identify the major issues around biotechnology and safety, to learn more about the current risk governance system and how people working in modern biotechnology view and experience this system. According to the issues and challenges mentioned by the workshop participants, these workshops were transcribed and analysed, and several clusters (groups of identified issues and challenges) were derived according to the frequency of issues and challenges mentioned by the workshop participants. In a second step, the authors discussed these derived clusters with biotechnology experts, brainstormed some first game ideas, and conducted a Moscow analysis as a third step (see Fig. 1). In general, a Moscow analysis can help to prioritize game objectives and / or ideas by putting them into one of the following four categories: must-haves, could-haves, should-haves and won't haves (see Fig. 1).

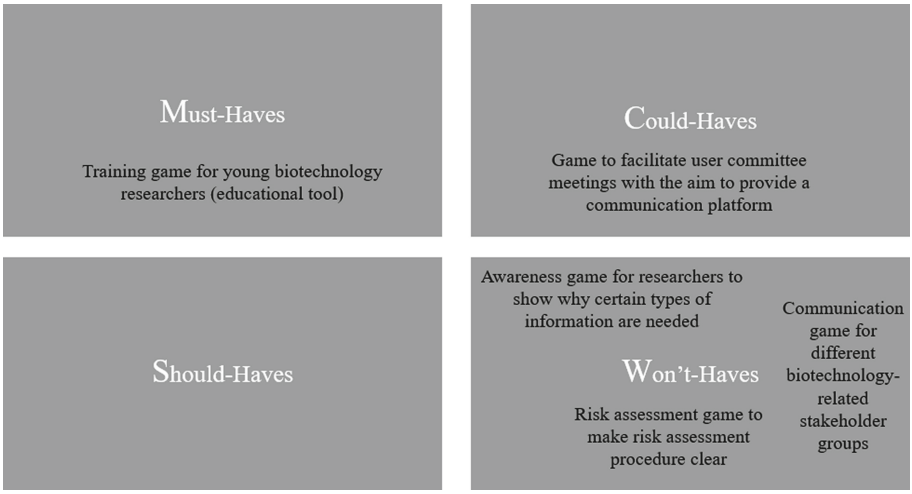

Fig. 1. Moscow analysis to prioritize derived game ideas as part of the IDEAS approach and with the aim to identify the problem the game should address.

As can be seen in Fig. 1 from the won't haves, the game will not address any of the following game objectives:

- Providing insight into risk assessment procedures (decisions, involved parties), because the risk assessment procedures in biotechnology are too complex to be covered by a serious game;
- Improving communication between different stakeholders, because the authors already developed the MachiaCelli game that can be used to focus on communication-related barriers [4];
- Increasing awareness of needs for certain types of information. Also here, the above mentioned MachiaCelli game be used as a game to address this topic.

The results of this Moscow analysis and the frequency of statements the authors got during the conducted workshops and interviews with biosafety officers included statements, such as:

- "It is difficult to explain the system/rules to a researcher"
- "For a researcher, publishing new innovative research is more important than safety"
- "[There are] differences in or lack of awareness amongst researchers"
- "Yeah, I'm not always following it [safety] because it depends on the workload I guess."
- "There is no clear definition of safety (what is safe?) and that is a problem in communication"
- "And it also means that everybody must be aware about the fact that safety is important, and that there's also kind of commitment to safety as being one of the primary values or norms […]."
- "I'm not always thinking about the risks, and I don't think all scientists do".

The above-described analyses have shown that a training game for young biotechnology researchers is needed with the aim to let them think more deeply about biosafety. In comparison to standard training methods (e.g., bi-annual refresher courses), such a game can create awareness of risks and measures related to different biotechnology scenarios by actively discussing them (and not only listening to a person who communicates very abstract input in a passive way) and it might help to prevent desensitisation. Also, Orhan and Sahin highlighted the added value of innovative teaching approaches in the biotechnology domain [5].

To understand the aim of the game more precisely, participatory online gamestorm sessions were held with project partners and partners from the field. During these meetings and several feedback loops it was concluded that:

- Authors follow the definition of biosafety by Biosafety Europe [6]: "Laboratory biosafety embraces facilities, equipment, practices and procedures deemed to reduce or prevent the risk of exposure of workers and environment to dangerous pathogens".
- Authors define junior researchers as Master students, PhD students or Postdocs. In addition to this, the authors recommend to let the game be facilitated by a more experienced senior researcher or a biosafety officer.
- Authors structure their game according to biotechnology-related scenarios, risks and measures.

These decisions functioned as a solid base for the development of the interactive Cards for Biosafety game.

2 Cards for Biosafety

The aim of Cards for Biosafety is to let junior researchers in biotechnology think more deeply about biosafety. The game should be played with both junior and senior researchers and / or biosafety officers to enhance the learning potential. The game is flexible in terms of play time because it is possible to play as many rounds as you want. It is

also easy to adjust the game for different scenarios or different biotechnology directions, because it follows a modular approach.

2.1 Game Play

Cards for Biosafety is a physical round-based card game and playable with up to eight players (up to five junior researchers, and up to three senior researchers or biosafety officers). Due to Covid-19 the game is also playable online on Tabletopia. The facilitator hosts the game and starts by choosing a predefined scenario or picking a random scenario and introducing it to the researchers. After this, every player will get five risk cards from which they must choose one card that represents the most appropriate or interesting risk for that scenario. The players also need to think about a good argumentation, presented as a short pitch, why they have chosen this card.

Depending on the general set-up, a first (in-between) debriefing can follow. Hereby, the discussion between the senior and junior researchers about the chosen risk cards including the players' argumentation, and also the connection with the real world is crucial. The senior researchers (who can take over the role of a facilitator) stimulate the other players in their discussion, argumentation and linkage with real life situations. Even if a player has chosen a card that is less suitable for the situation or contains some unrealistic elements, it is possible to convince the other players by appropriate argumentations and to discuss in exchange with the senior and more experienced scientists to what extent realistic elements are contained. More than 98% of all predefined risks and measures in the game can actually occur in reality and have been checked by experts from the biotechnology field.

Based on the chosen risk cards, a voting phase takes place, meaning that every player can vote for a risk card that represents the most appropriate risk for the chosen scenario in their opinion. Of course, this decision can be influenced by the short pitches and convincing arguments of the other players. Based on the scoring, the risk card with the most points will be the starting point for the next phase, namely the choice for an appropriate measure card. Every player will get five measure cards from which they must choose one card that represents the best measure for the previously chosen risk. After this, a second voting with regard of the best measure card takes place. A new round can be played after that, meaning that the facilitator can pick a new scenario, either randomly or from a predefined sequence of scenarios.

It takes approximately 20 min (1st and 2nd round) to get acquainted with the game plus 10 min (from the 3rd round onward) per round to play this game. This is excluding the final debriefing, which might take 15 to 30 min, or as long as the facilitator wants it to take. Quite some time of the 10 to 20 min per round is spent on the in-game debriefing between the different phases and different rounds.

To make a connection with the real working practices of the participants and with the aim to deepen the discussions about real-life (self-experienced) examples, the authors defined those in-game debriefing questions with regard to the choice of a risk card:

- Why did you choose this card?
- Do you have an idea about what a specific reason for the occurrence of such a risk could be?

– Have you (or a colleague) already experienced this or a similar situation?
– For the chosen scenario, what is the main risk you need to take into account when planning, preparing or doing research?

Possible in-game debriefing questions related to the choice of a measure card could be:

– Why did you choose this card?
– For the chosen scenario, what could be an appropriate measure to mitigate the corresponding risk?
– Do you see a connection between the information about the measure on the card and reality?
– How can you transfer such a measure to your everyday work and what is needed to do so?

2.2 Adjustments Due to Covid-19 Pandemic

To be able to test and play the Cards for Biosafety card game during the Covid-19 pandemic and its lockdowns, the authors published the game on the web-based board game simulator Tabletopia [7].

Tabletopia is a tool in which players can log in and play a board game in a 3D environment without automation. It is therefore a direct board game simulator which means that players need to move cards and pawns and roll dice themselves, just like playing a real board game. The authors chose to use Tabletopia because the platform is relatively easy to use, looks very realistic and has an easy to learn editor in which you can create your own board game. It does not take any programming experience and because it is such a direct copy of a real board game, the authors could design the game like a physical one.

To set up the game in Tabletopia, the authors needed to upload the art of the Cards for Biosafety cards (see Fig. 2) in the editor and place them on a virtual table, together with some pre-made tokens and coins. To play the game, one can create a virtual room that loads a pre-set of the game on a table and people can use a link to enter this room.

The system is quick in setup. However, some challenges in building and using the platform for playtests and sessions exists which the authors recognized during several prototyping sessions:

– The platform is still relatively limited in editing options and has some user interface issues. Cards for Biosafety is a simple game which did not limit the authors too much.
– Connection issues are a bigger challenge. In many cases players could not connect or needed to start in different browsers or on different computers.
– Using the 3D environment is difficult for some players. It is therefore important to provide a legend and do a tutorial or test round of five to ten minutes, so players can get familiar with the controls.
– You still need a secondary videoconferencing application to communicate.

Fig. 2. Design of Cards for Biosafety game cards.

3 Experimental Set-Up

To test the efficiency of Cards for Biosafety as a learning tool – that has the aim to let participants learn more about biosafety aspects – the authors conducted two workshops with five participants (junior researchers) in the first, and seven participants (six junior researchers and one senior researcher) in the second workshop ($n = 12$, $w = 6$). Two participants were Bachelor and nine participants were Master students. The authors also asked them about their experience in the field. Ten participants answered zero to five years, one participant said six to 10 years, and one participant chose 11 to 20 years (senior researcher).

Due to the ongoing Covid-19 pandemic, the authors organized two online gaming sessions in which they used a combination of both a communication platform and Tabletopia as the gaming platform. The sessions consisted of several phases:

- First, they had an interactive introductory round in which the authors asked the participants to think about a board game that represents their personality best.
- Second, the authors introduced the general aim of the session as well as the T-TRIPP project.
- Third, the authors explained the main functions of Tabletopia and the participants had the chance to get to know this platform by practicing certain actions.
- Fourth, the authors shared the link to the pre-game questionnaire with the participants. This questionnaire included some demographic questions, questions about board and digital game play experience, questions about personality traits of the participants, and their emotional state. It took approximately ten minutes to complete this questionnaire.
- Fifth, the authors explained the game rules by letting players interactively play the first round of Cards for Biosafety. After finishing the first round, the authors continued with the second one and added a new rule to the game, namely the exchange of two

risk and / or measure cards. This rule was added to increase the probability of finding a proper risk and / or measure card. In total, all players played three rounds in both workshops.
– Sixth, the authors shared the link to the post-game questionnaire with the participants. This questionnaire asked them about the game itself, about their in-game strategies as well as possible learning effects and emotional states after playing the game. It took approximately ten minutes to complete the questionnaire.

4 Results

4.1 Feedback on the Game

In the post-game questionnaire, the authors asked the players about game-related aspects. From the survey data,

– 50% of the participants completely agreed and 50% agreed that the objective of the game was sufficiently clear;
– 50% of the participants completely agreed and 41.67% agreed (8.33% neutral) that they were engaged in the game play and
– 66.67% of the participants completely agreed and 33.33% agreed that it was easy to understand the rules of the game.

During the feedback round, participants shared that it was a fun game to play and that all of them could imagine to use the Cards for Biosafety game in an educational setting.

4.2 Learning Goal

With respect to the learning goal, the authors asked the participants what they learned. In Fig. 3, an overview of self-clustered learning experiences is depicted. These clusters were grouped by the authors.

Choosing the 'right' risk and measure card is one of the most important game mechanics of the Cards for Biosafety game. To find out more about the motivation of the participants, the authors asked them about the strategy they followed for choosing an appropiate (risk and / or measure) card. Three participants said that they made use of "[…] knowledge I have on risk and calamity management […]", "[…] protocols I have learned […]" and "Mostly from experience […]". Three participants focused on cards that "could have the greatest impact" and "the likelihood that it would really happen". One participant specified his / her answer a bit by saying that "it can happen to me when I am in lab […]". Other participants "tried to come up with realistic risks and measure cards […]" or they tried to choose the "most out of the box […]" card.

In addition to this, Fig. 4 compares the achieved learning goal between the two sessions. Particpants of the second session agreed more that they learned something about biosafety. This can be explained by the attendance of a senior resarcher during the second session who explained several things to the junior researchers, shared his experiences

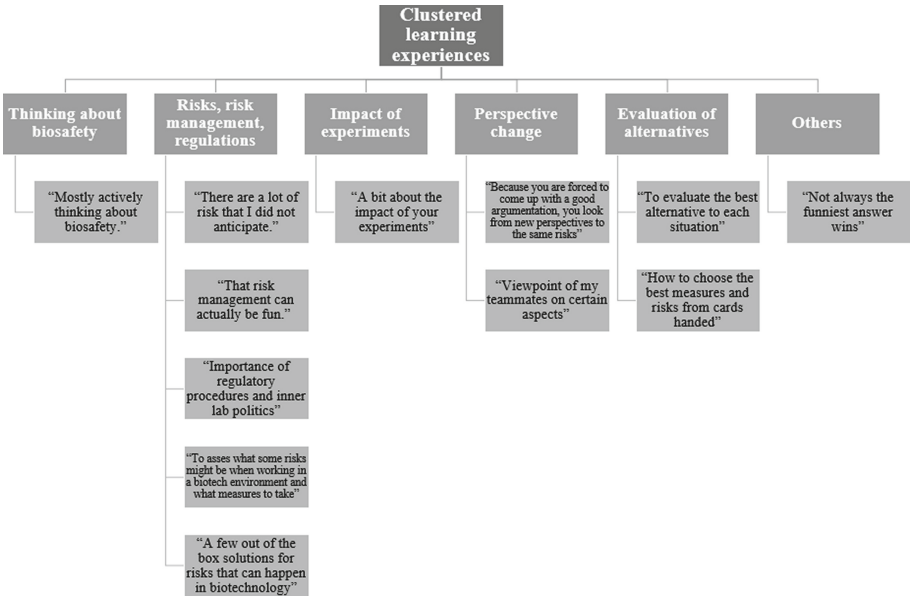

Fig. 3. Overview of clustered learning experiences.

with them and communicated interesting anecdotes. One participant mentioned that a senior or more experienced researcher is needed "to bring it [the game] to the next level". This shows that it is of utmost importance to include more experienced researchers in the game play.

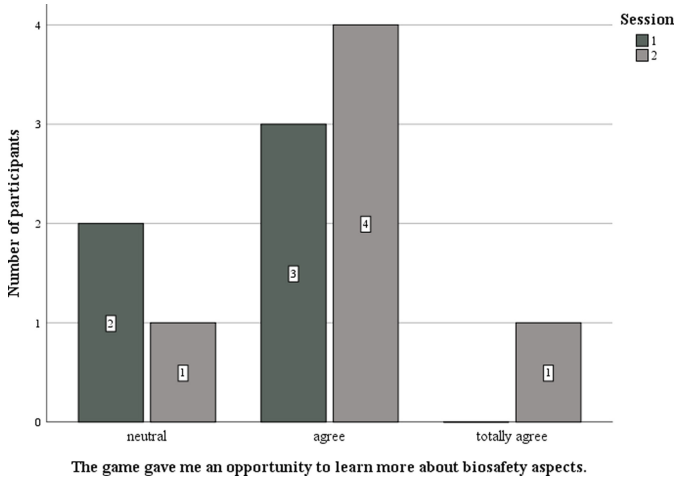

Fig. 4. Comparison of the two sessions with regard to learning outcome.

5 Discussion, Conclusions and Outlook

The present paper focused on the design and development steps of the Cards for Biosafety game which has the aim to let young biotechnology researchers learn more about biosafety. Due to the Covid-19 pandemic, the authors started with the development of an online-version of this game that they tested with junior and senior researchers from biotechnology. The results of these sessions have shown that Cards for Biosafety is a successful game to achieve the above-mentioned learning goal. The authors also recognized that the learning objective is not only limited to biosafety aspects, but also focused on related risk management and risk assessment procedures.

In addition to this, the results presented in Sect. 4 showed the added value of serious games. The serious part of this game is based on the learning through sharing principle, meaning that players learn from other players. The interplay between junior and senior experienced players and related self-reflection moments are crucial moments of the game in which learning happens. The game itself should be seen as a starting point for sharing of anecdotes and discussions on biosafety aspects. Due to the huge variety of different risks and measures cards, it is not that easy to identify and choose the 'right' risk and measure card during play. The players often have to pick the least non-fitting card and need to find good arguments for their choice. In many cases, the players will choose seemingly funny cards, but might defend their choice very interestingly or might cause other players to explain that their card is actually realistic and relevant. In this way 'fun' (e.g., "That risk management can actually be fun") leads to 'learning' in a very effective way. This 'Out-of-the-lab thinking' is what the authors want to support with this game, because it allows players to get to interesting anecdotes and lessons learned for the junior researchers. The seemingly funny cards might initiate the most interesting discussions and in addition to this, the players will be having fun doing so. Adding serious discussions as part of the debriefing closes the bridge between funny moments and the intended learning objective. The role of serious fun [8], related emotions, and their influence on learning could be an interesting subject of further research. Furthermore, the feedback of the participants will help us to improve some game mechanics of the Cards for Biosafety game.

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