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GamiTRIZation – Gamification for TRIZ Education

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Abstract. TRIZ provides tools and methods to meet complex challenges. Since most TRIZ-capabilities are based not only on theory but also on practical application, today's challenge is to make people not just learn about the TRIZ-method, but to learn actual skills and to get something done with them in a given time frame.

Learning TRIZ needs interactive settings to quickly transfer knowledge and methods into action. TRIZ-experts usually can rely on a long-term practice. Games and cases allow to teach and multiply this experience by activating learners and emphasizing individual capabilities – even by adding a fun factor. That is why gamification actually is a recognized learning and teaching approach. The authors have compiled, reviewed and analyzed a number of games and cases that offer playful learning and teaching of a variety of different TRIZ tools. The article gives an overview about the used settings and types of games and cases.

Keywords: Game, Case, Gamification, GamiTRIZation, TRIZ Education.

1 Introduction

Consider the intensity with which students engage in activities during their leisure time, such as sports, music, photography and video games. Motivation, learning and education seem to reach their peak in such situations, as engagement is coupled with intense personal commitment and involvement. This is why the authors felt that motivation and learning are but two sides of the same issue.

Play plays an important role in learning, and “Games are perhaps the first designed interactive system our species invented.” [1, p. 1]. The number of new contents, subjects and fields to attain competences in is rising. So is the complexity in which competencies have to be conveyed, e.g. within a limited time frame and to groups of people from a wide variety of technical and cultural backgrounds. Within this setting, play is more and more recognized as an answer to learning [2].

The authors' interest in using playful elements for education is derived from their outstanding objective guided by the question of how to promote situations in where

- students from various backgrounds (e.g. kids and adults, different cultures, technical and non-technical, ...)

- are motivated to learn,
- engage in the (learning and teaching) act,
- are ensuring that learning will occur and willing to reflect their learning act and
- find the learning process – not just the learning outcome – to be satisfying.

These goals seem largely unattainable at the same time. However, this is a common challenge, which teachers and trainers experience every day. Teachers, instructional designers, and trainers should not refrain from encouraging or expecting play behavior in their students when they wish to sustainably reach these goals for their attendees, never mind what the field is. The purpose of this article is to propose play in general and games and cases as special goal for learning and teaching TRIZ – considered a “hard nut to crack” for learners and teachers alike.

The authors compiled the best TRIZ games and cases known at the moment (status: **April 2018**) to transfer each learning and teaching act into an interactive situation, where the process and outcome produces high sustainability within the players. They go even further and suggest that learning environments that conjure up playful situations deserve recognition especially for spreading the TRIZ method, its tools and applications – due to the contradictory condition that TRIZ itself comprises. It is considered as highly fruitful and efficient in solving difficult, risk-creating problems, but at the same time is difficult, risky and time-consuming to learn in a way that it can be fruitfully and efficiently applied. To overcome this contradiction, play is considered a compromise-avoiding and at the same time contemporary answer; it shows contradictory elements itself.

2 The Paradox of Play

The English language distinguishes clearly between the words “play” and “game”, while in German (the authors’ mother tongues) this distinction does not exist. It is simply to be translated as “Spiel”. Exploring the English sources, it turns out, that two basic relationships between the terms play and game can be found [3, p. 72, 73]:

1. Play is a component of games: Games are complex phenomena and there are many ways to frame them and understand them.
2. Games are a subset of play: Play represents many kinds of playful activity. Some of these activities are games, but some are not.

As it looks, both terms can be used interchangeably; nevertheless, the authors have decided to follow the second, in which play is considered as highlighting the wider sense of the issue, and games being one component of it. Other sub-components, the authors are familiar with in their business affiliations and especially in their field of production management issues, are cases and simulations, e.g. to perfectly convey the ideas of lean production [4]. For their current research highlighted in this paper, they have restricted to games and cases, the latter being considered here as another subset of the wide definition of play.

Cases highlight given situations, in which the player has to solve some problem or fulfill some task, usually in a given time frame. In many situations, it is hard to decide whether a game or a case is at hand, as also a game may contain case-elements, and vice-versa. The authors sometimes intuitively decided about a repartition based on their experience in training issues, with heavily considering the main aspect underlying each of them: the fun-factor and that it would work interactively for the participants. These considerations paved the way for a newly published book entitled “Playing TRIZ – Games and Cases for learning and teaching inventiveness” [5]. This paper here more or less tells the story why the authors came up with such a publication.

For going deeper into the issue, various elements of the definitions of games and play are available (for an overview, see again [3]). The main author herewith deliberately selected some elements of play and games, and complemented the authors’ own thoughts on cases, which led to a better understanding of the three (Table 1).

Table 1. Selected elements of a play, game and case (as understood by authors), ‘++’= applies fully, ‘+’= applies.

Element of understanding	Play	Game	Case
Proceeds according to rules limiting players		++	+
Goal-oriented / Outcome-oriented		+	++
For the sake of it	++		
Activity, process or event (time frame)		+	++
Commitment		+	+
Conflict to be solved		+	++
Task to be fulfilled			++
Involves decision-making / influence		+	++
Entertaining and fun	++	+	+
Artificial/Safe, outside ordinary life	++	+	+
Creates special (social) groups	+		
Cooperation / Connection between people		++	++
Competition between groups / Players		++	+
System of parts/Resources and tokens		+	++
Absorbing, energy taking	++	+	+
...			

At a brief glance one could state that play is ideally considered as something free, without limitation and without being taken “serious”, as they work for its own. It sometimes even works without any material or physical token, and may just be fired by fantasy and imagination. Games and cases are more goal-oriented and limited, either by rules and / or by time, and in many cases require or offer game pawns or tokens. Perhaps, play is the ideal (according to the understanding of Ideality in TRIZ) as it constitutes human’s life right after birth, needs nothing and is thus essential for human development [6].

This can easily be understood when we observe children playing. They may be engaged or even engrossed (which is called “Flow”, see [7]) in an activity which for them is pleasurable just for the sake of it. At the same time, nobody would doubt that they are not learning anything. They might behave cooperatively and connectedly or working for oneself and for their or its own sake – just for the fun of it. Even if they are willing to commit a great amount of time and energy, they are enjoying themselves and even accept false starts and frustration, e.g. for not proceeding faster or achieving some result. They simply try again and see how it works. Being called to stop might be the only frustration they encounter. With such behavior, they are learning a lot, but for them it does not feel so.

Adults, on the other hand, have mostly internalized that analytical thinking is worthwhile; but possessing a lot of knowledge and/or life experience might be a hindrance when encountering new situations or solving complex problems, in which thriving through could be a much better approach [8]. Nevertheless, the prevailing logic especially in groups and when there is limited time is, that outcomes are much better when everybody follows rules.

Paradoxically, rules can also help to break rules, contributing to new, innovative ideas and outcomes. Rules, as limiting as they may seem, may also open possibilities and make broaden our perspectives, which again is the beginning of exploration – and then play. With a closer look on the elements column above, apart from these contradictions, many others could be enumerated, with parameter 1 as the one we would like to achieve, but parameter 2 considered as the possible deteriorating one (Table 2).

Table 2. Selected (technical) contradictions of play(-ful situations) for learning.

Contradiction #	Parameter 1	Parameter 2
1	Entertainment	Serious (learning) outcome
2	Enjoyment, fun	Engagement
3	For one’s own sake, for it’s own sake	Engaged for an outcome, for an activity, for competition,...
4	Cooperation and connection	Competition
5	Team-building / belonging / (social) groups	Working for oneself / achievement / working for a task
6	Winning	Losing
7	Exploring / Thriving through a given (new) situation	Gaining influence on and control over a given situation
8	Nobody forcing, free will, ...	For an outcome, for an objective, ...
9	Freedom, anarchy, creativity,...	Limitation of players, rules, structure, organization, ...
10	Rules (to break (former) rules)	Rising complexity
11	Ignorance if own knowledge will be helpful	Commitment
12	Real-life situation	Artificial / Story telling
13

Altogether, play as an activity for children always sounded fine, but adults often bristle at the thought, that play would describe something that they do, especially when we leave leisure aside and come to work or even education. For very long, work was considered the opposite of play [2].

This is the reason, why the term play nowadays seems to cheapen or degrade a learning experience, especially if it is for work purposes, and if so, the entertaining element is not taken serious. So it is no wonder, that in many sources we read about “serious play” to indicate all kinds of so-called real and hard learning, innovation and training outcomes achieved by playful elements [2, 9, 10, 11].

Fortunately, some recent authors are heavily calling for returning to more play in our (children’s and adult’s) life again, and even state that playfulness is the key to everything, not just creativity and inventiveness [12, 13, 14]. This trend is also supported by the growing market of digital computer games that frequently convey the term “gamification” not only in education, but in all aspects of life [15, 16].

The paradoxical and even contradictory situation of play being at once too complex to fully understand, and predicting yet an everyday phenomenon just waiting to emerge, is why the authors have taken such an interest in games and cases to transfer knowledge in their classes and trainings [4, 17]. Fortunately, play nowadays is more and more considered a suitable goal for learning situations that demand creative higher-order thinking and a strong sense of personal commitment and engagement [2, 10, 18]. Play is doing something right, and that “something” involves a complex set of conditions, especially when it comes to the comparatively difficult subject to learn – TRIZ.

3 Playing TRIZ – Overcoming Contradictions

3.1 Learning and Teaching TRIZ with Games and Cases

Learning TRIZ is not easy – but teaching TRIZ is even more difficult. Ellen Domb already explained this problem in detail [19]. Her thoughts in part were based on the "revised bloom's taxonomy for learning" [20]. This taxonomy contains the following levels of learning: the first (or lowest) level is „remembering“, followed by „understanding“, „applying“, „analyzing“, „evaluating“ and „creating“ the last or highest level. Of course there are also many other models of individual and group learning in classical and newer learning theories and considerations on how these theories can be used in teaching [21].

Many classical teaching approaches are based on taxonomies or classifications such as the one mentioned above. If teaching methods are dedicated to address only one certain level, it is easy to understand that different teaching methods may be better suited for one of these levels than for another one [19].

Teaching TRIZ typically addresses several levels of such taxonomies. In many cases the underlying learning theory is more process-oriented than leveled. The models of single-loop, double-loop and deutero-learning [22], e.g. can be used to design cases or simulations for learning (and also teaching) the proper usage, evaluation,

reflection and further development of methods and processes. The design of cases based on these learning models, for example, is used to enable students at the university to deeply understand and learn TRIZ-forecasting [23].

Games, cases and simulations fit very well to the requirements that are often placed on the teaching and learning of TRIZ. If we think in terms of learning models such as the above taxonomy, games and cases offer the possibility to combine several specific methods for the learning objectives on specific levels by combining different phases, game situations etc. If one thinks in terms of more systemic or process-oriented learning models, games, cases and simulations deliver the loops for e.g. single- and double-loop learning, as well as the experience for deuterio-learning.

Many teachers, consultants and professors use project- or problem-based tasks, case-studies for teaching TRIZ – a look at the proceedings of international TRIZ-conferences shows a wide range of specific teaching concepts. Problem- and project-based learning is a traditional learning-method in TRIZ-learning – even classical TRIZ books use many real-world examples to explain and illustrate knowledge, see e.g. [24].

The usage of games and the enrichment of case-studies towards more activating cases without pre-defined solutions fit also very well to these teaching thoughts and go hand in hand with the rising significance of gamification-approaches. There are certainly many interesting games and cases for learning and teaching TRIZ – some approaches have already been presented at conferences, e.g. in [23, 25]. However, since many treasures are still hidden, the authors have launched a call for papers to make successful games accessible to the general public, and thus support a stronger growth of gamification in the field of TRIZ.

3.2 Dealing with the Paradox in Play – Some Examples

In chapter 2 some paradoxes and contradictions in the use of games as learning methods were mentioned. Some games deliberately use such contradictions. The following examples will illustrate this:

The presented game "Umbrella 5.0" [5] is a game for children, which is held at the university as a learning event for school children. They work together in groups and these groups compete with each other. This competition ensures a high level of commitment and motivates the children very strongly. However, experience has shown that at the end of the game the disappointment is very big among the groups that cannot consider themselves winners. However, if the competition is waived, motivation and activity of the children are lower as in the competition scenario.

This contradiction can be treated as a physical contradiction (in terms of TRIZ): There should be some competition between the groups so that the children are highly motivated AND there should be no competition between the groups so that the children are not frustrated in the end. In this case, the contradiction seems to have been resolved by separation in time, but with a closer view it is resolved by separation in relation: In the first phase of the game, the children get the impression that the groups compete with each other – this gives them great fun and motivation to be better than

other groups. At the same time, however, the competition does not already name winners or losers – instead, it just prepares them for a "big final".

With this feeling and mindset, the children start into the second and final phase. However, due to an almost imperceptible change in the rules, the groups no longer compete with each other in the end. Instead, the solution ideas (of all group members) compete for the favor of each single child. While in the first phase, the evaluation is (apparently) the responsibility of the professor, in the second phase it is transferred to each individual child. That is why, in the end, there are no *children* that are winners or losers – the winners are not human, the winners are *ideas*. The gentle change of the rules leads to a first phase with different conditions and relationships than in the second phase [5].

A much simpler contradiction in the same game arose initially from the grouping of the teams. The grouping was necessary in order to create a competitive structure. But the grouping required a lot of time, because the children do not know each other and sometimes are shy. In total, however, only a very short period of about 90 minutes is available for the whole event. This contradiction was solved by separation in time, or specifically “preliminary action”. Today the tables and chairs are already arranged to groups *before* the children arrive and they automatically build the groups when they sit down [5].

The contradiction between rules (as a means of reducing complexity), and the necessity of being able to deal with growing complexity can be found in the game „TRIZmeta” by Darell Mann and Cara Faulkner [5]. Changing the rules of the game in parlour games (using TRIZ rules) creates a deep understanding of the TRIZ rules on the one hand and of reacting to changes and the individual learning process on the other. The learning models of single-loop and double-loop learning explained above can clearly be recognized in this game.

4 Compilation of TRIZ Games and Cases

4.1 Call for Papers for Chapter Creation

In order to show the already existing variety of games for TRIZ training and to increase their distribution, the authors launched a "call for chapter" in 2017. The submissions would be reviewed and published in a book in the autumn of 2018.

The aim was to provide as broad an overview as possible. Therefore, no narrow classifications regarding "game, play, case, simulation..." was asked for. Conversely, however, the collection may be used to develop such classifications for TRIZ-games or game-like forms of TRIZ-learning.

The call for chapter asked the authors to describe their game. Information on the practical implementation was also requested, e.g.: duration, number of attendees, materials, educational objectives/competencies and the areas of TRIZ addressed by the game or simulation.

There have been many requests of interested authors. Finally, 19 abstracts were submitted. It is expected that 13 of these games and cases will be described in detail in the book [5]. All exemplified hints for games and cases given here will make part

of the book, but not all games and cases could be referred to herewith, as the work in progress and the deadline for this paper more or less fall together.

4.2 Characteristics of the Games and Cases

Gamification maybe defined in various ways. With regard to the authors' goal to explore the variety of games in the TRIZ environment, a very broad definition of gamification may be helpful as a basis to explore the collected games and cases: "The application of gaming metaphors to real life tasks to influence behavior, improve motivation and enhance engagement" [26, p. 4].

In all submitted games "influence behavior, improve motivation and enhance engagement", is of major concern to increase the ability to solve problems with the help of TRIZ-tools or -principles. The "application of gaming metaphors" is very different for each individual contribution. This is illustrated below, using quality criteria for games as they are identified by the successful German game developer W. Kramer [27]: Originality, Replay, Chance to win, Surprise, Timing, Consistency and Quality of Materials, Influence, Target Group, Easy Start and Rule Complexity [acc. to 27].

Originality. Almost every game contains new elements. In some games, well known TRIZ-tools are used to solve witty problems. Some games invite the player to bring in his or her own problems – in these cases the rules of the game are the main aspect of novelty. Besides that, the criterion "originality" is always in relation with the target audience: people that never worked on Ellen Domb's (the author of, among TRIZniks very well-known "Titanic TRIZ", see her experience in learning and teaching TRIZ in [19]) Titanic-TRIZ-Case (see as well in [5]) will find it a very witty and entertaining endeavor.

Replay. According to Kramer [27], a good game should provide incentives for its replay. This only partially applies to the collected TRIZ games and cases. Some games are generic – they introduce general rules and procedures, but deal with individual problems and can be repeated by the same person for many problems. Other games, on the other hand, deal with specific problems and therefore offer little incentive to be used several times by the same person in exactly this form. Such specific schemes can of course be used to develop further games and/or cases in analogy. An algorithmic computer game does not offer these possibilities – it is certainly attractive to play this one, two or three times, after that the player should look forward to some new levels or another program.

Chance to win. In many games, there are winners and losers. In other games, all participants win – for example, in the fight against a threatening situation, as is the case with the Titanic problem.

Surprise. Good games contain surprising elements. Many of the collected TRIZ games contain elements based on chance that deliver surprises. The course of the game is therefore not exactly predictable, but suddenly shows variations. These variations are realized, for example, by drawing cards: Using the 40 innovation principles (IP) in a Lean TRIZ game, IP cards are drawn randomly. In a TRIZ-Bionics board game by Nick Eckert, see in [5], the game pieces are moved because of dice results and another action follows depending on the field reached on the board.

Timing. If several groups or single players take part in a game, the game sequence should ensure that the game ends for all at the same time. If one is finished much earlier than others, these players would have to wait, which does not have a positive effect on motivation and makes it difficult to facilitate the game. Some games with several groups therefore have a stock of problems that is larger than the amount of problems expected to be solved. In this way, faster groups can be employed with additional tasks or rounds, as long as slower groups also finish.

Consistency and Quality of Materials. The materials should be consistent. The Apollo 13 TRIZ-Case [see in 5], for example, remains consistently with its topic throughout the entire process and uses photos and other media from the original situation.

Influence. Players should be able to influence the game and be able to involve themselves to a certain extent. In most TRIZ games, this is at least done by generating solutions with the help of TRIZ tools. In other cases, various elements, such as the selection of problems to be solved or even the rules of the game, can also be influenced by the players.

Target Group. All TRIZ-games and cases submitted have defined certain target groups. These are, for example, job-related target groups, such as production workers looking for waste elimination or age-specific target groups such as children between the ages of 8 and 12. Other target groups are defined by the level of knowledge or ambition – so a computer game on the 40 innovation principles is mainly aimed at TRIZ beginners (although TRIZ professionals may also enjoy this).

Excitement. TRIZ-games and cases should not be boring. Excitement and suspense can be controlled through the game play. Many of the games collected rely on consciously controlled processes with phases of high tension and rather relaxing phases.

Easy Start. Many of the collected TRIZ games and cases allow a very easy start of the game. In these games, required TRIZ knowledge is built up during the course of the game. However, this is difficult if the game requires very extensive TRIZ knowledge and experience. In such games, the leaders of the game often switch to more extensive instructional TRIZ sessions before or during the game. The games can therefore not be judged as "good" or "bad" on this criterion, because it also depends very much on whether the games are played separately or are integrated into a larger context.

Rule Complexity. Kramer [27] emphasizes, that the complexity of the rules of the game should correspond to the complexity of the content. So simple games should also have simple rules. This is often the case with the collected TRIZ games. In some games, however, the complexity of the rules of the game overlaps with the complexity of TRIZ methods to be applied. This increases the complexity in certain game situations very much.

The editors of the new TRIZ book do not present on detailed examples here, as it is impossible to select one or several best game(s) or case(es) of the actual collection.

5 Outlook

The entire actual collection of TRIZ Games and Cases will first be shown in detail in the book. It could serve as the beginning of an empirical research in terms of analysis and synthesis of this topic. The Call for Chapter deliberately formulated only very vaguely what "games, cases, and simulation" is all about. As there have been numerous expressions of interest from further authors, national and international, volume 2 of the book is envisaged to continue the collection of existing approaches.

If a larger number of examples would have been collected, research activities can be carried out further. Based on a broader collection of examples, classifications and investigations can be developed with regard to various criteria. It will then be easier to define which special features gamification has in the area of TRIZ education – which are therefore special characteristics of “GamiTRIZation”, for the first time coined as a term within this paper here.

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