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EDITORIAL

Gamification in science education: a promising field for Action Research?

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In this editorial I outline the basic connections between playing and learning and define what a "game" actually is and how educational processes can be "gamified". I then try to find key arguments on why games are valuable for educational purposes. Because I believe that Action Research can contribute to a better implementation of games in the classroom, my editorial ends with a call for papers on this issue.

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Between playing and learning

The concept of playing is a fundamental part of human activity and can be found in various forms in all cultures and societies around the world (Roberts, Arth & Bush, 1959). Prominent psychologists and educational researchers such as Montessori and Piaget have acknowledged the value of playing for the development of children for hundreds of years (Murray, 2018). Vygotsky (1980), for instance, described games as providing opportunities for children to experience scenarios they are not yet able to live through in real life. Thus, the importance of games for one's development has led to the inclusion of game-based settings for learning purposes both in lower and upper secondary as well as in higher education (Kim, Song, Lockee & Burton., 2018). When it comes to overarching theories, gamification elements making up effective games for learning can be linked to the central theories of constructivism (Hayhow et al., 2019), namely social constructivism (and communities of practice) as well as situated learning (Kafai & Burke, 2015). While some researchers even consider educational games being one of the biggest "hypes" of the last decade in the educational context (Raitskaya & Tikhonova, 2019, p. 5), my impression for the science education realm is that this "hype" has not fully reached our community so far. It is quite surprising that the standard science education handbooks do not contain chapters on gamification – the terms "play" or "game" do not even appear in the index. Moreover, the evidence on actual learning outcomes in the science classroom fostered by games remains quite spotty - it seems that hardly any publication on this topic can do without mentioning existing research gaps. My claim here is that Action Research studies might contribute to the overall picture of the functional application of games in science education. In this editorial, I will briefly answer basic questions about playing and learning and announce a call for papers on this issue.

To begin with, different features of an activity that can be considered a "game" can be traced in the literature. A quite simple definition from over 50 years ago by Roberts et al. (1959) includes five criteria: organized play, competition, two or more sides, criteria for determining the winner and set of rules. Over the years, many other criteria were developed, such as strategy, fantasy, sensory stimuli, control, constraints, context, feedback systems or voluntary participation (e.g., McGonigal, 2011). Kim et al. (2018) compared a number of criteria from different publications and identified three central aspects that I believe are also functional for our considerations as educators: goals (desired outcomes from the game), rules and interactions (reciprocal actions between players).

When it comes to educational games, the term "serious game" is often used to describe them. In 1970, Abt defined the term as "games that have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement" (p. 9), but, at the same time, pointing out that the amusement aspects also don't need to be neglected. Serious games are also closely connected with game-based learning (GBL) (Gros, 2007). While GBL includes a wider variety of games such as traditional board and card games, the term "serious games" primarily, but not always, focuses on digital games (Tsekleves, Cosmas & Aggoun, 2016). It is certain that both terms aim at describing activities which employ game mechanics for learning purposes, which leads us to the concept of gamification. Gamification is commonly defined as changing processes that are not games through implementing a game or at least elements of one (Deterding et al., 2011). Here, game mechanics are explicitly used to follow concrete educational goals and solve specific problems (Kim et al., 2018).

Commonly mentioned elements for gamification in learning and education are story, dynamics, mechanics, collaboration, goal-oriented design, set of rules and technology (Aynsley, Nathawat & Crawford, 2018; Kim et al., 2018) – some of these are mostly applicable to digital games. However, this does not mean that specific elements must be used for gamification in learning and education. Also, using many gamification elements does not ensure more effective gamification or better results (Mora et al., 2017). Considering the given conditions, educators should choose necessary gamification elements to create an integrated solution that solves problems in learning and education (Kim et al., 2018).

Sometimes games in the school context are criticized for over-emphasizing the purely entertaining and competitive aspects of the game while neglecting the intended learning outcomes (Westera et al., 2008). Therefore, it is of great importance to thoroughly plan the educational use while creating or re-using a game setting. On the other hand, games have certain positive effects such as the increase of motivation due to the competitive character or fostering problem solving

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skills (Kim et al., 2018). Nevertheless, the educational value of games in terms of their effect on content learning remains uncertain (Young et al., 2012). Based on the research findings available so far, Tsekleves et al. (2016) as well as Kim et al. (2018) developed several quality criteria that educational games should possess to increase the probability of both motivational as well as educational effects. Games in educational frameworks should, among other aspects, be aligned with the curriculum, have clear learning goals like progression or repetition, be interactive, contain aspects which can be used for assessment and feedback purposes and thus allow students to check their own progress.

But, why are games widely considered to be enriching for educational purposes? The positive features of games can be, among others, linked to theories of motivation (Sailer et al., 2017), self-determination (Deci & Ryan, 2008), or the achievement goal theory (Pekrun et al., 2014). What is explicitly special about gamification in learning is that a well-designed game "automatically" increases students' engagement, which is an important factor for academic success (Newmann, 1992) – the question of how to boost engagement has been a concern of researchers for a long time (Kim et al., 2018). But why exactly are games so engaging? To provide a first answer to this question, I would like to point out the concept of the "flow theory" (Csikszentmihalyi, 1990). Here, the state of "flow" is described as a total absorption by a task which is both challenging and enjoyable. Probably, everyone knows the feeling when playing, when you lose track of time, are fully focused on the activity and start to ignore your surroundings – this is a state of "flow" as well as total engagement (Perttula et al., 2017). Educators can make use of this state when using games that are, as already mentioned, sufficiently challenging and fun (Kim et al., 2018). Before you set out to create games for your students that fulfill the criteria outlined so far, I want to briefly summarize selected types/typologies of games. Here, I will focus on those relevant for (science education). A quite simple general classification has been suggested by Vossen (2004), who distinguishes between the following meta-categories of games: competitive/noncompetitive, interactive/noninteractive, physical/nonphysical (e. g. digital). Elverdam and Aarseth (2007) call the last category "physical space" vs. "virtual space". When it comes to a more practical application of these categories, one can distinguish, among others, between these types: adventure game (a type where the players solve problems in a narrative setting, would include the recently popular escape rooms), board game, card game, puzzle game, role-playing game, simulation game, strategy game, trivia game (including all types of quizzes) and word game (Kim et al., 2018). When searching the literature on gamification, one might find an almost dizzying number of other games and game types as this field is constantly changing and developing. Kim et al. (2018) point out that "it is hard to define a unified framework for classifying game types, but understanding […] their characteristics can help educators to generate ideas for gamifying their instructions." (p. 22).

Call for papers on gamification

As mentioned earlier, there is still not enough evidence on the positive effects of games for teaching and learning of science as well as a lack of best practice examples of games that worked well for a specific educational purpose. Action research studies describing how problems in the science classroom were solved by designing and implementing a game can be a valuable contribution to enrich the overall picture of the role of gamification in science education. I therefore encourage teachers as well as science educators to contribute their experiences to ARISE.

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