New Perspectives in Science Education
International Conference
NEW PERSPECTIVES in SCIENCE EDUCATION

New perspectives on cooperative learning in science: What can Educators learn today from Social Game Design in University Online Teaching?

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Abstract

In recent years considerable research efforts have been made to provide evidence for a nexus between game design elements in non-game contexts. Our research presents a new approach to bridge game design elements and educational theory: defining a set of motivational "patterns" used for pedagogical purposes in teaching scenarios in science. To this end, we will build upon preliminary empirical results from a research project called EMPAMOS®. It derived a set of motivational elements frequently used in social game designs. Our hypothesis is that these elements resemble on a structural level and are directly transferable to motivational factors in online education contexts.
Focused on cooperative teaching and learning, we develop a curriculum to enable educators to implement motivational molecules from game design in their learning settings. The paper presents basic premises and a preliminary structure of the curriculum. By examining educational settings in terms of a "broken game", we provide a new perspective on the prerequisites for learning at the university level.

Keywords: *cooperative learning, gamification, motivation, train-the-trainer*, *curriculum*

1. Introduction

The pandemic situation diminished social interaction. Many university teachers seek solutions on fostering interaction and cooperation given the "new normal". We identified cooperative molecules in games from an empirical repository of game design elements. We bridged these molecules to educational theory and developed a train-the-trainer curriculum for university teachers to apply them in the design of collaborative learning opportunities.

2. Understanding the motivational drivers of cooperation

In studies covering the impact of COVID-19 on higher education, students complained most about missing relationships with other students and their teachers (e.g. [1]). At the same time, many instructors describe their challenges to encourage active participation: Educators complain about the "black tiles" in video conferences and the lack of exchange with their students.
Integrating cooperative learning could offer a solution for both—students and educators. It could ensure social exchange opportunities and unleash the untapped learning potential: Cooperation is not only a 21st-century skill necessary to "deal with highly emergent systems, organizations, and situations" [3]; it also improves the learning outcome. According to self-determination theory, every human being strives for relatedness—to feel connected with others in a social milieu [2]. Cooperative learning is a process of planned social interaction: learners cooperate by working together to achieve common or different goals or produce products [6]. Following this definition, cooperative learning is based on a broad foundation of research, which has already been operationalized for learning [7].
With further knowledge about the motivational aspects and design of cooperative learning scenarios, teachers could enhance their teaching for ongoing online education and face-to-face teaching, blended and hybrid education scenarios.
To find suitable solutions and creative ideas for fostering cooperation, it is worth taking a sideways look from higher education into other industries. For example, the game industry, which has been very successful in creating collaborative environments for decades—both offline and online. The way games are designed shows how motivation works: Players only engage voluntarily in social interac-

tions within game settings if these settings satisfy their motivational needs. Researchers have identified game design components like chance, victory conditions, badges, etc., that contribute to the motivation of games. As every game focuses on different behaviours of the players, each game rewards different achievements. For example, a game like *Memory®* rewards short-term memory performance while *Chess* relies on strategic thinking.

It is, therefore, natural that researchers have investigated how to transfer motivating factors from games to non-game domains [5] by identifying design principles and game elements [9]. Others have connected such principles to learning [10]. Our research shows how game design elements can be tied to didactically successful solutions and educational theories: The game design elements and patterns we could recognize in games as cooperative elements show similarities with the structure of didactic scenarios. Both use concepts and definitions that can be found in terms of educational science. Identifying those terms is building bridges between games and educational sciences. The results can be used to design motivational environments for collaborative learning. The results can be used to design motivational environments for collaborative learning. We embedded them into a curriculum to enable educators to understand cooperation's motivational and educational basics.

3. Games as a motivational base for learning

The project EMPAMOS® deciphers the "motivational DNA" of social games. Following an empirical approach, it has described more than 100 game elements as a pattern language. Voit et al. [11] derived from a dataset of 8,300 games and about 50,000 connection descriptions on how game designers combine these elements using machine learning algorithms. The resulting database contains quantitative information about the game elements, their combinations and a qualitative description of the semantic relation of each element connection. The database is accessible via a deck of cards and an application based on artificial intelligence (AI). The cards support users to identify gameful factors in their non-game domains. Then they can use the AI to recommend complementing game elements.

We used a two-step approach to identify the game elements that form cooperative molecules. First, we explored the pool of game elements using quantitative data analysis. Based on game elements that cover cooperation in games, we used the AI recommendations to gather adjacent elements. The limits to creating a molecule were between five and at least three game elements. After the data-driven and correlative assembly of molecules, we used the qualitative description of the elements' relations to validate and describe the molecules, resulting in a set of 18 hypotheses of cooperative molecules. The following example should help to illustrate this procedure:

A molecule called *Synergistic Roles* is described this way: *"Every player has action points according to his/her special role in the game. The players have to combine their action points to be able to perform joint actions"*. The initial game element of this molecule was *Cooperative Gameplay*. Further factors were explored using the AI recommendations. The resulting pieces were then selected using the qualitative semantic descriptions of the connections. The AI again recommended different game elements that specify how roles can act in games. The game element *Role* is a possible route to a solution: different roles can contribute to a joint goal and thus foster cooperation. However, this combination does not define an interpretable solution without further clarification on how the Role can contribute. A sensible solution is the distribution of *Activity Points* according to the different *Roles* of the players.

4. Bridging game molecules to educational research

As described before, the cooperative molecules are composed of individual game design elements, which repeat themselves from molecule to molecule. The elements contain terms belonging to the field of educational science, like *action*, *role*, or *resource*. These terms represent certain concepts, definitions, or assumptions in educational science, which play a role in didactic scenarios for cooperative learning. By connecting the elements with their definitions from educational science, bridges are built from games to educational theory. Automatically the molecules ultimately comprise a practice-oriented didactic guide for designing cooperative learning environments.

The starting point to include the individual elements and didactic results into one learning theory we started from the question of the status quo in higher education: As education is transforming worldwide, the future goal of education in universities is to prepare students to "deal with highly emergent systems, organizations and situations" [3], requires students "to develop curiosity, imagination, vision, resilience and self-confidence, as well as the ability to act in a self-organized manner" [3]. Here, the role of the educator shifts towards a guide or coach [12], where all participants share their knowledge voluntarily [13]. This can be linked particularly well to the concept of Situated Learning and reminds us of the voluntary and self-organized activities in games. Situated learning ties in "to a high degree with forms of self-organized study" and "especially those associated with interpersonal interaction, social exchange, and cooperative forms of problem-solving" [14].

5. Developing cooperative learning—A train-the-trainer curriculum

Based on these results, we developed a curriculum to enable educators to implement motivational molecules from game design to collaborative learning opportunities. This curriculum is based on our experience of more than 12 workshops and more than 70 participants from different fields of application. The development of an appropriate curriculum followed two fundamental ideas: to change the perspective on learning opportunities by examining them as "broken games" and to spark the participants' interest in the potential of cooperative molecules. In an initial workshop, we conveyed the basic concept of the card deck of 12 molecules and the corresponding game elements. In between meeting intervals of 2 months, the participants work on their projects. During the joint meetings, all members exchange their ideas and problems. Experienced users coach the whole group. We started to accompany this process using various instruments such as surveys, focus groups and auto-ethnographic approaches.

6. Discussion

The workshop prototype was evaluated very positively, but the results of this first evaluation can, of course, only be a snapshot. Our initial goal was to guide the participants in their first attempts to use the game molecules for cooperation within their respective teaching scenarios. At this stage of our research, it is too early to tell if the molecules can support them in designing motivating cooperative learning opportunities. Another limitation of our research becomes visible when considering a possible transfer of the curriculum to a broader community of teachers: The demand for subject-specific training is usually higher than the demand for training in general pedagogical design strategies.

There is also a constant need for organizational effort. The community and an appropriate technical infrastructure must be maintained to foster a formal and informal exchange of ideas and experiences.

The empirical database needs to be developed further as well. At the moment, it covers only a database of 325 social games. That is, the data basis for cooperative game molecules is even smaller. Our goal is to gain additional data and insights into the design process with the community's growing experience and practical results.

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