Examining Game Mechanics and Extrinsic Motivation in a GroupAwareness Tool for Collaborative Learning

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Abstract

This study examines the interplay of game mechanics and extrinsic motivation in a Group Awareness Tool (GAT), and its implications for student participation in a Computer Supported Collaborative Learning (CSCL) context. By analyzing the Self- Determination Theory (SDT) and the Learning Mechanics-Game Mechanics (LM-GM) model,we dissect the dynamics of a GAT integrated within an PyramidApp activity. Two game mechanics, Feedback and Behavioral Momentum, were identified and linked to variations in extrinsic motivation among students. Our analysis revealed that while the GAT succeeded in fostering participation, it elicited a spectrum of extrinsic motivation, from identified regulation to external regulation. The study also proposes potential enhancements to the GAT by incorporating game mechanics associated with intrinsic motivation. The findings provide valuable insights into the complex dynamics of GATs and contribute to the discourse on improving student engagement and learning outcomes in CSCL environments.

Keywords

Group Awareness Tools, Game Mechanics, Extrinsic Motivation, Self-Determination Theory, Learning Mechanics-Game Mechanics Model, Learning Analytics

1. Introduction

Collaborative learning is an educational approach that utilizes group dynamics and social interactions to boost learning. The integration of technological support has enhanced its efficacy, enabling the enactment of advanced pedagogical methods within virtual learning environments. Computer Supported Collaborative Learning (CSCL) fosters desired social interactions [1] that strengthens students' collaboration abilities and learning outcomes [2]. However, a lack of motivation,of task awareness, and a lack of social and self-regulation abilities may hinder learners' participation inCSCL activities [3-5]. A type of data-driven feature that aims at addressing these challenges are GroupAwareness Tools (GAT).

This paper opens a new perspective in the analysis of GAT from the perspective of motivation theoryand game-based learning. Interestingly, both GAT tools and game mechanics seek an increase in the motivation and engagement of the participants when integrated in learning environments [6,7]. By using the Self-Determination Theory (SDT) [8,9] and the Learning Mechanics-Game Mechanics (LM-GM) model [10], we present an example about how to decode the complex dynamics of GATs. Centralto our study are two research questions: "What game mechanics are present in a GAT?" and "How is aGAT fostering (extrinsic) motivation and participation?".

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2. Background

2.1. Group awareness tools

GAT are visual indicators designed to show the behaviors, goals, and contributions of a group to itsmembers, thereby improving the knowledge building process. Research differentiates three types of group awareness (behavioral, cognitive, and social) and, thus, of GAT types. For example, visual displays of previous knowledge have been used for cognitive awareness [11], while interactive maps to show group interactions have been used for social awareness [12], and participation levels have been used for behavioral awareness [13]. Most GAT relies on the use of learning analytics, as the visualized awareness information requires the use of real data about learners and their educational situations (e.g., their group context).

Behavioral GATs have shown promise in terms of increasing student participation and reducing negative interaction patterns [13,14]. However, empirical research on the effectiveness of GAT in generating balanced group involvement has yielded inconsistent findings [15-17]. While some research suggests that GATs contribute to more equitable group input [16], others show that complex mediating factors may still result in unequal participation [17]. A deep understanding about why this is the case is still lacking [20]. There is a need for analytical frameworks that facilitate a decomposition of the design of those tools and the afforded effects.

2.2. LM-GM framework

The Learning Mechanics–Game Mechanics (LM-GM) model maps game mechanics and pedagogical elements abstracted from literature on game studies and learning theories (see Figure 1). The model helps to relate a set of standardized learning mechanics to another set of standard game mechanics. It empowers designers to explore the interactions between these mechanics and ensures that a system is solidly rooted in both pedagogical and entertainment perspectives [18]. This provides a succinct method to align pedagogical intentions with ludic elements in a player's actions and gameplay.

The learning mechanics component refers to pedagogical methods and strategies that facilitate the acquisition and application of knowledge and skills. These might encompass elements such as problem- solving tasks, collaborative activities, and guidance. On the other side, game mechanics describe the interactive elements that make up the game's system and define the gameplay. They involve rules and procedures that dictate the dynamics of the game. Examples of game mechanics include competition, cooperation, game turns, and time pressure.

By aligning learning mechanics with game mechanics, the LM-GM model tries to develop a seamless integration of educational content and engaging game design. The LM-GM model can be used to either aid designers or researchers, as it provides a concise means to map how ludic elements link to pedagogic intent directly based on a player's actions and game play [7].

In the context of CSCL environments, understanding the LM-GM model can offer insightful perspectives on how GATs, as pedagogical tools, can be designed to foster motivation and participation, providing a rich and engaging collaborative learning experience. By identifying the game mechanics embedded in GATs, we can develop a deeper understanding of how these tools can be leveraged to stimulate learning dynamics, thereby optimizing student engagement and learning outcomes.

Learning mechanics	Game mechanics
Instructional Guidance	Behavioral momentum Role play
Demonstration Participation Action/task	Cooperation Collaboration
Generalization/discrimination Observation Feedback	Selecting/collecting Tokens Goods/information
Questions and answers	Cascading information Cutscenes/history
Explore Identify Discover	Questions and answers Communal discovery
Plan Objectify	Strategy/planning Resource management Pareto optimal Appointment
Hypothesis Experimentation	Capture/eliminate Tiles/grid Infinite gameplay
Repetition	Game turns Action points Levels
Reflect/discuss Analyze	Time pressure Pavlovian interactions Feedback
Imitation Shadowing	Protégé effect Meta-game
Simulation Modeling	Design/editing Movement Simulate/response Realism
Tutorial Assessment	Tutorial Assessment
Competition	Competition
Motivation Ownership Accountability	Urgent optimism Ownership
Responsibility Incentive	Rewards/penalties Status Virality

Figure 1: LM-GM framework adapted from [7]

2.3. Self-determination theory

The Self-Determination Theory (SDT), proposed by Deci & Ryan [8,9], is a comprehensive theory of human motivation that proposes that people have innate psychological needs for competence, autonomy, and relatedness. These needs, when fulfilled, contribute to optimal function and growth, fostering intrinsic motivation and internalization of extrinsic motivation.

A particularly noteworthy aspect of the SDT is its conceptualization of motivation along a continuum (see Figure 2). At one end of the spectrum lies intrinsic motivation, where individuals engage in activities purely for the inherent satisfaction, they derive from it. At the other end is extrinsic motivation, where activities are undertaken to attain separable outcomes. Extrinsic motivation itself can vary in its degree of self-determination and is categorized into four types: external regulation, introjected regulation, identified regulation, and integrated regulation.

External regulation, the least autonomous form of extrinsic motivation, involves behavior driven by external rewards or punishments. Introjected regulation involves actions performed to avoid guilt or to enhance ego, where the regulatory process is somewhat internalized but not fully accepted as one's own. As we move along the continuum towards more self-determined forms, we find identified regulation where individuals consciously value the activity and self-endorse the goals associated with it. Finally, integrated regulation, the most autonomous form of extrinsic motivation, occurs when the identified regulations are fully assimilated with the individual's self, such that the behavior becomes an integral part of the person's values and needs.

Understanding this continuum of extrinsic motivation is very important, especially in educational settings like CSCL, where the aim is not only to increase participation but also to ensure that the learning process is meaningful and self-directed. The different forms of extrinsic motivation can manifest distinctly in student engagement, and recognizing this can guide the design of pedagogical tools like GAT to optimally stimulate motivation and foster the desired outcomes.

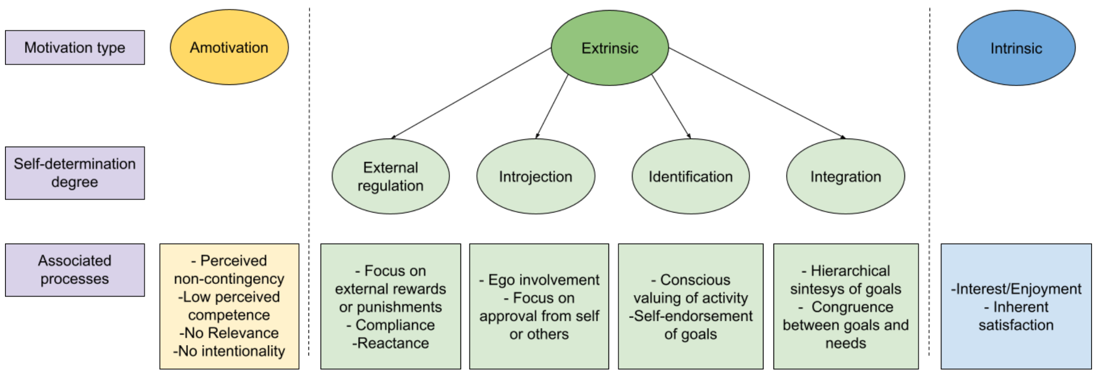

Figure 2: Taxonomy of human motivation adapted from [19]

3. The case of GAT in PyramidApp

PyramidApp is a web-based system that incorporates a Pyramid CLFP-based approach for the creation and deployment of collaborative learning activities in both traditional and remote learning settings [21]. The system provides a platform for teachers to design activities and for students to carry them out. Within the PyramidApp enactment tool, individual students can submit their responses to the assigned tasks and engage in preliminary discussions in small groups. After evaluating various perspectives, a common option is agreed upon and subsequently propagated to larger groups at higher levels. These groups deliberate and ultimately reach a consensus on one or a few options at the global level.

The GAT under study [20] consists of a bar embedded in the PyramidAPP, that visualizes the participation level of each student and appears under their name (see Figure 3). The participation level is updated every 5 seconds and allows students to compare their participation to others in their group, raising behavioral awareness among the participants. It is calculated by the number of characters sent, edited, or deleted from the chat and the collaborative writing editor. To promote equal participation, the bar changes colors depending on the level of participation: a) if the student contributes to the discussion sufficiently the bar is green, b) if the student is contributing quite less or more than the average the bar turns orange, c) if the student dominates the discussion or is not participating sufficiently the bar turns red.

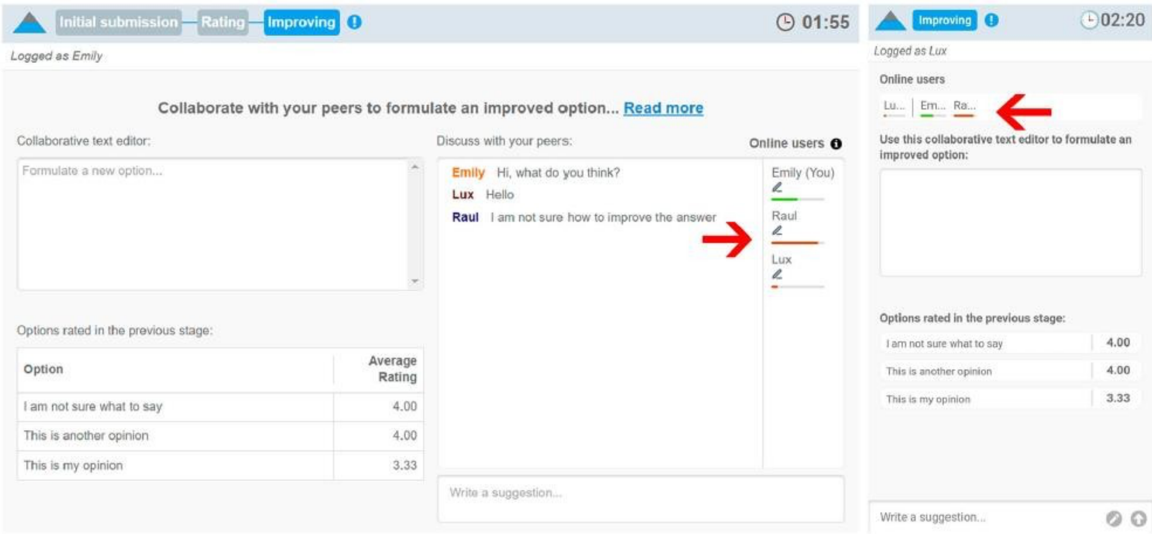

Figure 3: The interface of the answer improving stage of the PyramidApp. In the web GUI (left) the GAT appears under the username of each online user. In the responsive design GUI (right) the GAT appears on top of the chat, under the users' initials.

An analysis through the lens of the LM-GM framework (Figure 4) revealed that the GAT integrated in the PyramidApp tool presents two game mechanics associated to the extrinsic motivation category: Feedback and Behavioral momentum. The feedback mechanic is observed in the GAT function that shows the users what they have just done, giving them a kind of instant gratification. This game mechanic relates to the "shadowing and feedback" learning mechanics in the LM-GM framework. Behavioral momentum is defined as a game mechanic used to give confidence and motivate players tocontinue a game. This game mechanic is identified in the GAT function that aims at encouraging students to continue participating in the discussion by providing instant visual indicators of their level of participation and how it relates to the overall group participation. The LM-GM framework relates the behavioral momentum game mechanics with the "repetition and instruction" learning mechanic.

Game mechanics	
Extrinsic motivation	**Intrinsic motivation**
	Designing Ownership Status/Titles Strategy/Planning
Action points Assessment Rewards/Penalties	Collaboration Comunal discovery Game turns
Feedback	
Progression Time pressure	Competition Cooperation Movement Selection/Collection Simulate response
Appointment Cascadin information Questions and tutorial	Role-play
Behavioural momentum Cut-scenes Story Goods/Information Pavlovian interactions Tokens	Virality

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Figure 4: Game Mechanics presented in the analysis.

The decomposition of the LM-GM mechanics in the GAT tool offers a new perspective in the interpretation of its effects and potential improvements. An evaluation of the GAT tool, comparing an experimental group with a control group using the same CSCL tool without the GAT, showed that theexperimental group achieved the highest participation level in comparison to the control group (87% vs 78%). This result can be aligned with the expectations of the Behavioral momentum mechanics. Moreover, the students in the experimental group found the tool useful: 64.2% felt that their participation was supported by the tool and 50.7% felt the need to participate. This effect can be relatedwith the expectation of the feedback mechanics. Overall, these results correspond with the SDT as students' extrinsic motivation can fall along a continuum, with various degrees of self-determination (the % suggests a division in students' effects). For some students, the GAT mechanics represent an identified regulation form of extrinsic motivation (SDT), where students are consciously valuing the activity and self-endorsing the participation goals (an extrinsic motivation that is closer to intrinsic motivation), while for other students, the GAT mechanics offer more an external regulation form (SDT) influenced by external rewards and punishments (a more stressed form of extrinsic motivation).

In terms of potential improvements, the analytical lens used reveals some improvement opportunities. Different game mechanics from the intrinsic motivation category can be explored to enhance the interaction with the GAT. For example, the ownership GM can be boosted by using avatarsto communicate the awareness analytics. The progression GM can enhance the students' participation by employing visual cues or messages that give personalized feedback based on the accumulated progress and the status of the discussion within the group. Finally, the GM of cooperation and competition can be amplified even more by the sharing of analytics related to the status of the other groups, in addition to the collaboration structure provided by the CSCL tool in which the GAT is integrated.

4. Conclusions

The present study, grounded in the SDT and LM-GM model, analyzed the dynamics of game mechanics and extrinsic motivation within a GAT in a CSCL environment. The findings show that the GAT integrates game mechanics such as Feedback and Behavioral Momentum to boost participation. However, the elicited extrinsic motivation varied across students, with some displaying identified regulation and others showing external regulation. This variation pointed towards the complexity of motivation within learning environments, indicating that fostering participation using GAT requires a detailed analysis from different points of view such as pedagogical, motivational and visual design.

The identification of Feedback and Behavioral Momentum mechanics underscore the role of immediate gratification and sustained engagement in promoting participation. This aligns with prior literature emphasizing the importance of feedback in learning environments [22] and the effect of behavioral momentum on sustaining student engagement [23]. The effectiveness of these mechanics isfurther confirmed by the increased level of participation in the experimental group and the students' perception of the tool's usefulness.

Moreover, the study offered insights into potential enhancements for GATs. The inclusion of gamemechanics that are related to intrinsic motivation can further promote participation and foster deeper engagement.

Finally, this study adds to the continuing discussion about CSCL and GATs. It gives a comprehensive knowledge of how game mechanics interact with motivation in collaborative learning environments and paves the road for future GAT design advancements.

As with any study, ours is not without limitations. The present investigation focused on one specificGAT in a particular CSCL environment. Future research should aim to generalize these findings acrossvarious tools and settings. Furthermore, while our study centered on extrinsic motivation, an interesting avenue for future research would be to examine how GATs can be designed to promote intrinsic motivation, further enhancing the quality of engagement and learning outcomes in collaborative learning settings.

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