CLEVER: Gamification and Enterprise Knowledge Learning

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Abstract
This paper describes the design and a preliminary implementation study of a gamified knowledge management system (KMS) that supports the learning component within knowledge management (KM). KM includes acquiring social capital through the process of acquisition, sharing, and dissemination of knowledge within a company. Employees often lack the motivation to share their implicit knowledge with one another and are reluctant to engage in a collaborative forum for such knowledge exchange. We developed a gamified learning component of an enterprise KMS to help foster this process of collaborative and participatory learning. More importantly, this game combines trivia and strategy elements as game elements to motivate the players for knowledge exchange. We report preliminary results from an exploratory study with nine participants which indicates that the above combination of game elements does contribute to participatory knowledge learning within an enterprise KMS.

Author Keywords
Gamification; knowledge management; gameful design.

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H.5.2. Information interfaces and presentation (HCI); K.3.1. Computers and Education: Collaborative learning; K.8.0. Personal Computing: Games.

Introduction

Knowledge management (KM) represents the process of effectively capturing, documenting, assimilating, sharing, and deploying organizational knowledge [13,16]. Focused aggregation of such knowledge to maximize the organizational objectives is critical for the efficient and effective functioning of any enterprise [16]. However, a main challenge for companies is the reluctance of their knowledge experts to share their intellectual capital [13,21]. While KM systems provide the information technology to store, retrieve, and share knowledge, users often lack the motivation to engage with them [30].

One way to motivate employees is to leverage their intrinsic and extrinsic motivation [26] using gamification. *Gamification* is a strategy or a process to use game design elements in non-game contexts [9], e.g. business applications [15,23]. The organizational issue of motivation for KM needs to be addressed in two different activities: (1) *knowledge sharing* by intellectual capital experts and (2) *learning* of previously shared knowledge from new employees.

Our gamified KMS, CLEVER, provides a forum to satisfy both the above needs of knowledge sharing and learning within an organization. Our focus here is to present our exploratory study of one half of this gamified system and our future agenda: the game prototype that motivates employees to interact with the existing knowledge repository, which will be a part of CLEVER. In the following sections, we describe our game design with gameful design elements, and our exploratory study to investigate employees' motivation to play the game and learn from the content in the knowledge repository.

Related Work

Efficient and free knowledge exchange occurs within an enterprise when employees are motivated to share implicit or explicit knowledge [6]. Within any enterprise, KM provides a measure of intellectual capital and knowledge mapping in domain areas ranging from sales and marketing, productivity, customer loyalty, training and recruitment, operations, and safety [13]. Knowledge is divided into implicit and explicit [6]. Implicit knowledge reflects the subjective inferences, personal experiences, and gut feelings, while explicit knowledge represents objective, rational, and technical information [13]. Together, both implicit and explicit knowledge are key information, which provides a person the ability to make decisions [14]. We believe that sharing and dissemination of knowledge can be afforded by means of fun, gameful interactions implemented through a gameful KMS.

The self-determination theory (SDT) of human motivation distinguishes between intrinsic and extrinsic motivation [8]. Intrinsic motivation implies doing an activity because it is inherently interesting or enjoyable, whereas extrinsic motivation implies participating in an activity as it leads to an external outcome [26]. Additionally, SDT posits that intrinsic motivation is dependent on autonomy, competence, and relatedness [8,25]. The motivational affordances that are commonly employed in gameful design are properties added to a system to allow its users to experience the satisfaction of these motivational needs [10,28]. Within this intersection of gameful design, motivation, and behaviour, researchers have often posited that gameful systems must be designed to be intrinsically motivating [15,28] and that extrinsic motivations can undermine intrinsic motivations [27]. Nevertheless, an experiment by

Figure 1. Example tiles from CLEVER's trivia strategy game.

Mekler *et al.* showed that extrinsic affordances increased player performance, but did not affect perceived autonomy, competence, or intrinsic motivation [20]. An increase in overall motivation of participants was reported in an empirical study investigating the effects of gamification in a market research domain [4]. A meta-analysis showed that intrinsic and extrinsic motivations can play complementary roles in motivation [5]. Thus, we decided to employ both kinds of motivation in our system's design.

Regarding the application of gamification to motivate employees in knowledge exchange, Wiegand *et al.* [32] conducted a literature review and identified human-work-related needs (i.e., mastery, autonomy, and self-expression) and gamification elements (i.e., points, levels, challenges, and social incentives) to foster intrinsic motivation and lower barriers to knowledge exchange. For knowledge exchange, the authors stated social capital enabled KM and identified 11 gamification elements as the missing link to connect human work-related needs and knowledge-exchange barriers.

Interactive game-based training provided engagement by giving users the power of narration, storytelling, and quick recall of information in an enterprise [1]. Game-based learning provided increased perceived performance within a learning and knowledge acquisition perspective [2]. Examples of gamified KM systems include associating meanings to documents to motivate employees [19], ProjectWorld, a gamified KMS for knowledge documentation and reuse [30], and measuring user engagement within an enterprise system [31]. KM Quest is a simulation game designed as a learning tool for KM professionals, rather than an enterprise KMS for all employees [17].

While the above research focused on theoretical models and extrinsic affordances for training and learning, little research has been done to investigate the influence of intrinsic motivation within an enterprise KM context. There is also a lack of empirical research investigating intrinsic motivation within a KMS. Our research is important because it investigates the influence of intrinsic and extrinsic motivational affordances to provide a knowledge learning strategy within a KMS. Our exploratory study using focus groups provides many strategic deployment opportunities for gamification specific to KM by leveraging employees' motivation.

CLEVER: A gameful KM system

CLEVER is an online KMS that incorporates game elements. The system is composed of two parts: (1) an online knowledge repository, where employees can provide important knowledge to the company, and (2) a trivia strategy game that motivates players to interact with content from the knowledge repository. Next, we describe this game, its implementation, and the exploratory study we conducted to test the prototype of the learning game component.

Game Description

Inspired by traditional board games such as Risk [22], Antike II [24], and Diplomacy [12], CLEVER is a strategic, turn-based trivia game in a digital play space. The prototype incorporates several game elements, including movement, combat, competition, feedback, rewards (stars, energy, and domination points), exploration, and loss avoidance. The players' goal is to eliminate all enemy units on the game's digital board. The game can be played by a minimum of two and a maximum of four players who compete against each other on a single digital map, constructed from tiles (see Figure 1).

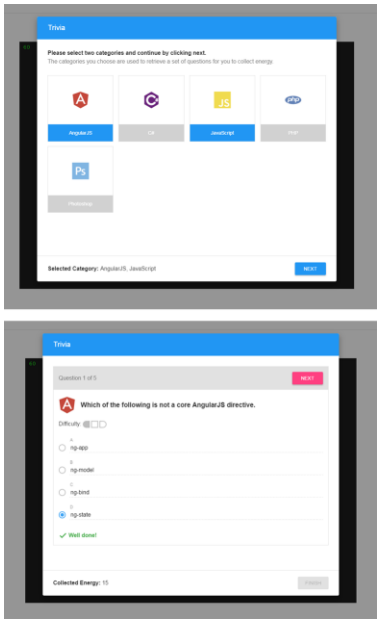

Figure 2. Category selection (top) and trivia dialog (bottom), waiting for the player to choose an answer to continue with the next question.

CLEVER's gameplay focuses on a trivia and an action phases. Players collect energy by answering questions with different levels of difficulty in the trivia phase (see Figure 2). This collected energy can then be used to perform a game action (i.e., move, defend, attack, charge, or heal) in the action phase. If all questions are answered correctly, the player is awarded a star, which can be used for executing special actions in the game, such as charging and healing. Stars may be accumulated over time to be used with actions that are more expensive. The collected energy is used to perform an action on a unit as part of the action phase which follows the trivia phase. Units represented as a token on the map are present as different types of units – archer, fighter, and tank. Each unit type differs in health points, attack, and movement range, giving players the opportunity to pursue individual strategies.

CLEVER's game interface (see Figure 3) features panels for each player showing the player's username, race, stars, energy, domination points, a number of units, and available actions. While the username, stars, number of units and domination points are visible to all players, another information such as energy is hidden. The number of stars and domination points is used as an indicator of competence and performance. The game's digital map interface is placed in the middle of the screen. Each player starts in one corner and has four units. The units were selected and placed by the players before the game started.

A more detailed description of the game can be found in our game design paper [11] and the video figure[1].

[1] https://youtu.be/wpIZ9Fnq0iY

Figure 3. CLEVER's online game interface.

Motivational Elements

Trivia questions trigger player interaction with knowledge from the repository, which fosters learning. CLEVER facilitates the players' intrinsic and extrinsic motivation, as suggested by self-determination theory [26,28] in the following manner:

- **Competence**: Players receive immediate feedback after answering a question correctly, in the form of energy and stars, which helps them feel competent.
- **Autonomy:** Players can freely choose which units they will use as well as the category of questions they will answer on each round.
- **Relatedness:** Players can play together with peers from their company, to establish a social connection which provides the feeling of relatedness.
- **Rewards:** Competitive players may feel extrinsically rewarded when they win the game. Additionally, performing actions can be seen as a reward for answering questions during the trivia phase.

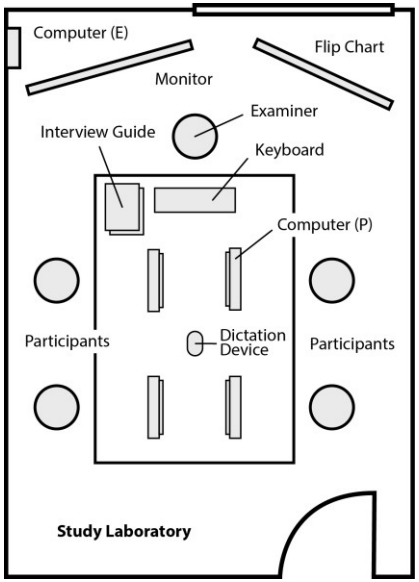

Figure 4. Experimental setup for the exploratory focus group study.

Evaluation

We conducted an exploratory focus group study to gather players' thoughts, experiences, and motivations to use CLEVER. While interest-enjoyment, perceived competence, perceived choice, and pressure-tension are the main categories of the Task Evaluation Questionnaire from the Intrinsic Motivation Inventory (IMI) [27], due to the nature of playing the game in groups and the learning objective of our system, we also added questions for the following categories: relatedness, perceived learning, and extrinsic motivation. We converted scale items from each category into open-ended interview questions to gauge participants' subjective experiences related to game activities. The IMI has been used before [18,29] to acquire data related to intrinsic motivation, self-regulation, and facilitating internalization [7], including in the context of games [3,18].

Nine participants (four females, five males), aged 22–46 years (M=28 years), who were employees of neusta software development GmbH, played the game in a conference room arranged as shown in Figure 4. The employees played the game for 30 minutes in three groups. We then conducted a deductive analysis of the focus group sessions using a standardized form with the categories of the IMI. Finally, we compared the clustered items from the three researchers for reliability and collated the results into a single document.

Results

We analyzed the focus groups' answers to identify insights related to participants' motivation to interact with knowledge through the game. Additionally, we sought to verify the potential usefulness of the system to improve employees' learning of the content provided by the KMS. When referring to participants, we refer to the group in which they played (G1–G3) and their individual number within the group (P1–P4).

Interest and Enjoyment: Participants described the game to be entertaining (G1 P1), exciting (G2 P1), interesting (G3 P4), fun (G1 P1; G2 P2), tactical (G3 P3), and challenging (G2 P3). The game elements that made it enjoyable were strategy (G1 P2), trivia (G1 P2), competition (G2 P2), challenge (G2 P3), and achievement (G3 P3). The combination of questions for learning and a strategic game was reported to be interesting (G3 P4) and tactical (G3 P3).

Individual Impression: Participants felt the game was different from existing ones, mainly due to the combination of trivia and strategy (G2 P1; G3 P4).

Perceived Competence: Participants reported the game to be challenging. The challenge came from strategy, trivia, and competition. Strategic elements and questions provided challenge throughout the game (G1 P2; G2 P1). Participants felt accomplished when answering questions successfully (G1 P1; G2 P1) or when overcoming an opponent's unit (G1 P2; G2 P2).

Pressure and Tension: Overall, the game was relaxing, but combat and trivia raised players' anxiety and excitement (G1 P2; G2 P1). Participants felt nervous when their units were attacked (G1 P2; G1 P1; G2 P3), in combat (G1 P1; G1 P2; G2 P3), near to other players (G2 P3), and moving (G1 P1), but felt relaxed when the game continued as planned (G2 P1) and they were able to answer questions (G3 P3).

Relatedness: Participants liked the opportunity of playing with others, but they would prefer to play with

known colleagues than with strangers. Participants enjoyed playing the game together with colleagues (G3 P2), friends (G1 P1), team members (G3 P1), or known persons (G3 P3). Additionally, participants would play the game voluntarily (G2 P3; G3 P1).

Autonomy: Freedom of choice in the selection of question categories (G1 P1; G3 P2) and provisions for players to be able to perform more than one action (G2 P2) and choose from more than one mode (G2 P3; G3 P1) during gameplay projected a sense of autonomy among the players.

Extrinsic Motivation: Participants felt rewarded by the game mechanics, especially energy, stars, and combat (when attacking). While fun was attributed to collecting stars and energy (G1 P1; G1 P2; G2 P1; G3 P3), participants suggested the possibility of being rewarded with honour points for eliminating a game unit (G3 P1; G3 P3) or creating new content (G1 P2).

Perceived Learning: Participants felt that the game would be better to learn smaller things or to recap content they already knew rather than to learn something new and complex (G1 P2; G2 P3; G3 P3; G3 P2). Participants reiterated the importance of learning by doing (G3 P2; G2 P3) for complex topics such as programming.

Conclusion and Future Work

This paper represents the first step in our larger goal of improving enterprise KM by augmenting a KMS with gameful design elements. Our work so far was exploratory in nature and focused on the learning component of KM within an enterprise. Nevertheless, by approaching the implementation of a KMS by employing gamification as a design strategy to overcome some of the challenges involved in this complex system, we were able to gather important insights and design strategies for gameful KMS. While individual impressions of the game were diverse, many lauded that s*trategy* and *trivia* combined as game elements helped differentiate it from other trivia or strategy games. Therefore, this combination was effective in motivating players to interact with knowledge through trivia questions. Our preliminary study informed that gameful elements helped foster the employees' intrinsic and extrinsic motivations to interact with a KMS. These motivations fostered player engagement with the gameful system and, thus, with knowledge from the repository, which may lead to improved learning. However, participants felt that this kind of gameful KMS is better for learning or reinforcing explicit rather than implicit knowledge.

Future work will extend this study and contribute to gamification research on KMS by further evaluating how CLEVER will affect the employees when they play it asynchronously in between their daily work activities instead of in a laboratory setting. Furthermore, we plan to design, implement, and test the other half of CLEVER: the gameful knowledge repository, which will be aimed at facilitating employees' motivation to share new content into the knowledge repository.

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