CLEVER: A Trivia and Strategy Game for Enterprise Knowledge Learning

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Abstract
Knowledge management (KM) includes the acquisition, sharing, and dissemination of knowledge within a company. The problem with many enterprise KM systems is that they are complex and hardly used, because workers lack motivation to engage in a collaborative process of knowledge sharing and learning. To address this, we developed a gameful learning component of an enterprise KM system (KMS). Our game features an innovative combination of trivia and strategy elements, put together to afford motivation within a KMS. It can be played by employees in the same organization to foster collaborative knowledge exchange and learning.

Author Keywords
Gamification; knowledge management; gameful design.

ACM Classification Keywords
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 [7,9]. KM is often implemented by means of Knowledge

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

Management Systems (KMS), which manage both knowledge sharing from experts and knowledge learning for employees.

While providing the infrastructure for knowledge sharing and learning, KM systems commonly fail to motivate users into interacting with them [7,11]. We address this challenge by developing a KMS that leverages employees' intrinsic and extrinsic motivation [15] using gamification. Gamification is a strategy or a process to use game design elements in non-game contexts [4] and business applications [8,13]. We have designed a KMS called CLEVER to respond to both needs of knowledge sharing and learning in an organization. However, the focus of this paper is on motivating employees to interact with the system to learn from previously shared knowledge.

To increase employees' motivation for system interaction, we have designed an online trivia strategy game that can be played by 2–4 employees in the same organization. One of the game's core mechanics is players answering questions each turn. They collect energy from correct answers to perform actions such as moving, attacking, or defending. The questions are retrieved from a knowledge repository, a part of CLEVER. By designing a gameful KMS, we aim to foster employees' intrinsic and extrinsic motivations to answer questions from the repository. The ultimate goal is that employees learn more about topics covered by questions from this company-relevant knowledge base.

In the following sections, we describe our game design and how we employed gameful design elements to foster employees' motivation to play the game and learn from the content in the knowledge repository.

Game Concept

We designed the KMS called CLEVER to make use of gameful elements in KM. The system is composed of two parts: (1) an online knowledge repository, where employees can provide important knowledge to the company, and (2) trivia questions embedded in an online game. The system's objective is to improve employees' productivity and efficiency at work through increased learning. Additionally, it engages and motivates people to share knowledge within the organization by creating content in form of questions. CLEVER can be used to foster knowledge exchange regarding any topic within any organization.

At this stage, we have implemented and tested a prototype of the learning game component, which will be further addressed in this paper. For the prototype, we have implemented several game elements, including grid movement, combat, competition, feedback, rewards (stars, energy, and domination points), exploration, and loss avoidance.

Gameplay

The game can be described as a strategic, turn-based trivia game in a digital play space. It is inspired by traditional board games, such as chess and checkers, and strategy games such as Risk [12], Antike II [14], and Diplomacy [6]. The players' goal in the game is to eliminate all enemy units on the board. It can be played with a minimum of two and a maximum of four players, which play against each other on a single map.

The game's digital map is constructed from tiles (see Figure 1). A tile can either be blocked or free. Blocked tiles include archways, ruins, and mountains. A blocked tile cannot be occupied by units, whereas a free space

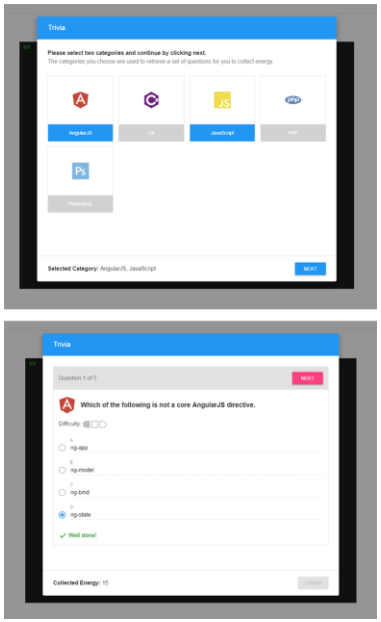

Figure 2. Category selection (top) and trivia dialog (bottom), waiting for the player to choose an answer to continue with the next question.

can be occupied by a single unit at once. Additionally, deep forests may be used to conceal a unit. A hidden unit is only visible to its player.

The gameplay of CLEVER focuses on the trivia and action phases. The goal of the trivia phase is to collect energy by answering questions with different levels of difficulty. In the action phase, this collected energy can then be used to perform a game action (i.e., move, defend, attack, charge, or heal).

During the trivia phase, the player answers a set of questions from an integrated knowledge repository and earns varying amount of energy points, depending on the difficulty level of the questions (see Figure 2). If all questions are answered correctly, the player is awarded a star. A star is a special item that can be collected over time and used for executing special actions in the game, such as charging and healing. Once the trivia phase is completed, the player can use the collected energy to perform an action on a unit as part of the action phase. A unit is represented as a token on the map. There are three 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. Furthermore, the effectiveness of units against certain other units is determined by a Rock – Paper – Scissors principle. Effectiveness in the context of CLEVER is represented as a damage multiplier. An archer for instance, is weak but shoots from distance making him an effective unit against heavy infantry such as tanks, since tanks are slow and they will not likely be dodging arrows from archers. In this scenario the damage is being multiplied by 1.5 (which represents the effectiveness and is derived from a lookup table).

An archer can also protect other units from distance. A player can move a unit to adjacent spaces according to its movement range and cannot skip over blocked tiles. A player can also defend one of their units. Defending a unit means that the system will add a certain amount of armor to the unit. The amount of armor is determined by a set of three questions, one question from each difficulty level that the player has to answer. The defensive bonus continues for one round. Furthermore, a player may choose to attack an enemy unit within its attack range. In this case only the current player is involved. The player whose unit is being attacked cannot actively participate in the fight and can only prevent severe damage by defending a unit in advance. If a player kills a unit, the attacker will receive a domination point. Domination points are indicating how many units a player has killed already and foster extrinsic motivation. A player may also choose to charge. This action enables a unit to move and attack in one turn. Finally, healing a unit will restore a certain amount of health points. Charge and heal are special attacks that require stars and a considerable amount of energy to be performed. Special actions are valuable to players because they facilitate an advantage in the game. This advantage can only be used if players perform well in the trivia phase and collect stars.

CLEVER's game interface (see Figure 3) features panels for each player showing the player's username, race, stars, energy, domination points, number of units, and available actions. While the username, stars, number of units and domination points are visible to all players, other information such as energy is hidden. The number of stars and domination points is used as an indicator of competence and performance.

Figure 3. CLEVER's online game interface.

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.

Motivational Elements

CLEVER makes use of gameful design elements to foster employees' intrinsic and extrinsic motivation to interact with knowledge from the repository in form of trivia questions. We designed the game purposefully to satisfy players' intrinsic needs of competence, autonomy, and relatedness, as suggested by self-determination theory [15,16]. Next, we describe how CLEVER affords the satisfaction of each of these psychological needs.

- **Competence**: Players receive immediate feedback after answering a question correctly, in the form of energy and stars, which helps them feel competent. In addition, the strategic part of the game, together with the combat mechanic, provides a challenge layer that affords a gameful experience [5] and leads to a feeling of competence when one is victorious in combat. Furthermore, players are being rewarded with a domination point for eliminating an enemy unit. Domination points are an indicator for performance that make players feel competent.

- **Autonomy**: Players can freely choose which units they will use in each gameplay section, as well as the category of questions they will answer on each round. Moreover, the strategic part of the game allows players to make tactical decisions on each round. This helps them feel autonomous and in control of their destiny in the game.

- **Relatedness**: Players can play together with peers from their company, which provides the feeling of relatedness. Players establish a social connection, even if it's just for helping or challenging one another during the fleeting tasks created during a game session.

Employees might also feel competent and autonomous as they learn new content by choosing trivia categories in which they have a learning interest. However, the key element is autonomy, because employees' can choose what to learn and when to learn.

Moreover, the game also affords extrinsic motivation through potential sources that may be perceived differently depending on the player's personality and preferences. For example, competitive players may feel extrinsically rewarded when they win a combat in the game. Additionally, performing actions can be seen as a reward for answering questions during the trivia phase. Loss aversion is also a form of extrinsic motivation. It is implemented in the trivia phase where players lose energy for wrong answers. The fear of losing energy is a powerful reason for players to carefully think about their answers to the questions [3,18].

Innovations

Trivia games have been widely used as facilitators of knowledge learning and assessment. Nevertheless, the main innovation of CLEVER is to combine mechanics of both trivia and strategy games to further foster players' motivation for interacting with the game. The

strategical mechanics of the game add a fun and gameful layer that motivates players to increase their efforts in the trivia phase because they wish to be successful in the action phase, when they will be entering in combat against their fellow employees.

Another major difference between our game and others is the possibility of non-continuous usage, i.e., players can complete their turns asynchronously, in between their daily activities. This design was purposefully conceived to allow gameplay within an organization without disrupting the employees' regular activities.

To test players' reactions to these innovative aspects of our game, we conducted an exploratory study with nine employees within the same organization. The employees played the game for 30 minutes in three groups. The study showed that CLEVER was an efficient way to increase learning. Overall, participants acknowledged the game's potential for helping them learn and recall explicit knowledge and praised the innovative combination of trivia and strategy. Being able to defeat other players' units added a fun game element. Players were more motivated to answer trivia questions correctly since they knew it would help them to defeat their opponents. The possibility of non-continuous gameplay was also appreciated. The complete report from this study is currently under review for publication elsewhere.

Related Works

Ballance described an interactive game-based training experience that provided engagement by giving users the power of narration, storytelling, and quick recall of information in an enterprise [1]. Bayart *et al.* studied serious games in the context of academic learning and showed that they provided increased perceived performance of apprentices in a teacher-apprentice training simulation [2]. ProjectWorld is a gamified KMS that showed the benefits of gamifying knowledge documentation and reuse through qualitative statements from participants [17]. KM Quest is a simulation game designed as a learning tool for KM professionals, rather than an enterprise KMS [10]. These related works focused on specific applications of KM, namely training [1,10], academic learning [2], and document sharing and reuse [17]. Our system proposes a bigger picture including knowledge sharing and learning in an enterprise context.

Conclusion and Future Work

Within enterprise gamification, we designed and implemented CLEVER, a gamified KMS. At the present stage, we have implemented and tested a trivia strategy game focused on helping employees learn topics from the enterprise knowledge repository.

Our game demonstrates that gameful elements can help foster the employees' intrinsic and extrinsic motivations to interact with a KMS. Specific game elements like strategy, competition, conflict, trivia, challenge, and achievement can fulfill players' intrinsic needs of competence, autonomy, and relatedness. Rewards and loss avoidance can afford extrinsic motivation. These motivations together can foster player engagement with the gameful system and, thus, with knowledge from the repository, which may lead to improved learning.

Our work so far was exploratory in nature and focused on the learning component of knowledge management within an enterprise. We plan to conduct additional user

studies with a larger participant sample to validate our game's usefulness in fostering knowledge learning. The design, implementation, and test of the knowledge repository will also be addressed in future work. The future integration of the game with the knowledge repository part of CLEVER will provide additional sources of extrinsic motivation, as players might feel motivated to contribute difficult questions to the repository to challenge their opponents in the game.

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