Gamification in Mobile and Workplace Integrated MicroLearning

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ABSTRACT

Business analysts and human resource executives consider MicroLearning and Gamification as two of the currently hottest topics in corporate learning and workplace learning. MicroLearning is seen as a solution for the limitations in dedicated learning time of employees, already stressed in their daily work routines. Gamification fosters users engagement and creates higher intrinsic motivation to learn. In this case study, we report and analyze the learning behavior of 175 employees using gamified MicroLearning over the course of seven months. The study setup allows observing behavior with and without the extrinsic motivation of an employee competition. While we observe a large increase in activity compared to groups studied in previous work, we did not see an increase in the amount of average daily learning sessions. However, we could identify a shift in learning times from working hours towards high attention periods in evenings and weekends. Consequently, we regard gamification as a means to raise user engagement, which yet bears challenges for the deployment in corporate environments to shape learning behavior as intended.

CCS CONCEPTS

• **Applied computing → E-learning**; *Collaborative learning*; • **Information systems** → *Collaborative and social computing systems and tools*;

KEYWORDS

MicroLearning, Gamification, Workplace Learning

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1 INTRODUCTION

As with other forms of learning, successful MicroLearning is very dependent on intrinsic motivation as a driver for learners to engage in learning activities. Reports on the effects of competitive game design elements and the commercial success of player-versus-player quiz games[1] inspired this research project on competitive gamification for MicroLearning. For this, we used and adopted the commercially available MicroLearning solution from KnowledgeFox GmbH and its gamification extension called *KnowledgeMatch*[2]. In this paper, we present a case study with 175 users in a corporate education scenario in a multi-regional Austrian bakery and bakery products company and report the evaluation of the deployment of *KnowledgeMatch*. The objective in the product design of *KnowledgeMatch* has been to improve user engagement and motivation by adding competitive game-play to the existing *KnowledgeCard* system used by the KnowledgeFox MicroLearning solution. While the standard system already incorporates many game design elements, it does not include one to one or one to many competition or elements of social gamification. Recent research [11] suggests that social gamification amplifies positive effects of game design elements when considering retention rates, accuracies in answers and test scores. In our study, we were looking for and expected even stronger effects on user engagement.

Before we describe the case study in detail in Section 5 we will provide background on MicroLearning and gamification in Section 2, on the used MicroLearning system in Section 3, and on *KnowledgeMatch* in Section 4. Finally, we present the results of the case study in Section 6 and before presenting our conclusions in Section 7.

2 BACKGROUND

The presented work is the latest in a list of research efforts that look at improvements in corporate learning. In the following, we introduce and point out how our research builds upon the established concepts of MicroLearning and gamification.

2.1 MicroLearning

MicroLearning refers to a didactic concept and approach that uses digital media to deliver small, coherent and self-contained content for short learning activities.

While such a definition is widely undisputed and can be found in most publications, different interpretations and foci developed as the popularity of MicroLearning grew over the past decade and a

[1] Quizduell — Das Buch. riva Verlag, 2014, ISBN 978-3-86883-436-9.
[2] http://www.knowledgefox.net and http://www.knowledgefox.net/knowledgematch

half. We follow the definition, that MicroLearning refers to characteristics of Micro-Content (nuggets) and MicroLearning activities (steps). Micro-Content is small (e.g. fits on small screens) and topically focused (single fact or concept), it has a simple structure and is easy to grasp (reduced cognitive load). MicroLearning activities are short (seconds rather than minutes), interactive (require user input), provide feedback (as a direct reaction to user input), and trigger reflection on part of the learners. Thus, learners choose their own pace and integrate learning activities into their daily routines. We, therefore use the concept of *Integrated MicroLearning*[7] or *Workplace Integrated MicroLearning* in the context of corporate learning. As mobile devices accompany learners throughout the day *Integrated MicroLearning* is often done using mobile devices and thus closely related to mobile learning.

Although often used for learning following formal curricula and highly specified learning objectives, MicroLearning happens informally, meaning between other activities, on the move, during waiting moments — often driven by knowledge needs or inner impulse [10]. Such impulses may be supported or even triggered by a MicroLearning system using learning pushes as a teaser to call up attention and/or raise interest [2]. As an interactive, informal form of learning focusing on small feedback loops and instant reflection MicroLearning can be viewed as a specialized form of self-regulated learning [3].

2.2 Gamification

Deterding et.al. define gamification as "[. . .] the use of game design elements in non-game contexts." They identify five different levels of game design elements:

(1) game interface design patterns
(2) game design patterns and mechanics
(3) game design principles and heuristics
(4) game models
(5) game design methods

Over the past years, gamification has received a lot of attention, influencing many different application domains. Many attempts have been undertaken to systematize the plethora of elements. The Octalysis Framework[4] provides such an approach, clustering game design elements into eight categories. The model positions those eight categories along two continuous scales:

(1) left-brain (logic, calculation) vs. right-brain (creativity, social)[3]
(2) white hat (positive reinforcement) vs. black hat (negative punishment)

Figure 1 illustrates the Octalysis Framework with left-brain associated categories on the left, right-brain associated categories on the right, white hat associated categories on the top and black hat associated categories on the bottom.

Many elements in MicroLearning didactics are also game design elements. This is not surprising as one of the first publications on MicroLearning as we understand it today[7] was largely inspired by Prensky's work on Digital Game-Based Learning[15]. In this regard, a notable example for the overlapping area of MicroLearning

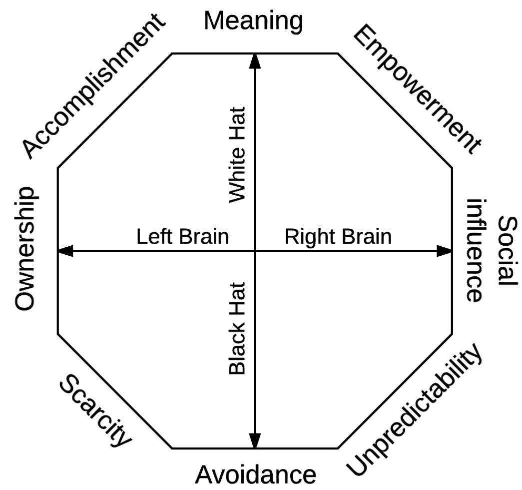

Figure 1: The Octalysis Framework [4]

and gamification is Duolingo[4], which besides of being a popular language learning application also has the ambition to use language learners to crowdsource translations[16]. A general view of the overlapping concepts in the context of corporate learning is provided by Decker et.al.[5]. They analyze the applicability and suitability for MicroLearning of various game design elements for didactic requirements or goals on a theoretical level. Below, we use the categories of the Octalysis Framework to systematically introduce the game design elements that are relevant in the context of this work and relate them to Decker's results.

2.2.1 Epic Meaning and Calling. Games oftentimes use a *narrative* to relate the user's activity to a higher goal or greater meaning. In learning environments learning goals typically provide such a meaning. To engage the learners by relating them to the greater meaning learning goals are often presented at the beginning — just like in video games where players are engaged by the ambition to ultimately save the princess.

2.2.2 Development and Accomplishment. Games typically require users to complete *challenges*, *missions* or *quests* and reward *badges* or other rewards upon success. *Points* that players can use to compare themselves with others are another type of reward. Oftentimes *leaderboards* and *rankings* are directly incorporated to trigger such a comparison directly. For goals with quantifiable progress, indicators such as *progress bars* inform the user about his goal achievement. Decker concludes that these game elements are well suited for MicroLearning.

2.2.3 Empowerment of Creativity and Feedback. Games often grant users room to unleash their *creativity* and require them to solve problems through *exploration.* To successfully direct the user's creativity towards solutions, games provide *instant feedback* on

[3]the left/right brain model is a symbolic model and not neurologically sound

[4]https://duolingo.com

the user's actions — a mechanic that is closely related to the self-regulated learning loop. A similar game mechanic deals with longer loops. It is described as *Milestone Unlocks* that users want to accomplish before stopping. They are defined by players themselves beforehand, achieved after a sequence of actions and reflected upon afterward. A user might, for example, try to reach a certain level before leaving a game, plays until the level is reached and reflects by checking unlocked rewards or skills. Again this mechanic is directly comparable to the cycle of self-regulated learning.

2.2.4 Ownership and Possession. When players acquire something of perceived value in a game they develop the motivation to keep it. This holds true for typical elements like in-game currencies or resources, for in-game reputation, and also for an *avatar* or a profile picture.

2.2.5 Social Influence and Relatedness. Social components are main motivation drivers in games. *Collaboration* and *Competition* can be found in many different forms in games. Decker postulates a limited suitability of collaborative mechanics for MicroLearning and does not cover competitive mechanics besides the aforementioned leaderboards.

2.2.6 Scarcity and Impatience. A typical game design includes some form of scarce resource. Scarcity makes games hard and therefore challenging and interesting. It forces players to focus and by doing so involves them also emotionally. The scarce resource might be game specific or as simple and universal as time. A *Countdown Timer* is a typical example that creates a scarcity of time to accomplish something. Decker states that a Countdowns align well with the didactic goals for MicroLearning activities.

2.2.7 Unpredictability and curiosity. Unforeseeable events in games increase thrill and challenge. In unpredictable environments, players are driven by their curiosity. What's in that box, behind that door, in that cave? While not covered by Decker, it might be difficult to excessively apply the element of surprise in the context of learning. That said, the diverse set of activities, rewards and lesson goals in Duolingo are partially suited to excite somebody's curiosity.

2.2.8 Loss and Avoidance. Game design elements in this category make use of punishment of negative or unwanted behavior. Players lose lives, achievements, progress, points, items or skills in certain conditions. Decker denies the suitability of such elements for MicroLearning in the context of corporate learning. Conversely, Duolingo uses a variety of implementations of loss and avoidance such as skill level depletion and streaks. In section 4 we will present an application of loss and avoidance for depletion of points of achievements in *KnowledgeMatch*.

3 THE MICROLEARNING SYSTEM FORMERLY KNOWN AS KNOWLEDGEPULSE

As mentioned *KnowledgeMatch* is an extension of an established MicroLearning system, originally developed under the brand name KnowledgePulse. It was re-branded to KnowledgeFox[5] two years ago in the course of increased market success. In this paper, we use the original name to emphasize the coherence and continuation of the research efforts. Over the past few years, the system has served as a platform for long-term research efforts and has been described and evaluated at various stages in [2]. These results also serve as a baseline for this case study. For consistency of argument, we present here briefly the core concepts and features of KnowledgePulse without going into technical details.

[5] https://knowledgefox.net

3.1 System Overview

KnowledgePulse is a multi-tenancy client-server application with a strong focus on mobile usage. A tenant is called an organization and consists of users with different roles such as organization administrator, user administrator, content author, and learner. It provides currently native clients for Android, iOS, Windows Mobile[6] and Windows Desktop as well as a responsive web application. Content and learning progress is synchronized across all clients if Internet access is available, but all native clients support learning offline.

3.2 Knowledge Cards

KnowledgePulse builds upon the concept of a Knowledge Card as a base unit for learning. As a first step Knowledge Cards present a question or MicroLearning activity that requires user input as a response. Learners can optionally request a hint as a support in answering the question or solving the activity. In direct response to the users answer or input the Knowledge Card provides direct and immediate feedback on the user's performance. Additionally, learners are provided with an in-depth explanation of the answer and content referred to in the Knowledge Card. Content authors can group Knowledge Cards into Lessons and Courses. Lessons have a predefined order to ensure that prerequisites are understood before more advanced topics or concepts are tackled. Each course and each lesson have an introductory text. This text should be used to describe the content and learning goals. From a gamification standpoint, this can be viewed as *Epic Meaning and Calling*. Also, the checkpoint character of lessons that need to be completed to unlock the next lesson can be viewed under the aspect of *Development and Accomplishment* and in relation to learning goals under the aspect of *Empowerment of Creativity and Feedback*.

3.3 Sequencing and Spaced Repetition

Resembling a mental bookmark, KnowledgePulse uses the notion of an Active Lesson. The sequencing of Knowledge Cards within the Active Lesson is determined by a probabilistic spaced repetition algorithm loosely based on the work of Leitner[12]. Consequently, the likelihood that the system presents a certain Knowledge Card is determined by a function of previous performances of the user and decreases with increasing proficiency. Such sequencing strategies draw off classical psychological research[6] and are supported by more recent neurological findings[9]. We wish to point out that the concept of the scaffolded feedback and reflection loop of a Knowledge Card is distinctively different from Ebbinghaus' experiments

[6] Windows Phone 8, Windows 10 Mobile

on memory capacity[7] and related flashcard research solely building on a stimulus-response model[8].

3.4 Learner Involvement and Contribution

MicroLearning in our definition follows the paradigm of small structured, living content rather than static, predefined, monolithic compendia. To involve learners and encourage the reflection process, KnowledgePulse fosters user contributions. It supports learner created Knowledge Cards and direct user feedback on Knowledge Cards to benefit from the learners' reflection processes and embrace participatory learning design. The mobile clients make use of platform features such as smartphone cameras in the card creation process to enable users to easily create rich learning content.

3.5 Learning Teaser

A central concept in the development of KnowledgePulse is the integration of learning into daily routines - be it in the workplace or elsewhere. The very first prototype was a screen-saver based application called *Lernschoner*. Instead of colorful animations, it presented users with a learning question as part of an early version of the Knowledge Card. The presented question acts as a teaser to users and triggers the intrinsic motivation to start a learning activity. This design has been refined and is an integral component in the current solution of KnowledgePulse, providing platform-specific notification mechanisms.

3.6 Gamification

As mentioned in Section 2.2 MicroLearning has roots in game-based learning and KnowledgePulse incorporates various gamification traits. Badges hallmark completed courses and a short thumbs-up animation rewards correct answers as good performances on single activities. The most essential and at the same time very subtle gamification element is the visualization of the learning progress. An unobtrusive progress bar at the top of the screen constantly indicates the progress within the Active Lesson. A click on the bar or a respective menu item reveals more detailed information using Leitner's learning box as an illustrating model.

A more recent feature is called *Intervention Screen*. As Knowledge Cards are constructed around a teasing question, a sequence of Knowledge Cards leads to a pull effect captivating learners. This counteracts the idea of short, integrated, and spaced learning activities. The Intervention Screen *intervenes* after a sequence of 10 learning steps and triggers reflection on the learning activity. It presents the performance of the learner on the past sequence using achievement visualization as often used in games and a random motivational quote related to learning (see Figure 2).

4 KNOWLEDGEMATCH

KnowledgeMatch was designed as an additional feature to the existing system. The following section provides a concise summary of the functionality of *KnowledgeMatch* and the main design decisions.

[7]Ebbinghaus conducted lab experiments on retention of nonsense syllables as a function of time [6]. His results are known as the *forgetting curve* and have been evaluated and even replicated several times [14]

[8]flash card instruction, flash card drill and incremental rehearsal [1, 8, 13]

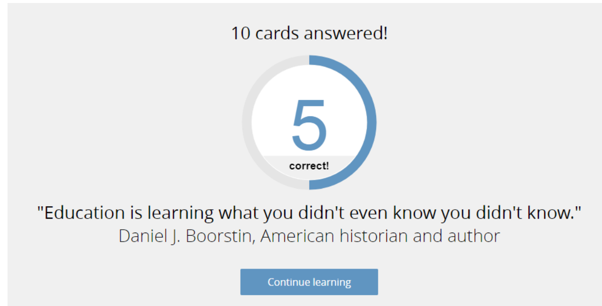

Figure 2: Intervention Screen

4.1 Topic Selection

While interactive quiz games select arbitrary topics and subjects to increase thrill, tension, and challenge, curricular learning activities are planned and thoughtfully arranged for learners. The focus of player versus player quiz games is in the choice of opponents. Conversely, learning is focused on learning goals and therefore on the choice of content.

KnowledgeMatch keeps a match focused on one particular topic, namely a course. Learners set learning goals by subscribing to courses. As pointed out earlier users define an active course in the standard learning mode to mark their current focus. For *KnowledgeMatch* however limiting users to matches on their current active course seemed too restrictive to yield sufficient opponents. Consequently, eligibility is defined through course subscription. A user can either be subscribed to a course or not — and thus eligible for a *KnowledgeMatch* on a particular range of topics.

The journey of a match initiating user starts with the selection of a course. The content of the course defines the topic of a match. Only then the user is asked to choose an opponent eligible for the chosen topic. What to learn has priority over who to learn it with.

4.2 Match Design and Turn-taking

KnowledgeMatch was designed as an asynchronous competition with alternating player turns. A central goal was to engage and motivate learners to frequently use the system for short learning activities in spare minutes that occur during the day — for instance in a coffee break while waiting for a meeting or while commuting. The turn-taking strategy fosters these small but more frequent interactions. A single player should interact with five to ten Knowledge Cards before the game switches to the opponents turn, to ensure that a typical session does not exceed two to five minutes. Such short learning sequences align with the concept of Integrated MicroLearning.

During a match, we refer to the interaction with a single Knowledge Card as a move. A move has a time limit indicated by a countdown clock on the top of the screen. The organization administrator can set the time limit tenant wide. After the user has submitted his answer or the time has expired the solution and the in-depth explanation are displayed (see Figure 3). A user can briefly pause, read and reflect as this screen has no time constraint. The instead the timer displayed at the top of the screen is frozen at the time the move was submitted. In the left upper corner, the current round is

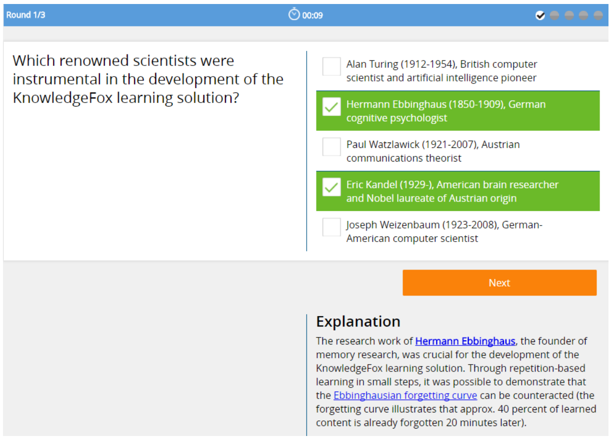

Figure 3: Knowledge Card in match mode after the answer was submitted

indicated while the results from previous moves are displayed in the upper right corner.

As different mental effects and types of motivation can be observed depending on whether a player opens a new round or tries to equalize or surpass the opponent's performance, round openings alternate between players. *KnowledgeMatch* uses alternating round openings and a round size of five Knowledge Cards. Matches consist of three rounds to reduce the likelihood of being decided before the final round to prevent players from dropping out.

The first round is opened by the initiating player and closed by the accepting player, who in turn starts the second round thereafter. The second player receives a match invitation and subsequently plays the first and second round before his turn ends. The initiating player is then notified and plays the second and third round, completing his part of the match. The second player is then notified and completes his third round yielding a match result. The initiating player gets a notification about the match completion and the result.

4.3 Multiple Matches, Knowledge Card Selection and Sequencing

As a result of the asynchrony of *KnowledgeMatch* a single match can include plenty of idle time for a player. To avoid blocking motivated users, there is no restriction to start new additional matches. Multiple matches can be played at the same time — even with the same opponent.

The Knowledge Card selection for a match needs to be defined beforehand as both players receive the same cards. The implementation of *KnowledgeMatch* defines the Knowledge Card selection when a match is initiated. To provide a selection that grants fair chances to both players from a game point of view, both players should have the same experience regarding the selected cards. The card selection is based on both players learning records associated with a single Knowledge Cards and the number of its selections for other matches (played or yet to play). While the system uses elaborated and well established didactic concepts for sequencing in standard learning mode, algorithms can only control the frequency but not the sequence of Knowledge Cards in *KnowledgeMatch*.

In general, quiz game players expect to receive new content rather than repetition. Players perceive items that are reoccurring frequently as monotonous or even assume that software bugs cause the observed selection behavior. Quiz game item selection and spaced repetition, therefore, work quite differently.

As the selection of Knowledge Cards for a match cannot determine their sequence, *KnowledgeMatch* does not implement spaced repetition. Rather, the card selection strategy focuses on improving the game experience by preferring unknown and less known cards. This leads to an even distribution with constant spacing between repetitions instead of an increasing one.

4.4 Profile Page and Avatar

KnowledgeMatch allows users to personalize their game presence by selecting avatars or setting profile images to increase the experience of ownership and relatedness. On the profile page, learners can configure their name, upload or take a picture or choose an avatar. Avatar sets can be defined for each individual organization (tenant), in order to allow companies to use their corporate identity or branding as part of the avatar collection. Before a match is started learners see the avatars or profile images of both players, their own and their opponent's. The visual representation of the players are also shown on the result, intermediate result and leaderboard screens.

4.5 Points and Leaderboard

KnowledgeMatch also introduced a leaderboard into the existing system as an additional means of gamification. The analysis of different existing ranking systems (chess, football, tennis…) showed two central, reoccurring features:

- the amount of awarded points depends on competitiveness (e.g. opponent strength, tournament prestige) and
- awarded points expire or deplete.

In terms of the Octalysis Framework, these features fall into the categories *Development and Accomplishment* and *Loss and Aversion*.

In the case of *KnowledgeMatch*, up to 10 points are awarded for victories and up to 5 points for ties. The amount of awarded points is based on opponent strength (similar to ELO-system). Additionally, one point is awarded for playing a complete match as an incentive to participate. The depletion or expire strategy decreases points of achievement by 1/365 which leads to a stabilization for players with a constant performance after one year.

5 CASE STUDY: LEARNING — FRESHLY BAKED

In this paper, we describe a case study conducted at a super-regional Austrian bakery and bakery products company. The company has established human resource development programs for onboarding and continuous training. Most of the training was conducted face-to-face by internal trainers or external experts. Several new approaches such as a new talents program, conventional e-learning, and MicroLearning were evaluated. The learning system was set up and a sales division was selected to do a pilot project[9]. Eleven persons were trained for content authoring on-site and a MicroLearning course on content authoring was made available to them. After the first phase of two months for content authoring, the first increase in system usage could be detected after three months when about 75 new users were registered.

Accompanying a broader rollout of the system an employee-challenge was organized in project month 5[10]. Our case study focuses on the impact of this extrinsic motivation on learning activities. We investigate usage patterns in standard learning mode and match mode over the course of seven months and compare pre-challenge activities and activities during the organized challenge.

For the employee-challenge, 175 users of 15 different regional sales and key accounting teams were invited to participate. Team sizes were ranging from 6 to 18 members. Participants were located at operating sites in different parts of Austria (96 employees) and Germany (79 employees). Within the selected sales division 78 employees were field service salespersons, 47 were back-office employees and 20 persons were sales managers or directors. The remaining persons held other sales related positions such as sales assistant. The participant group was balanced with respect to gender, as 89 were female and 86 were male employees. The age ranged from 19 to 64 years with an average of 42.9 ($Q_{0.25} = 35.28$, $Q_{0.75} = 50.29$).

For the employee-challenge, 386 Knowledge Cards of four existing courses were combined into a new course. This course was configured to be available only for matches and not for standard learning mode. The original four courses remained available for standard learning mode. The content covered knowledge on sales, service, products, production process, branding, the company itself, economic indicators, internal key performance indicators, salary payment and remuneration schemes.

As an incentive to participate the HR department announced prizes to the top three contestants. Scores were based on the sum of individual and average team points. The scoring scheme and prizes were communicated upfront. The prizes were an IPad 5, a €400 travel voucher and a €150 consumption voucher. The vouchers were redeemable at restaurant, hotel and catering partners of the company. Additionally, for all active users, two tickets to a symposium including accommodation were raffled off.

Employees were encouraged to use *KnowledgeMatch* during the working hours, but not while being with customers.

6 RESULTS

After project month seven and the completion of the employee-challenge, we conducted the analysis of the recorded data.

6.1 Client Usage

Participants could choose freely which device and clients to use. The KnowledgePulse server records client information for all web service calls allowing a detailed investigation of client usage. The client usage distribution extracted from all recorded actions in Table 1 shows the significance of mobile devices for MicroLearning. Almost 9 out of 10 recorded user actions were executed on mobile devices. As the web application client is responsive, it cannot be clearly determined to what extent it might have been used on mobile devices.

[9]The project and the evaluation study were started in December 2016

[10]The challenge was held from May 1st to July 31st 2017

Table 1: Device distribution

Client	Learning Steps (relative)
Android	75,85%
iPhone/IPad	12,63%
Web	9,94%
Windows	1,58%

6.2 Overall Activity

A simple indicator of user engagement used in literature is the overall user activity. Previous research reports 10-20 learning steps on average per day and six daily learning sessions for the most active users [2].

6.2.1 Pre-Challenge Activity. In the present case study, 102 users had already completed at least a single learning activity and 57 users completed at least one course before the challenge kick-off. Overall a total of 164 course completions, where 37 learners had completed two or more courses and 12 learners even completed five or more. On average 494 learning activities per active user were recorded in that time frame. These activities comprise standard learning mode as well as match mode. Although not promoted yet, *KnowledgeMatch* was already actively used by 51 users and 28 matches were started on average per day in the month before the start of the company-wide challenge. This amounts to exactly 50% of the 102 users that had made at least a single learning step till then. About 37% of all pre-challenge learning activities were made in *KnowledgeMatch* mode.

Another important indicator regarding the motivational assessment of MicroLearning is the number of learning daily learning sessions. To analyze learning sessions we extracted contiguous sessions from a stream of activity data. Two adjacent activities belong to the same session if the timespan between is below a defined threshold of one minute. This threshold has been defined iteratively by statistical comparison of intra-sequence intervals and inter-sequence intervals, finally yielding an average interval of more than 5 hours between two sessions. On average users started 2.35 learning sessions per active day. The median of average daily sessions is 1.86 and 70% of all users are below the average daily sessions. The most active 5% of all users (in terms of daily sessions) average 5.5 or more sessions per active day.

6.2.2 Activities during the Challenge. When the game challenge with KnowledgeMatch started 175 employees were invited to participate. The number of monthly active learners increased subsequently from 97 before to 130 at the end of the challenge period. Overall 136 users (77% of all invited users) were active within in this period, i.e. completed at least one learning activity. Of those active users, 95 (70%) participated in at least one match. As an expected result of the promotional activity, the growth in match participants of 44 (+86%) surpassed the growth in active users of 34 (+33%). 92 users played at least one match completely (all 3 rounds, i.e. 15 cards). During the challenge period, an average of 585 matches per day was created and match activity peaked at almost 6000 matches

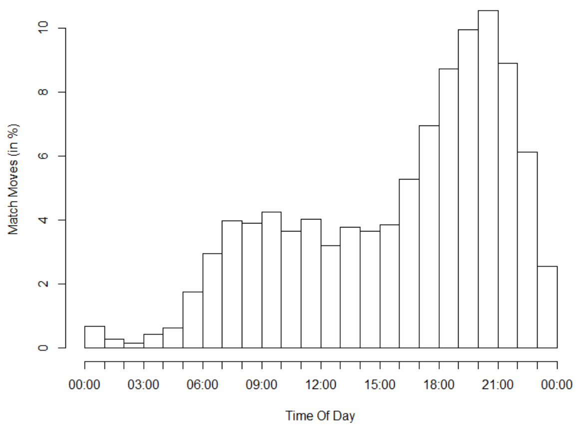

Figure 4: Usage Times of *KnowledgeMatch* (Jan-Jul)

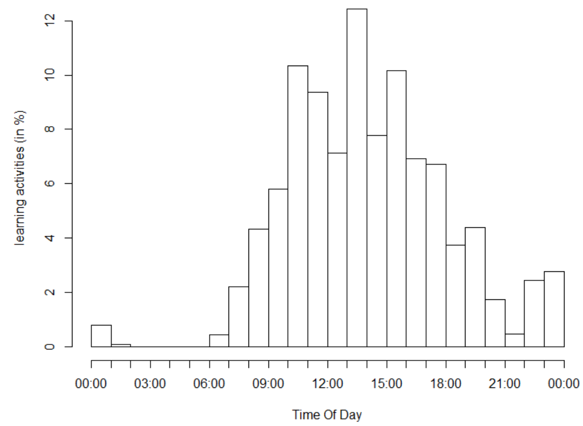

Figure 5: Usage Times of Standard Learning Mode (Jan-Apr)

in one of the last weeks. During the challenge, 95% of all recorded learning activities were made in *KnowledgeMatch*.

The average learning sessions per active day dropped to 2.22 with a median of 1.8, where the 0.95-quantile decreased to 4.5.

At the end of the challenge, 90 users had completed at least one course, 67 users had completed at least two courses and 39 users had completed five courses or more.

6.3 Usage Patterns

The aggregated overall activity described in the previous section gives an indication of user engagement. Below we try to identify differences in usage patterns between standard learning mode, learning with *KnowledgeMatch*, and extrinsically motivated *KnowledgeMatch* learning during the challenge.

6.3.1 Time of Usage. Bearing in mind that learners were encouraged to use the MicroLearning system during their working hours, the distribution of activities over time of day is surprising. While matches were played evenly distributed during the working hours (7 am to 4 pm), a significant increase of match activity occurred after 5 pm peaking in the evening between 8 pm and 9 pm. Figure 4 shows this distribution of match turns over the course of a day. A comparison between typical working hours and after work hours shows that 37% of all match activity was recorded between 7 am and 4 pm while 53% of all match moves were made between 5 pm and midnight. The challenge and incentives provided by the company did not influence this distribution as a comparison with data recorded before the challenge shows: 37% of all match moves were made between 7 am and 4 pm while 57% were made after 5 pm.

The distribution of activities in the standard learning mode in the same period, however, was distinctly different. As shown in Figure 5 about 70% of the learning activities in the standard learning mode was recorded between 7 am and 4 pm while only 22% occurred after 5 pm in the pre-challenge time frame.

6.3.2 Weekday Activity. For the whole observation period, the weekday did not influence activity. Similarly to the time distribution, the data shows activities on days off such as Sundays. In fact, the average activity on Sunday was even slightly above the average daily activity. In the pre-challenge period, the weekday distribution of activities between standard learning mode and *KnowledgeMatch* shows no significant difference regarding workdays and weekend. The overall weekend activity amounts to 27% and 24% of the *KnowledgeMatch* activity was recorded on weekends. During the challenge, a shift of activity towards the weekend occurred. Figure 6 shows a comparison of activities in *KnowledgeMatch* before the challenge and during the challenge. Note that the illustration shows the relative activity as the absolute amount of activity is magnitudes higher during the challenge for all weekdays. During the challenge, 37% of all *KnowledgeMatch* activities and 36.4% of all activities were recorded on weekends.

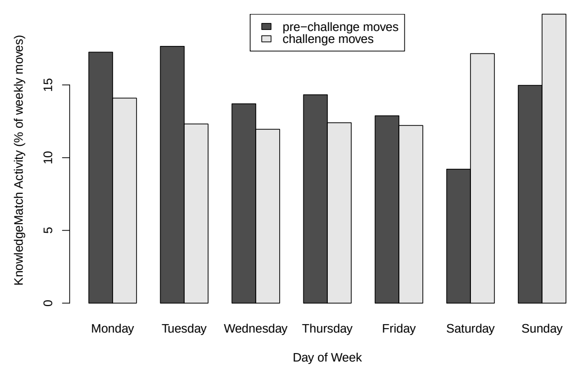

Figure 6: Distribution of *KnowledgeMatch* activity before the challenge(Jan-Apr) and during the challenge(Mai-July)

7 CONCLUSION

From our results, we conclude that *KnowledgeMatch* strongly contributes to user engagement. We found increased activity in the pre-challenge time frame compared to previous results that can largely be explained by a 37% share of *KnowledgeMatch* activities. Although the overall activity increased, the number of daily learning sessions did not. Also, not all users respond to gamification as 50% of active users were reluctant to play before the challenge. Those who did play also used *KnowledgeMatch* outside their working hours. The analyzed data shows that learners played *KnowledgeMatch* especially in the evening. It is interesting to note that learners did that voluntarily and may have treated it as a leisure time activity.

The employee-challenge advertised *KnowledgeMatch* and offered extrinsic motivation through incentives. This lead to a large increase in activity. However, the number of learning sessions per active day decreased slightly in comparison to pre-challenge activities. The extrinsic motivation led to a stronger concentration of activities in fewer sessions compared to the pre-challenge phase. This concentration of activities in fewer but longer sessions is counteracting spaced repetition in MicroLearning didactics. Another noteworthy effect of the challenge was the shift of activities towards the weekend.

This raises issues whether corporate learning activities are to be considered as part of work and whether regulations regarding working hours should apply. While this is the case for mandatory courses and training, it is not for training offered learners for use on a voluntary basis. However, sometimes there might be a thin line between mandatory and voluntary. Employees might feel obligated to learn material that is not mandatory but might be tracked by corporate Learning Analytics. Conversely, it can be argued that users might not want to be restricted in learning to 9-to-5 workdays in a knowledge economy. After all, knowledge is a personal asset benefiting learners, especially in the long run as much if not more than companies.

In our case study, gamification led to more after work activity in the pre-challenge condition. We believe that this due to many participants perceiving *KnowledgeMatch* as fun rather than work. To conclusively validate this assumption future work on gamified MicroLearning should investigate and record employees' views and perceptions.

For Mobile and Workplace Integrated MicroLearning the increase of average daily learning sessions remains a goal for future improvements. Gamification has proven to be a successful approach to shape user behavior and will be a central pillar in our efforts to do so according to didactic paradigms.

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