USING CASUAL GAMES AND ONTOLOGIES TO TRAIN UNSKILLED WORKERS

An Experience with the FoodWeb2.0 Platform

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Keywords: Web2.0, Collaborative Learning, Games with a Purpose (GWAP), Ontology Enhancement.

Abstract: Training and continuing education in and for the food industry face the challenge of reaching and motivating workers without or with only a low level of formal qualification. In the FoodWeb2.0 project a platform with specific support for training opportunities and selected Web2.0 enabled courses has been established. This paper reports on first results of a Web2.0 course conducted on the platform and elaborates on the usage of a casual game for training knowledge on food safety and hazardous material regulations. Since the tentative results show that the students are motivated to influence the content of a course by commenting provided material, we designed the casual game in such a way that it can be used in two modes: as a learning game and as an interactive mechanism for ontology enrichment. Our evaluation at a private professional training academy has shown promising results.

1 INTRODUCTION

The food industry in Germany is characterized by a high amount of workers without or with only a low level of formal qualification. While these workers can be easily recruited and trained to perform simple and often physically exhaustive tasks, there is a lack of skilled workers who are able to use and control the complex machines and processes of the food production industry. Thus, human resource managers try to develop some of the unskilled workers to a higher qualification level to close this gap. Typical obstacles are language problems (often German is not the first language) and a lack of motivation and confidence to learn because of various reasons, e.g., education is not seen as an asset or their current work is so exhausting that they are not ready to learn. The project FoodWeb2.0 (funded by the German Ministry of Research and Education) aims at training the employees of the German food industry using two basic strategies: motivating employees for vocational training and performing education in collaborative, blended learning scenarios using Web2.0 technologies. One of the applications combining both strategies is the use of a collaborative casual game called “Matchballs”.

In the subsequent sections of this paper we present the general approach of the FoodWeb2.0 project, the tools set up to achieve the project goals as well as first results of on-going courses using this platform from a qualitative study conducted with 40 students. The paper continues with a description of the Matchballs game, its underlying architecture and ontology enrichment mechanisms. Afterwards we present the results of an evaluation of the game conducted with 18 students of a vocational training school specialized in sweets production. The paper concludes with a discussion of the results and an outlook on future work.

2 THE FOODWEB2.0 APPROACH

The FoodWeb2.0 project focuses on professional training in the food industry. These trainings are characterized by students of heterogeneous background and knowledge. Furthermore, there are only a few training facilities in Germany offering specialized training for the food industry. At the moment, these courses are conducted at the training institutions. This implies that students from all over Germany have to travel to the training facilities. To reduce travel costs most of the courses are quite

Malzahn N., Ziebarth S. and Hoppe H..
USING CASUAL GAMES AND ONTOLOGIES TO TRAIN UNSKILLED WORKERS - An Experience with the FoodWeb2.0 Platform.
DOI: 10.5220/0003914605310537
In *Proceedings of the 4th International Conference on Computer Supported Education* (SGoCSL-2012), pages 531-537
ISBN: 978-989-8565-07-5

intensive, i.e. much information is covered in a very short time. The courses are often organized in phases of training at a training facility and phases in which the students have to apply their newly acquired knowledge at their particular enterprise setting. In the latter phase they are often not supported by training facilities, since they are not in touch with their trainers. This leads to a difficult learning and transfer situation.

The FoodWeb2.0 project aims at improving this situation by providing an online platform where students and trainers can be in touch before, during and after a face-to-face training block. We use a Liferay portal as basis for our platform. It offers basic tools like wikis, blogs, forums, document libraries etc., and a sophisticated role/permission system that allows to offer courses of several training facilities on a single platform without compromising their security and data privacy.

The most challenging part of further education and learning at work is the application of “book knowledge” to the specific work situation (cf. Baldwin & Ford, 1988; Burke & Hutchins, 2007). Web2.0 provides adequate ways of supporting this kind of learning. Instead of just presenting knowledge like in web based trainings or (video) pod casts explaining the content with a most often artificial case study (at best), the students are instructed to share their experience regarding the lessons learned with the other students by providing blog entries, wiki based learning or in the case of the more craft-oriented courses by recording videos of their own performance.

In addition to providing learners with the opportunity to communicate with their trainers during phases of work at their specific enterprise the platform is also used to provide preparatory courses. Especially in the area of qualification courses from unlearned workers to skilled workers, there is a diversity of age and educational background implying a wide variety of learning skills and background knowledge. To harmonize the knowledge levels with respect to specific courses, the involved training facilities offer preparatory courses, where the students may refresh their knowledge on topics that are considered pre-requisites for a particular course. Due to the Web2.0 spirit of the platform the students may always discuss the subject matter in forums and present their solutions in form of blog entries or videos, which can be uploaded into the platform. Other students are asked to peer-review these solutions.

We think that the Web2.0 spirit of the platform helps to overcome the motivational issues of the target group, because by providing user generated content the students are allowed to shape the course content by providing learning materials for other students and getting feedback on their own real-world solutions (for real-world problems) from their colleagues. The basic pedagogical approach is borrowed from collaborative learning designs like jig-saw or gallery methods, but furthermore the learners are always asked to comment on the learning material provided by the trainers for further improvement of the course content.

A first qualitative study during the testing phase of a preparatory course (see Figure 1) with 40 students from a class of food technicians at a private training facility was promising. The students were excited by the possibility to give feedback on the presented learning material and the comments of their co-students. There was only one drawback. The teachers had turned off the possibility to rate a comment, because this did not seem necessary to them. However, some of the students did not comment on any resource, because they agreed to a previously written comment. That explains why we had only 28 comments from 40 students. The follow-up group discussion confirmed this hypothesis.

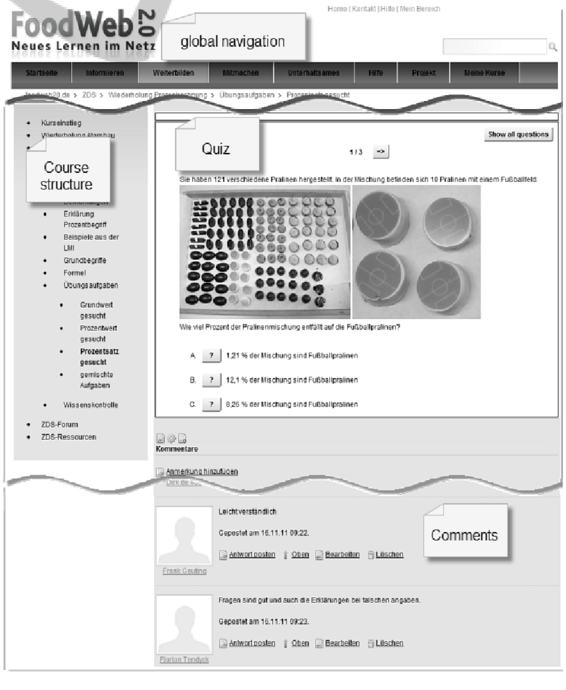

Figure 1: Glimpse of a preparatory course conducted on the FoodWeb2.0 platform.

The students liked the possibility to repeat lessons from school and prior courses by conducting quizzes with immediate feedback. Whenever the students were not able to solve an issue – regardless if it was a technical issue or a task provided by the trainer – they tried to solve it by requesting help from peer students.

As the students liked the quizzes so much we thought of using their motivation effect to pursue three goals: 1) help the students to learn, 2) help the trainers to detect misconceptions to improve their teaching 3) provide a means to collect and formalize knowledge about a specific domain. To achieve these goals as sub goals of FoodWeb2.0 we developed a framework for casual games.

3 MATCHBALLS

Matchballs is designed as a simple allocation game, in which the player creates statements by linking ("*matching"*) concepts displayed as *balls* (see Figure 2). A statement consists of two concepts linked by one of four predetermined relation types. The game can be played either as two player game or as single player game with a bot. Each pair of players sees the same game field (concepts) and the goal is to agree with the teammate on as many relations as possible in a given time. To agree on a relation both players have to create it. If they agree on a relation, they score points and get time bonuses. Players may see the relations of their teammates, but not the relation types. The connecting symbols representing the relation change according to the state of agreement. There are different symbols for proposals, agreements and disagreements of the players.

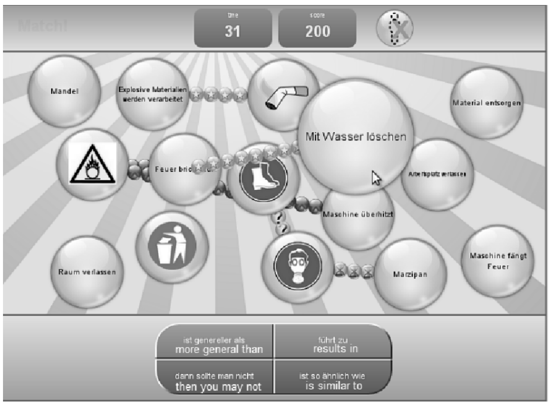

Figure 2: Matchballs user interface.

As knowledge domain we use the domain of food safety and hazardous material regulations, which is an important topic of further education in the German food industry. The considered concepts are specific situations, actions, dangerous substances and edibles, which can be linked by using the four semantic relations "is similar to", "is more general than", "results in" and "then you may not". Such a statement might be:

<Machine overheats> <results in> <fire danger>

To be flexible concerning the learning domain we decided to use an ontology-based approach. The ontology may be easily exchanged to adapt the game to another domain. Furthermore, the ontology principally offers the opportunity to encode specific feedback for common misconceptions like it is often done in intelligent tutoring systems. However, ontologies are usually incomplete, since it is nearly impossible to represent even a limited domain in exhaustive detail. Accordingly, relations created by the players that do not occur in the knowledge base are not necessarily wrong, but possibly just missing, especially if a significant amount of players creates them. Thus, it is possible to use the so called "wisdom of the crowd" of the game players to enrich a pre-built ontology like it is done in *games with a purpose* (gwap) for semantic applications (cf. Siorpaes and Hepp, 2008).

The game has been designed as casual game: The rules of the game are very easy to learn, the controls are simple, single play sessions are short and agreements are instantly rewarded. Casual games are considered as "games for all", which not only appeal to gamers but to the mass audiences irrespective of their age, gender or background (Kuittinen et al., 2007). They are not very time consuming and can be played occasionally. Thus, this game genre seems appropriate to our divergent target group.

There are several different incentives for different types of players: For competitive players there are high scores and time bonuses, which are a well-known and often used incentive since early arcade games. Furthermore, players can collect "achievements", which are trophies for solving certain predefined tasks (e.g. for team play with another player or for scoring many points).

While playing the game the players have to remember facts and rules in the context of food safety and hazardous material regulations. Thus, it can be used in a corresponding course for training and recapitulation, not only in the class room, but also online at home.

4 ARCHITECTURE

The central game server is based on a tuple space middleware called SQLSpaces (Weinbrenner, et al., 2007). Software agents communicate by writing and reading messages on and from the tuplespace. These messages consist of tuples made of primitive data types (integer, characters, booleans) and strings. A single tuplespace server may contain several tuplespaces used to divide the data stored in the server into logic or semantic units.

The Matchballs architecture distinguishes four different categories of tuplespaces: the *Coordination Space*, the *Game Spaces*, the *Intermediate Space*, and the *Ontology Space* (see Figure 3). The Coordination Space is used to conduct the matchmaking between two human players or to start a single player game. The GameClients, which reside in a Liferay portal, register at the Coordination space to announce their availability for a new game session and retrieve the information about the Game Space they have to connect to. The Game Client is implemented using HTML5 and JavaScript to cover a wide amount of browsers and operating systems.

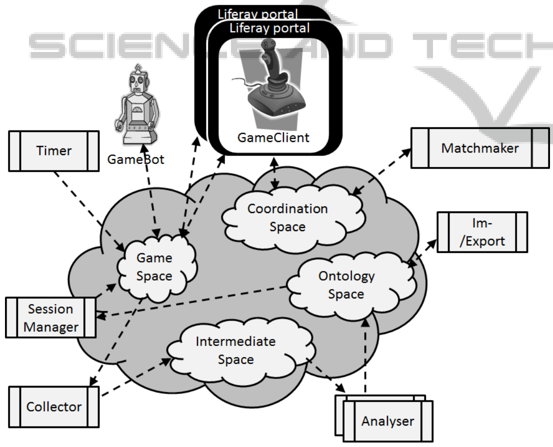

Figure 3: Architecture of Matchballs.

Each game session has its own Game Space, to which either two human players (multiplayer game) or a human player and a GameBot (single player game) are connected. The Game Space holds all necessary information for a Matchballs game. That means the Game Space consists of an excerpt of the ontology space, the current timer as set by the Timer agent, the current score, and the links made by the players as well as its assessment by the Session Manager. The GameBot has access to the whole information stored in the ontology excerpt, i.e. it is aware of the complete knowledge that is represented in that ontology excerpt. Thus, all associations made by the GameBot are correct assuming that the ontology is adequately modeled. The excerpt from the ontology is created by the Session Manager agent. It takes care that there is always a minimum of possible relations between balls in the beginning. It also detects concordances of the two players with respect to the links between balls made by each player. If an agreement on an association is detected by the Session Manager, i.e. both players' GameClients wrote exactly the same relation tuple into the Game Space. A game ends if the time is up. Afterwards the links made by the players are collected by the Collector and put into the Intermediate Space for further inspection. At the moment the Collector just counts the occurrence of the specific relations made by the players and stores or updates the amount in the Intermediate Space.

The Intermediate Space is used for analyses. There is a threshold of at least five different players linking two concepts with the same association type (not present in the ontology yet) to propose this association for inclusion into the ontology. Another basic analysis looks for common misconceptions by the players, i.e. the players frequently contradict an association in the ontology by using another association type than the one represented in the ontology. Both analysis results are specifically marked in the Ontology Space.

The Ontology Space holds a tuple representation of the ontology. Every concept and relation is represented by a tuple. The ontology design is based on SKOS (Simple Knowledge Organization System) (Miles and Bechofer, 2009). We distinguish only four association types, easily derived from SKOS-relations and we have few concepts/classes and many individuals/instances, which can be categorized in SKOS's concept schemes. The restrictions on the ontology are caused by the spirit of the game. Since it shall be a casual game for unskilled people a huge, sophisticated system of associations and concepts/classes is misleading. Furthermore, SKOS is suitable for teachers to express their domain knowledge without much help from ontology engineers. Last but not least there is a plugin for Protégé for SKOS. Thus, we can use a popular editor for ontology creation, inspection and refinement.

The markers of the analyses agents are translated into respective concept schemes: misconception and new. Accordingly, the specific individuals may easily be found by teachers and ontology engineers. The ontology used in our evaluation (see below) consists of 191 individuals connected with 91 associations distributed on the different association types.

5 EVALUATION

The Matchballs game has been evaluated with a class of 18 students at the Academy of Sweets in

Solingen, Germany. Since there were only six laptops available for conducting the experiment, after a short plenary introduction of the game, the class was divided into three groups of six students. The students of each group had a timeslot of five minutes for playing as many games as possible and were encouraged to start with a single-player game for learning the controls and then perform at least one game with a human partner. After playing the game they had to complete a questionnaire and at the end there was a short plenary discussion.

The subjects consisted of five females and thirteen males, sixteen were German native speakers. They rated themselves to have high knowledge in the fields of safety at work and danger symbols (median of five on a scale from one to six) and also some knowledge of hazardous materials (median of four on a scale from one to six). Thus, the participants are considered to have at least basic knowledge of food safety and hazardous materials and to represent a group recapitulating their knowledge on these topics. Together the subjects created 155 different relations, most were only created by one user, but there were also relations created by up to seven different participants.

Table 1: Comparison of minimal support for considered relations, precision of relations and percentage of errors based on wrong direction of the relation.

minimal support	precision	errors based on wrong direction
4	1.00	none
3	0.85	100,00 %
2	0.68	58,33 %
1	0.40	25,80 %

The higher the amount of users supporting a relation, the higher is the probability that the relation is correct (precision) (see Table 1). A frequent error lies in choosing the wrong direction of the relation, around 26% of the overall wrong relations are correct except for the direction; if not all relations but the ones with a minimal support higher than one are considered, the percentage is even higher (see Table 1). These errors can be considered as careless mistakes instead of real misconceptions.

All frequently occurring, correct relations which have a support of at least three are already in the ontology. This is due to the initial composition of the playing field containing two-thirds of concepts being linked in the ontology and only one-third of concepts being not linked with the other selected concepts. But these relations only cover 17.7% of the correct relations created by the users. Thus, the relations with high support have a high precision, but a low recall. 75.8% of the correct relations already are in the ontology, 4.8% of the correct new ones are supported by two and 19.4% by only one user. The low support of the correct new concepts on the one hand can also be explained by the initial composition of the playing field and on the other hand by the limited number of games played in the experiment.

The “wisdom of the crowds” approach is often criticized arguing that expert contributions would be enough. In our case, the four “best” students (22.2%) who created the biggest amount of correct new relations could only provide 46.67% of the overall number of correct new relations.

Table 2: Cluster centers.

	Cluster 1 (14 students)	Cluster 2 (4 students)
Distinct Relations	14.07	5.25
Precision	0.49	0.51
Innovativeness	0.07	0.07
Sloppiness	0.14	0.00

The users show different profiles in creating relations in terms of the number of different relations created, their precision, the number of correct relations missing in the ontology and the number of errors based on direction issues. Each user averagely created twelve relations, of which six (0.51 %) were correct, one (8.3 %) was new and correct and approximately two (15 %) were wrong because of direction problems. There is no correlation between these variables, but partitioning the students into two clusters using the kMeans algorithm (see Table 2), reveals one small group of students (22.2 %), who create a number of distinct relations far below average, are a bit more precise and make no direction mistakes and a larger group, who creates slightly more distinct relations than average, are a bit less precise than the other group and make much more direction errors.

On the whole the students had fun playing the game and experienced it as motivating (each variable had a median of four on a scale from one to six). 77.8 % stated they would like to play the game again and averagely stated they would play it once to several times a month. The complexity is perceived as medium (median of 3.5 on a scale from one to six), which is an indicator that the game is neither overstraining nor boring and hence appropriate.

6 DISCUSSION

The evaluation results show that the Matchballs game was perceived as a casual game. Based on the data generated during the game sessions we were able to identify 17 relevant associations or relations previously not present in the ontology. These relations were integrated by knowledge engineers. In this sense, our learning game can also be seen as a "game with a purpose" to enrich an initial ontology is feasible.

Thus, the game may be used as an interactive mechanism for closing gaps in the. At the moment, the game can only be used for adding new relations to the ontology. In the future, we plan to use the game to acquire knowledge from new fields in class sessions. The teacher may add an originally disconnected set of new concepts to an existing ontology. The students are then asked to play the game by connecting these concepts with each other as well as with the old ones, thus integrating them into the existing ontology. This activity may be viewed as a multi-player concept map creation game in which the players create a shared concept map. Concept maps have been successfully used as learning tool for linking existing and new knowledge as well as for evaluation and identifying valid and invalid ideas of students (Novak & Canãs, 2006). If the game is played in single player mode, the game may still be used as an advanced vocabulary trainer. Even when playing the game individually the students still collaborate indirectly. Teachers can use the game to extract information about typical misconceptions of the group but also of individual students.

In the context of the FoodWeb2.0 project there have already been several requests by teachers and students for transferring the game to further knowledge domains. We will try to incorporate these domains and enhance these ontologies with specific feedback on the newly introduced relations. For the multi-player scenario, feedback will be given about the existence of these relations in the ontology. In single-player scenarios the feedback will identify possible misconceptions automatically based on information on particular error types explicitly represented in the ontology. Similar to intelligent tutoring systems the semantic ontology structure will be used for the generation of generic feedback.

Evaluation results concerning the FoodWeb2.0 platform in general (and not only the game lements) are currently Janus-faced: On the one hand, the perceived usefulness of the platform rated by the students in general is very high. They like to be able to look up subject matters on the internet, especially if the trainer or peer students provide additional information for further learning. On the other hand, the trainers are either very enthusiastic or quite reluctant to use the platform. Those of the trainers that are enthusiastic often underestimate the time needed for transforming their material and lesson planning to an online supported course. The reluctant ones overestimate the needed effort and underestimate their students' skill with Web2.0 tools. The trainers usually have a professional background in one of the disciplines related to the food industry (like veterinaries, food engineers or biologists) but not in pedagogy. This may explain why some of them are hesitant to employ collaborative learning strategies in their courses and consequently have issues with Web2.0 learning. They use a "traditional" line of argumentation: loss of control, quality control of the results, perceived inefficiency of group work. Thus, they are surprised by their students' enthusiasm to work with the platform and by the positive results that are achieved. We plan to conduct an elaborate study concerning the perceived usefulness of our platform differentiated by roles and the changes to the course content and pedagogical design that have happened as a consequence of student feedback and the projects' "train-the-trainers" program.

ACKNOWLEDGEMENTS

We would like to thank Christopher Charles, Peter Horster, Dominik Kloke, Carolin Pohl and Carsten Wieringer, who implemented the Matchballs game during a student project.

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