Exploratory Game Play to Support Language Learning: Dinner Talk

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Abstract: In response to the contemporary influx of refugees to Europe, the authors' team has developed and implemented a digital game concept to support language learning of any written language. Fast progress in small steps is required and small and flexible software tools are necessary. The core implementation is available on the web and runs on mobile devices such as tablets and smartphones, on conventional desktop PCs and on special purpose devices such as interactive learning tables. This core implementation allows for a very flexible and fast exchange or modification of contents to fit to varying needs. This paper puts emphasis on the potential of the approach beyond the needs of refugees. Educators may apply it to regular courses in school, in higher education, in vocational training, and in further education.

1 MOTIVATION

In response to the contemporary influx of refugees to Europe, the authors' team has developed a potentially infinite family of digital games (Arnold et al., 2016). A certain core implementation is available on-line at https://webblebase.net/placementgame.tobo.game-compound-0.4.1-SNAPSHOT/index.html.

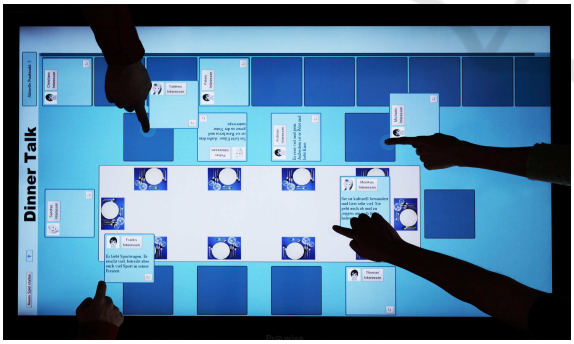

Figure 1: An early version of the core variant of the game family DINNER TALK on an Interactive Learning Table.

There is an intelligible introduction available in an on-line magazine (Jantke and Bosecker, 2015) that is complemented by a short interview (Jantke, 2016).

It may be no surprise that the usage of these games is not restricted to the language learning needs of refugees. The intention of the present short paper is to inform a wider audience about the potential of the game family and to discuss the use of these games in more detail emphasizing several issues of pedagogy.

2 DINNER TALK IN THE EUROPEAN CONTEXT

Thanks to the advice of an anonymous reviewer, the authors found the "Common European Framework of Reference for Languages: Learning, teaching, assessment" (Council of Europe, 2001) a valuable source to put the present work in context. This document works as a guideline by "raising questions, not answering them." (ibid., p. 4) The DINNER TALK project may be seen as an approach to provide some partial answers.

The present short section summarizes a condensed characterization of the DINNER TALK approach with respect to this framework.

To the above-cited framework's initial questions (see the NOTES FOR THE USER section of (Council of Europe, 2001)), the DINNER TALK approach offers the following answers. The target audience is heterogeneous. Not all of them have access to textbooks, but all of them are actively using the Internet. The time they can afford to spend is largely varying.

The original motivation of this project is literally "to avert the dangers that might result from the marginalisation of those lacking the skills necessary to communicate" (ibid., p. 4).

The methodology of choice is exploratory game-based learning. The aim is to literally attract learners.

The technology and the interaction design should allow both for single player self-controlled learning and for collaborative learning including the discussion of content. Furthermore, it should support novel approaches such as flipped classroom scenarios.

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3 ESSENTIALS OF GAME PLAY

DINNER TALK (DT) is the name of an infinite family of digital games. It has a large number of parameters. Every instantiation of parameters leads to a particular game of the DT family.

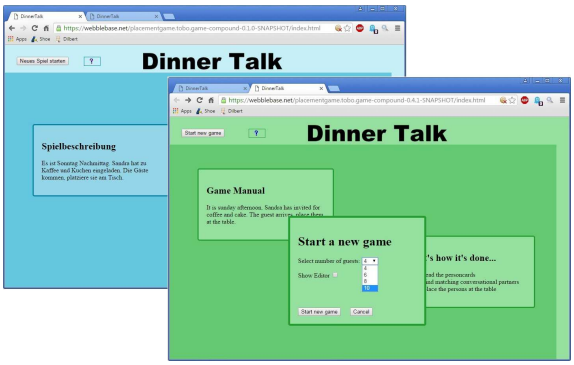

Figure 2: DINNER TALK start screens of the German (background) and the English (foreground) game's core variant; there are similar versions for learning French and Swedish.

Every game of the DT family is a *combinatorial game*. Within the family of combinatorial games, the *board games* form a quite prominent category. Board games are characterized by a board which consists of cells and by pieces which may be placed on cells, moved on the board, and so on. A board game is a *path game*, in particular, if most of its cells have exactly two different neighboring cells. Apparently, this is a fuzzy concept due to the imprecision of the term "most". A path game is a perfect one, if all cells have exactly two neighbors. The most simple variant of games in the DT family is a *perfect path game*.

Figure 3: Players shall read, understand and relate texts.

The narrative of DT is to consider the board (the path) as chairs around a certain table. The pieces are understood as virtual guests to be seated. The size of the table, i.e. the number of guests to be seated, may be chosen initially (see fig. 2). Seating a guest is performed by placing a piece on a cell. In contrast to many other board games like CHECKER, CHESS, and NINE MEN'S MORRIS, e.g., pieces must not be moved on the board along the path. DINNER TALK belongs to the particular category of *placement games* like, e.g., REVERSI, HEX, and CONNECT FOUR in which playing the game means just to place pieces. There is no concept of "moves" in placement games.

The pieces carry texts or text fragments which are interpreted as the virtual persons' interests (see fig. 3). Intuitively, players should seat guests in such a way that neighbors at the table share some interest. If this happens, they score points. The goal of every game of the DT family is to seat guests in such a way that the human player scores many points. It is practically impossible to find good seating solutions just by trial and error without checking the texts.

For illustration, if there are 8 seats around the game's table, there exist 10,080 different variants of placements. In the case of 10 chairs, the number of possible placements sums up to 907,200. Furthermore, for 12 chairs, the corresponding figure would be 119,750,400 which is large enough to motivate the authors' decision to confine themselves to 10 seats, at most.

These figures above are the result of dividing the factorial of the number of seats by 4. To find out all possible arrangements, one may begin by seating the first piece at the upper front end of the table followed by others pieces clockwise around the table. If there are n seats, the number of different placements is $n!$ called the factorial of n. Because it does not matter whether one starts at the upper front end or the lower front end of the table, the number of distinguished placements is divided by 2. Similarly, because it does not matter whether the seating is done clockwise or counter-clockwise, the figure must be divided by 2 once more.

The issues of combinatorics mentioned above lead to related conclusions as follows. First, because it is unlikely to score many points just by trial and error, players who want to perform well need to read texts and to think about semantic relations between texts. Second, because players tend to compare only a few texts at a time, they may find out particular relevant semantic relations later than others. The correction of earlier seatings may become desirable.

In response, the rules of play are slightly relaxed. We consider *dynamic placement games* in which the players have permission to take seatings back, i.e., to undo an action. This helps to achieve better results, to reduce frustration, and to increase the fun of playing. Dynamic placement games are *exploratory games*.

To sum up, the design of the DT game family leads to a form of *exploratory game-based learning*.

4 SOFTWARE TECHNOLOGY TO SUPPORT EXPLORATION

The game design described in the preceding section 3 has been implemented to allow for the educational scenarios under discussion in section 5 below. This section is bridging the gap by informing the reader briefly about the technology in use. Some emphasis is put on technological features that are decisive to exploratory human-computer interaction.

Digital games of the DINNER TALK family are conceptually based on webble technology (Kuwahara and Tanaka, 2010) which is a recent form of meme media technology (Tanaka, 2003). To be available on a large variety of terminal devices, the type of webbles in use for the DT games family are implemented in HTML5, CSS and JavaScript (Fujima, 2013).

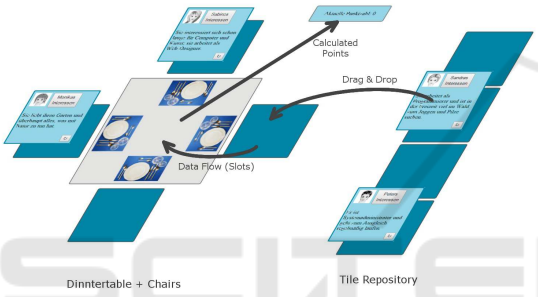

Figure 4: Webbles are essentially structured like trees.

Interestingly and, perhaps, even a bit surprisingly, Yuzuru Tanaka's technological approach (Tanaka, 2003) has some philosophical background. He found himself challenged by Richard Dawkins' speculations about the *non-biological evolution* (Dawkins, 1976). Interested readers may find a quaintly folkloric explanation of Dawkins' ideas in Susan Blackmore's book (Blackmore, 1999).

A variety of applications illustrate the enormous expressiveness and the flexibility of the technology; see (Arnold et al., 2013) and the contributions therein as well as the following individual papers (Tanaka and Imataki, 1989), (Tanaka, 1996), (Ito and Tanaka, 2003), (Sugibuchi and Tanaka, 2004), (Dötsch et al., 2005), (Kaschek et al., 2006), (Ohigashi et al., 2006), (Ohigashi and Tanaka, 2006), (Lamonova et al., 2007), (Fujima, 2010), (Kuwahara and Tanaka, 2010), (Fujima et al., 2010), (Fujima and Hofmann, 2011), (Guo and Tanaka, 2011), (Fujima and Jantke, 2012), (Jantke et al., 2012), (Arnold et al., 2012), (Fujima et al., 2012), and (Jantke and Fujima, 2015) which cover an interesting spectrum of approaches.

There is a current competition of meme media variations, but its discussion is beyond the limits of this paper.

Webbles are objects that have a Model-View-Controller (MVC) structure and may be manipulated on a webble desktop. The webbles' key touch and feel is decisive for usage. Every webble contains data in places that are called slots. Readers may think of the contents of pieces in the games of the DT family as illustrated before. There are slots for names, for URLs of pictures, and for text. Humans may click a webble on the screen and move it to whatever place desired. When one webble is dragged over another one, there is established a slot connection. Readers may have a look at fig. 1 where four piece webbles are dragged and dropped simultaneously over different seat webbles. The slots of the pieces are connected to the slots of the seats which, in turn, are connected to the table webble (see architecture on display in fig. 4). The content of slots is propagated downwards into the table webble where the texts are compared. Similarity values are calculated and propagated to provide feedback to the player (see fig. 4).

The features of meme media technology decisive for exploratory playful learning are

(i) *auto-connection* (webbles latch when dragged and dropped one over the other),

(ii) *peeling off* (compound webble objects may be decomposed for trying out alternative constructs),

(iii) *direct execution* (Fujima and Jantke, 2012),

where the latter means that completed webbles run immediately, an effect crucial to learner feedback.

There is a very interesting deeper relationship between direct execution and *partial evaluation* (Jones et al., 1993). In logics, this is called *currying*. And in recursion theory, it relates to Stephen Kleene's so-called *s-m-n theorem* (see (Rogers jr., 1967) and (Sipser, 1997)). "Partial evaluation is a technique to partially execute a program, when only some of its input data are available." ((Mogensen and Sestoft, 1997), p. 247). There is no space to go into detail.

All the game variants of the DT game family are implemented in the way sketched.

When a player picks up a piece representing one of the virtual guests, this piece is a webble object peeled off the repository. By drag and drop, the player is seating the virtual guest on one of the virtual chairs. Every chair is a webble plugged into the table webble. When a piece representing a guest is plugged into a chair webble, certain slot connections are established. Data flow from the piece webble to the table webble which is (partially) processing all the data available. If possible, a score is calculated and visualized.

5 EDUCATIONAL SCENARIOS OF EXPLORATORY GBL

As Richard Mayer put it, "games are artificial environments that are rule-based, responsive, challenging, and cumulative" ((Mayer, 2011), p. 282).

Learners are encouraged to play DINNER TALK by seating virtual guests at the virtual table. To score as many points as possible, players need to place guests with related texts next to each other.

This requires (a) reading texts, (b) understanding essentials, and (c) relating meanings of different texts.

To prepare game play, educators assign similarity values to pairs of texts. A first version of an editor has been implemented (see fig. 5).

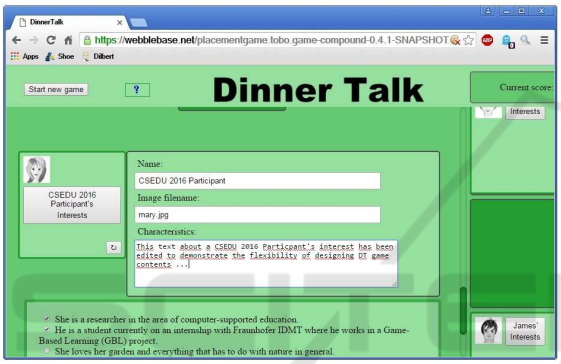

Figure 5: An early version of an editor for DT games; here is the English version in use where the piece has be renamed to "CSEDU 2016 Participant" with the picture "mary.jpg".

The core variant of the digital games of the DT family is ready for use (Jantke and Bosecker, 2015).

5.1 Single-Player DINNER TALK

At a first glance, every game of the DT game family may be played in a single-player mode. This mode may be adopted in and adapted to any educational setting such as elementary school or further education.

Playing a game of the DT family can be assigned as homework to students. Similarly, one may offer the service of playing the game for free and let just those play who are interested in.

In these unsupervised learning scenarios, there is no immediate and apparent way of how to get learners engaged in communication about their results.

The most simple way to draw more benefits from playing the game is encouraging students to tell each other about their learning experiences, to compare their respective results, and to discuss the reasons for differences.

5.2 Elementary Extensions

In class rooms, one can easily implement a variety of interesting scenarios relying on the communication of human learners. Due to the power of human-human communication, those scenarios are light-weight from a technological point of view.

This brings us close to the border between the single-player mode and different multi-player modes. As illustrated by means of fig. 1, simultaneous game play is enabled. However, playing together is not only an issue of interface technology and of appropriate client-server architectures. It is primarily an issue of game design.

Unfortunately, some investigations and related publications on multi-player games in education such as (Richter and Livingstone, 2011) reduce play to competition and overlook the potential of co-operation (Koster, 2005).

As a first scenario, let us consider the following one. The teacher is asking the class to form small groups which play together aiming at high scores. This encourages learners to read texts individually and together, to discuss the meaning of language expressions, and to compare and evaluate alternatives. With little effort you get engaged minds.

5.3 Technologically Enabled Scenarios

Because of the limitations of unsupervised learning, educators ask for in-game features to substitute for the missing communication.

A comparably easy approach is to provide continuous feedback to the learners which ingeniously integrates gratification feedback and control feedback[1]. There are varying forms of feedback such as

- current scores compared to scores reached so far (local maxima) during the learning session,
- current scores compared to the optimal solution (which requires a priori calculation),
- some visualization of where the current points scored come from.

The latter item is interesting because of the overwhelmingly large amount of possible implementations. The current implementations illustrated above reflect the user's success of scoring points simply by showing the current high score. As already discussed, the current score may be compared to local maxima achieved before or to the global maximum w.r.t. the present texts and their overall similarity.

[1] An in-depth investigation of feedback in game play may be found in (Jantke and Gaudl, 2010)

But how to point directly to the origin of the point(s) recently scored? One may show speech bubbles between virtual guests who share some virtual interest due to real text similarities. But what about those speech bubbles over the table? And in case we have more expressive similarity measures which may return different values, not just 0 or 1, do we show speech bubbles of different size? Or do we show speech bubbles with score points inside?

Other scenarios assume that virtual characters are determined by more than interest. Educators like to see virtual in-game characters to have age, gender, and possibly familial relationships. This requires specific slots. Whereas slots for age and gender are easily implemented, familial relationships may require some ontology. Do we expect ad hoc ontologies on the server providing the learning service? Or do we aim at the federation of relevant services over the web?

5.4 Innovative Scenarios

There are novelties like flipped classroom scenarios. Ask one student or a small group of students to set up an instance of the DT family for their fellow students. After set up, all students of the class play the game. After completion of game play, results are presented and compared. Those who have set up the game need to explain to their fellow students where the scores come from. This requires the explanation of texts and of semantic relations between texts. Teachers may supervise the discussion and intervene, if necessary.

Seen from the technological point of view, this scenario requires (i) the ability to save edited pieces of the game locally, at least, and (ii) to make them available to a certain group of registered learners. There is a need either (iii) to specify the semantic similarities of texts put in or (iv) to compute similarity values of texts put in by hand automatically, perhaps, within a certain context or corpus of words.

The basic functionalities are already available (see fig. 5).

Furthermore, one may imagine a way to publish successful game contents. Even further, one may enrich these games by reports about successful deployment in education. This may establish communities of players of the DT family world-wide.

In the very end, one should mention that technological extensions will allow for different experiences of game play. Spoken text output, i.e. reading the texts to the players, will definitely change the game playing experience. All those ideas are appealing, attractive, but computationally expensive. This is future work.

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