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Improving mechanical engineering vocabulary through the use of a game

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Abstract

In the present paper, we shall firstly show how a learning game to teach basic technical vocabulary can help players to improve their language skills. The benefits this new tool can have on teaching methods and on motivation will then be examined.

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Keywords: Learning game; evaluation; vocabulary learning; NC machine tools; digital game-based language learning; English for specifications purposes

1. Introduction

Nowadays speaking, writing and understanding English at work for non-native English people has become necessary for all technical professions and especially in manufacturing engineering fields [1]. But in France, English teachers' training is often broad-based and rarely prepares them to teach ESP (English for Specific Purposes).

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Consequently, teaching technical English vocabulary is difficult for English teachers. They cannot be proficient in all technical fields; they need new tools developed with expert teachers of the field to help them and their students become specialized and acquire technical vocabulary.

In this context, the University of Toulouse has decided to promote trainings in English, both to broaden its students' perspectives and encourage outgoing mobility, and also to accommodate incoming international students. At the same time, evidence of the relevance of games to learning is visible in mainstream media, language teaching circles [2, 3]. Some research aims to develop technical tools to improve Language for Specific Purposes courses. As an illustration, a French national platform named "Check Your Smile" aggregates various types of gameplays for each of which games are generated, based on the content of a collaboratively-constructed/user-generated multilingual dictionary [4].

In this paper, we present a tool set that has been developed to allow students to learn technical vocabulary and memorize terms that can be reused in training. The "Train yOur Technical English for Mechanical engineering" (TOTEM) project, which will be presented in this article, was fully financed by the University of Toulouse1 . The committee is composed of researchers from different laboratories: a mechanical engineering laboratory (ICA), an educational science laboratory (EFTS), a computer science laboratory (IRIT), and an applied linguistics laboratory (LAIRDIL). This project is composed of 2 main tools. The first one is a free online collaborative dictionary, with technical tags to describe the mechanical engineering terms named "The Little Ingenius". The second one is a set of mini-games including interactivity, sounds, pictures and text to train students on technical English vocabulary.

This work presents the first exploratory study which was carried out in France. In the near future, a second experiment will be conducted in other educational institutions in two countries (France and Spain). This experiment was conducted with a small group of French students. Traditionally, the digital training mini-games were first assessed by measuring their utilisability and their user-friendly design level. Secondly, we tested a research methodology that allows assessing whether students improve or not their technical language skills. The method applied is one of the most practical ways of collecting data: social and interactive surveys were provided to the students to assess their knowledge in terms of technical vocabulary. The training session was audio and video recorded in the classroom.

The feedback from its use in situ highlights the students' practices, their attitudes and their point of view. The main advantage of using interactive and social survey is that the students express their opinion immediately and they can compare their educational score to each other in real time using the audience response system. The second advantage of the experimental method is that it also allows us to compare the response-time to the global students' score.

2. TOTEM presentation

The technical vocabulary used both in the mini-games and the online collaborative dictionary of technical mechanical engineering terms focuses on the 4 main fields of machining: tools, tool holders, NC machine tools and machining operations... The "Little Ingenius" (see Fig. 1) has been designed to allow students to easily access the technical terms they use in their training. Compared to the available online dictionaries, it provides 2 main advantages: images to reinforce the users in their choice, and the possibility for the expert teacher to add or describe a new term if necessary.

Several games have been developed to allow a more playful learning. The objective is to allow each student to progress gradually. The set of mini-games allows the student to associate a term with an image and its pronunciation. As an illustration, the screen (see Fig. 2) shows how mechanical engineering technical vocabulary is embedded in an anagram-like mini-game.

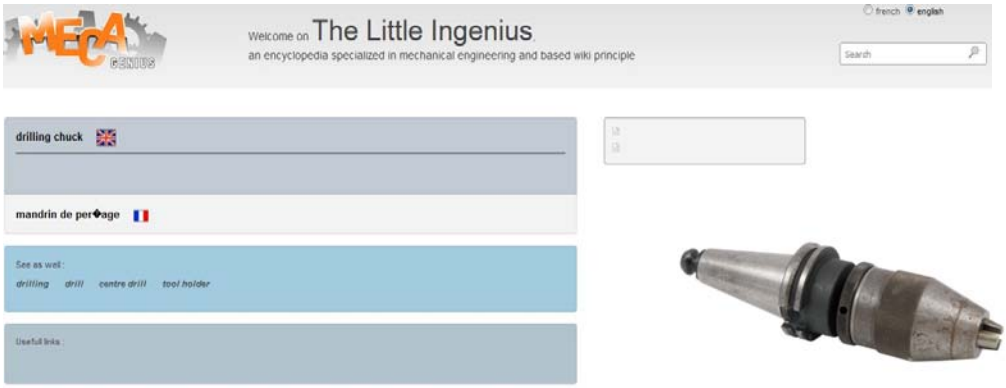

Fig. 1: “The little Ingenius”: an online collaborative dictionary of technical mechanical engineering terms.

This mini-game (Fig. 2) was designed to be used in a learning context. At the beginning, an item is selected randomly among a large library of items and appears on the screen. A set of elements composes the item’s characteristics: picture, name and pronunciation (sound) of the item. The user needs to match the item with its name thanks to a set of predefined letters. In order to help them, users can hear as often as necessary the name of the item. It aims to help the memorization of technical terms.

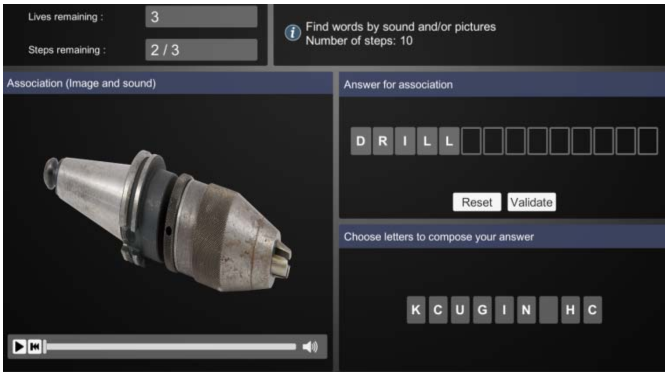

Fig. 2. “Machine tool accessory” mini-game.

3. Experimental protocol

In this exploratory study, we used an anagram-like mini-game template and focused on the technical terms used for machining operations and machine tool equipment. In this mini-game template (see fig. 1), the student must associate a term with an image and its pronunciation.

The set of anagram-like mini-games is broken into 8 mini-games for French students and 8 mini-games for Spanish students. Each mini-game uses the same template; however each one uses a particular library of items. As an illustration, some mini-games propose to write the English machine tools equipment name giving the French (or Spanish) name of the item. Other mini-games offer to write in English the machining operation name providing the English pronunciation of the name of the item. Some mini-games randomly pick the items in a small library (for example 4 items). Others randomly pick the items in a larger one (for example 10 items).

The objective of this study is to validate the experimental protocol that will be used in a larger experiment.

Table 1. Origins of the student population.

	L3 Champollion University - France	
	Number of students who have knowledge in Mechanical Engineering	
Last completed degree	YES	NO
"BTS", eq. To a two-year undergraduate diploma in Mechanical Engineering	3	0
"BTS CPI", eq. To a two-year undergraduate diploma in Electrical Engineering	0	3
"BTS ET", eq. To a two-year undergraduate diploma in Wood Engineering	0	1
DUT, eq. To a two-year undergraduate diploma in Physical Measures	0	1
Other diplomas	0	1
	33%	66%

Table 2. Composition of the students by age and genre.

Boys	6
Girls	3
Mean Age	21,88
Max	25
Min	20

The experiment took place during a learning session with nine students and their teacher in the University of Toulouse. The students were in their third year of Bsc (L3).

In this experiment, the students were in the same classroom as their teacher and used a mini-game during a practical work session for thirty minutes. The average age of students is 21.88 years. –.

Table 1 and Table 2 provide the composition of the group of students who took part in the experiment.

All the students already had a technical training. However, only 33% of students had had a prior course in Mechanical Engineering, and 66% had taken another prior disciplinary course. This group was selected especially for this experiment according to its considerable heterogeneity and its very program. There is a high disparity between students' knowledge due to their different origins ("DUT MP", eq. to a two-year undergraduate diploma in Physical Measurement, "BTS", eq. to a two-year undergraduate diploma in design of industrial products, etc.).

We would now like to turn to the description of the training session itself. Firstly, the teacher introduced the mini-game explaining the playful component and the educational objective. Secondly, students played the mini-game during 30 minutes. Each one played alone on their own computer. They were free to interact although they had a headset to listen to the pronunciation of the items. Thirdly, they had to answer an interactive and social survey using the electronic remote control. The students individually used a remote control to respond a series of questions projected via a multimedia support. The questions were asked during a limited time. In order to identify the students and their answers, the voting system provided personal codes to the students. Then, in order to quantify the vocabulary they had learnt using the mini-game, the students answered a Multiple Choice Test Questions before and after the game session.

Following Leutenegger[5], we decided to analyze two students' answers, contrasted by their position of excellence in the classroom. As a result, we studied the answers of two students: Student 1 who is considered as a good student by his/her teacher and Student 2 who has difficulties in Mechanical Engineering. The analysis of these two students' votes should help to better understand the learning progress.

In brief, the purpose of this research was to collect both qualitative and quantitative data to understand how students use a mini-game designed to learn technical English vocabulary.

The main objectives of this experiment are to:

- Validate the pedagogical relevance of the tool
- Evaluate students' interest in this innovative teaching method.

4. Results

Previous work has shown the possibilities of learning games to facilitate learning [6, 7]. The implementation of these new tools should therefore provide an additional motivation with the introduction of playful aspects, and help the player to match a term, an image and a pronunciation.

Ongoing experiments will quantify both the learning dynamics and student engagement.

4.1. Experiment feedback

In this part, we analyze the data collected from the experiment described in the previous section. At the end, the students were asked to give their opinion on the pedagogical test they had experienced. The subjects covered in these questionnaires were related to the usability of the mini-game, and their feelings. The students were free to give their point of view. Following these interviews, we gathered the verbalized data and then analyzed the terms the most frequently used by the students. Thus, the three most frequently used expressions are (in decreasing order of citation): "I learn faster", "easier and more interesting", "effective learning". We can also quote two sentences given by these same persons:

- "I learned vocabulary".
- "I liked this kind of playful learning". We note here the interest of students for this new mode of learning, and their attraction for novelty [8].

First, the main advantage showed by the experimental sessions with the students is the feeling of satisfaction. For both groups of students, there is a clear appeal for this learning system (Fig. 3).

Fig. 3. The student on the left has just won a game.

Fig. 4 below shows, among the 9 subjects, the proportion of those who enjoyed TOTEM and those who did not. The two particular students (the “strong” one, Student 1, and “the weak one”, Student 2, both enjoyed the mini-games. It is noteworthy that nearly 80% of the students appreciated this learning medium very positively, which confirms the interest generated by this learning game among our students.

The students wrote, however, that they would have liked to test several games and proposed to insert other parameters to increase the attractiveness of the game as: a timer, a limit to the number of times you can listen to the

English term, a ranking system... These remarks are relevant, but these parameters were not part of the exploratory study.

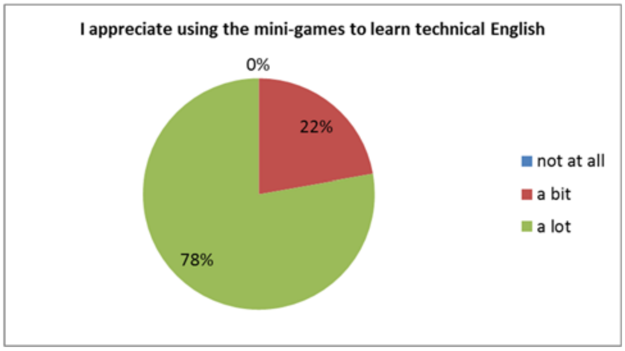

Fig. 4. Proportion of students who enjoyed using TOTEM.

The data we studied in the following sections includes:

- The time students need to answer to the questions during the interactive educational quiz,
- The success rate per exercise (individual and collective),
- Information on the paths of student 1 and student 2.

4.2. Analysis of the success rate per student

A multiple choice quiz was conducted to test students' acquisition of knowledge. These questions were written by the teacher, according to the expected competencies.

Table 3. Result of the questionnaires before and after the game.

	Results before using the mini-games	Results after using the mini-games	Mean	Ranking	
Student 1	10,91	20,00	15,5	5	↗
Student 2	14,55	16,36	15,5	3	↗
Student 3	7,27	20,00	13,6	7	↗
Student 4	7,27	20,00	13,6	7	↗
Student 5	14,55	16,36	15,5	3	↗
Student 6	14,55	18,18	16,4	1	↗
Student 7	10,91	20,00	15,5	5	↗
Student 8	12,73	12,73	12,7	9	→
Student 9	12,73	20,00	16,4	1	↗
Mean	11,7	18,2	14,9		↗
Max	14,5	20,0	16,4		
Min	7,3	12,7	12,7		
Standard deviation	2,7	2,4	1,2		

Table 3 shows students' results on a technical English vocabulary quiz. The first column gives the average score (out of 20) obtained before using the game, the second column the one obtained after using the game.

Before using the game, the average score for the 9 subjects was 11.7 / 20 (Min = 7.3 / 20, Max = 14.5 / 20), with a standard deviation of 2.7. After using the game, all the students improved their score. The average score of the class increased by 6.5 points, the standard deviation decreased from 2.7 to 2.4. It should also be noted that the min and max scores increased by 7 points. Student 1 increased by 9 points, student 2 increased by 2 points. These results demonstrate that the transmission of knowledge has been correctly performed by the mini-games regardless of the students' original training and whatever their starting level. But above all, they show that this tool is well adapted to each student of the sample.

4.3. Analysis of the success rate per exercise

Table 4. Result obtained by technical terms.

	Correct answers		Average response time, post (sec)
	Ante	Post	
3 - Drilling chuck	22,00%	100,00%	5,16
1 - Radial VDI	33,00%	88,89%	4,65
2 - Axial VDI	33,00%	88,89%	4,34
4 - Pocketing	89,00%	100,00%	3,39
3 - Drilling	100,00%	88,89%	4,35
1 - Tapping	22,00%	88,89%	5,25
2 - Threading	22,00%	88,89%	4,38
2 - Slotting	67,00%	77,78%	4,71
2 - spotting	67,00%	77,78%	3,40
2 - Facing	100,00%	100,00%	4,48
1 - Screw	100,00%	100,00%	2,08

Table 4 shows that the transmission of technical terms of mechanical engineering was made even for students in Wood and Electrical engineering (for example Drilling and Tapping). But the knowledge transfer is weaker when the meaning of the native terms is not understood by the students (Slotting and spotting). The experiment shows that the mini-games do not allow to make the students understand the meaning of native mechanical engineering terms. However it helps them to learn English technical vocabulary when they know and understand the meaning of these terms in their native language.

4.4. Response time analysis

An extraction of the response times was performed and analyzed to determine whether students responded spontaneously or not.

Table 5 shows that the reflection time varies according to the difficulty of the questions for all the students. The difference between the shortest and longest response time is on average more than 8.25 seconds. This difference can be up to 9 times the shortest time, even though it is not possible at this stage to link the reflection time with the student’s score.

Table 5. Student response time

	Mean	Min	Max	MAX-MIN	(MAX-MIN)/MIN	Mark obtained after the game session
Student 1	2,47	0,98	6	5,02	5,12	20,00
Student 2	4,52	2,1	9,34	7,24	3,45	16,36
Student 3	5,58	1,94	13,16	11,22	5,78	20,00
Student 4	3,68	2,12	9,9	7,78	3,67	20,00
Student 5	3,94	1,64	8,56	6,92	4,22	16,36
Student 6	6,15	2,24	14,88	12,64	5,64	18,18
Student 7	3,95	1,94	9,42	7,48	3,86	20,00
Student 8	4,94	2,5	9,12	6,62	2,65	12,73
Student 9	2,55	1,06	10,4	9,34	8,81	20,00
				8,25		

5. Conclusion and future work

The first aim of this exploratory research was make students experiment a set of mini-games designed to teach technical English vocabulary in Mechanical Engineering.

The second goal was to settle down a method to quantify the knowledge transfer using a set of digital mini-games and to assess the relevance of these mini-games.

Our Experiment shows that students are interested in these learning innovative tools. Moreover, the analysis of the results suggests a progression of the class as a whole and not only a progression for some students. Thus, this first study encourages us to extend this experiment to the students of Université Paul Sabatier – Toulouse (France), INSA-Toulouse (France) and Universitat Politècnica de Catalunya – Barcelona (Spain) in the following months. The cooperation between the research teams from these two countries will strengthen its innovative dimension for teaching English technical vocabulary to non-native students. Future work is likely to include collaboration with additional countries.

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