WordBricks: Mobile Language Learning Microworld

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We created WordBricks, a tool for learning natural language grammar. WordBricks was evaluated in a classroom to prove its pedagogical value. Our experiments show that WordBricks indeed help the students to acquire learning materials more efficiently, and obtain higher scores during grammar tests.

We have designed and implemented WordBricks - an innovative mobile instrument for practising natural language grammar. The design of the current WordBricks version is heavily inspired by Scratch programming system. WordBricks has been evaluated in a real classroom setting in order to collect user opinions on its usability and prove its pedagogical value. Our experiments show that the students generally like the appearance and interface of WordBricks. Furthermore, WordBricks indeed help the students to acquire learning materials more efficiently, and as a result, obtain higher scores during post-study grammar tests.

natural language processing

NLP CALL

１．研究開始当初の背景

The use of computing technology is widespread in language education. However, in actual practice teachers and learners typically rely on general-purpose services, such as electronic dictionaries or video sharing websites rather than specialized language learning instruments. We believe that natural language processing technologies are not mature enough to meet the needs of nontrivial educational scenarios, and suggest following a 'technology-driven approach': instead of relying on immature technologies in traditional learning activities, we propose to design the activities on the basis on available technologies. We implemented this idea in the WordBricks system. WordBricks is a step towards 'virtual lab' in language learning, allowing the users both solving predefined exercises and experimenting independently with language constructions, thus exploring the rules of natural language.

２．研究の目的

The purpose of the research is to design, implement and evaluate WordBricks — a specialized virtual lab-like language learning environment, aimed at improving learners' grammar skills.

In brief, WordBricks lets the users to connect individual words and phrases into complex combinations, and guarantees that any pair of bricks can be connected if and only if the result is grammatically correct. Grammatical rules are implicitly encoded in the bricks shapes, so in most cases the admissibility of any brick combination is clear.

One of the most challenging goals of WordBricks is to provide a visual model of natural language that represents grammatical rules with brick colors, shapes, and connectors, thus forming an explicit model of grammar in a learner's mind. This approach arguably supports conscious learning, and helps the learner understand the basic principles of language internal structure and operation.

３．研究の方法

The project was conducted in two large phases. During the first phase, we have designed and implemented the proposed WordBricks system. This phase required a series of evolutionary redesigns as a result of our preliminary usability studies and user feedback analysis. During the second phase, we evaluated WordBricks in a real classroom environment involving English classes attendees (the students of the University of Aizu). Several aspects of WordBricks were evaluated: usability, graphical aesthetics, coherence and integrity of design, and ability to meet pedagogical goals.

The quality of design and interface was evaluated via qualitative analysis of student surveys. The ability of the system to meet pedagogical goals (i.e., to improve actual language skills of the students) was revealed by comparing performance of students who used WordBricks with performance of students who relied on traditional learning materials only.

４．研究成果

In the course of the project, the following activities have been carried out.

1) We analyzed the modern state of intelligent computer-assisted language learning (ICALL) and identified factors that prevent ICALL systems from being widely adopted. Our literature review revealed that the current situation suffers both from limitations of current natural language processing technologies, and from the limited agenda of ICALL research activities.

We compared ICALL software with educational instruments available

in natural sciences, and identified a clear trend towards "open experimentation" scenarios, enabling the users to explore the subject of study via interactive experiences (such as experiments in physics of chemistry). This is achieved via "virtual labs" that exhibit greater flexibility than typical multimedia textbooks [C2, J5].

The current design of WordBricks was heavily influenced by these findings, and the design of Scratch, a virtual lab-like environment for studying programming.

These ideas were further extended in the work [J1], introducing a metamodel that can be used to define learning models of language grammar structures in order to support teacher/student interaction.

2) We experimented with several approaches to convert sentence parse trees into convenient and natural-looking "bricks", and refined the interface of WordBricks in a series of experiments and user surveys. The evolution of the system is shown on the figures below.
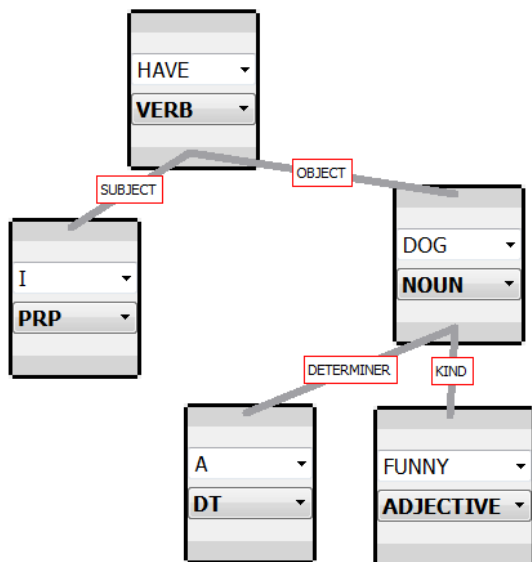
WordBricks: initial prototype (desktop)
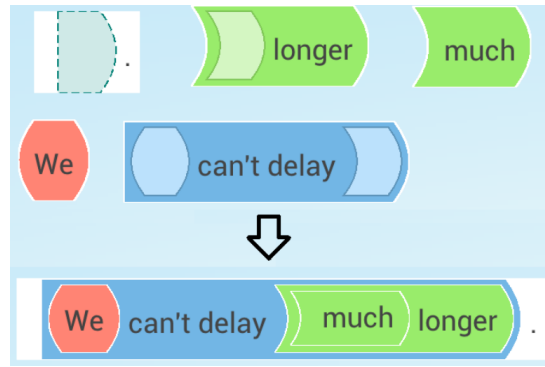
WordBricks: current version (mobile)

Usability surveys showed that the users liked the overall design of the system and there are no significant objections against the present interface decisions [C1].

3) The mobile version of WordBricks underwent a preliminary evaluation in a real classroom setting at the University of Aizu [C1].

Two groups were randomly assigned from the same class: a control (non-WordBricks) group, and an experimental (WordBricks) group. All participants studied grammar materials from the same English textbook with the same teacher over the four-month period. Both groups studied the same content and underwent the same grammar assessment procedures, the control group was taught in a traditional way, while the experimental group interacted with WordBricks using an Android-based tablet PC.

In the experiment, WordBricks was loaded with a number of predesigned exercises, based on the respective paragraphs of the textbook. In order to measure the impact of WordBricks, the pre- and post-test were executed before and after each lesson.

The results indicate that the WordBricks group scored relatively higher than the control group in the two tests (see the table below).

Unit	Test	Group	Avg score
Ch 69	Pre-test	WB	15.90
		Control	15.18
	Post-test	WB	24.20
		Control	21.00
Ch 70	Pre-test	WB	4.20
		Control	6.00
	Post-test	WB	11.60
		Control	9.18

Our findings support the positive correlation between using WordBricks and English grammar performance. However, we must note that the current experiments were conducted in small-size groups (20-25 participants) and with limited learning materials. We are working on larger-scale experiments.

4) We have extended our international cooperation network via project-related activities (development and evaluation of WordBricks).

One of the challenges of the present project is to organize a proper evaluation of the resulting system, which will prove its pedagogical value. Such evaluation is impossible without partnerships in external educational institutions. The list of institutions agreed to evaluate WordBricks include University of Eastern Finland, Dublin City University (Ireland), and Northern Federal University (Russia). The experiments are scheduled to be conducted during 2016.

5) One of the ongoing research activities is to automate the creation of bricks for WordBricks. This is done by means of a variety of natural language processing (NLP) methods. Experiments with these methods in WordBricks significantly helped us in adjacent research directions, related to emotion analysis [J2, J3], and language semantics analysis [C3].

５．主な発表論文等（研究代表者、研究分担者及び連携研究者には下線）

〔雑誌論文〕（計　５件）

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〔図書〕（計　2　件）

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