EFFECTS OF STUDENTS' PARTICIPATION IN AUTHORING OF MULTIMEDIA MATERIALS ON STUDENT ACQUISITION OF VOCABULARY

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ABSTRACT

This study investigated the effects on vocabulary acquisition of student participation in authoring a multimedia instructional module. Sixty-two subjects were randomly assigned to two groups, and each group was randomly assigned to one of two treatments. The control subjects were asked to study a French text downloaded from the Internet and presented on a computer. In the text, 20 relatively low-frequency words were annotated with text, sound, and pictures. The experimental subjects had the same text but without annotations. They were asked to participate in creating annotations for the same 20 target words.

The study produced evidence that students learn vocabulary significantly better when they participate in the creation of the instructional module, provided time is not considered. However, when the variable of time on task is taken into account, there is no statistically significant difference between the experimental and the control treatments. In addition, annotations containing text, sound, and pictures were found to be more helpful for vocabulary learning than annotations with sound and text only. The results are discussed in light of theories of vocabulary acquisition and active student involvement in the learning process. Practical applications and ideas for further research are suggested.

INTRODUCTION

In recent years the development of computer-assisted language learning (CALL) has created the need and opportunity for investigating the effects of multimedia on vocabulary acquisition. Thus far, numerous studies (Al-Seghayer, 2001; Aust, Kelley, & Roby, 1993; Brett, 1998; Chun & Plass, 1996; Davis & Lyman-Hager, 1997; Duquette, Renie, & Laurier, 1998; Groot, 2000; Hulstijn, 2000; Laufer & Hill, 2000; Lyman-Hager & Davis, 1996; Lyman-Hager, Davis, Burnett, & Chennault, 1993; Plass, Chun, Mayer, & Leutner, 1998; Siribodhi, 1995) have shown that computerized media and a multimedia environment can be helpful for learning foreign language vocabulary. In these studies, however, the materials used for foreign language teaching were commercially available or teacher-produced. No studies have investigated how the student authoring of computer-based materials for foreign language learning affects student acquisition of vocabulary. The idea of cognitive and affective benefits from authoring of learning materials in a conventional or computerized environment has been the topic of numerous studies (Arnett, 1995; Bowman & Plaisir, 1996; Brown, 1993; Kramsch, A'Ness, & Lam, 2000; Kubota, 1999; Marchionini, 1988; Meek, 1990; Milone, 1995; Renzulli, 1977; Turner & Dipinto, 1992). The encouraging results of these studies have prompted the work described in this article.

The present study reports data from an investigation of the effects of student participation in authoring of multimedia materials, based on authentic French texts downloaded from the Internet, on student vocabulary acquisition. This investigation sought to determine whether acquisition of foreign language vocabulary was higher for students who helped author the materials compared to students who simply

utilized teacher-created multimedia materials based on the same texts. A comparison was made between the scores of the two groups with and without time on task taken into account.

REVIEW OF RELATED LITERATURE

Creativity and Authoring of Multimedia Materials

One of the major contemporary learning theories -- the constructivist learning theory -- considers authentic creative experiences the main vehicle of the learning process (Bednar, Cunningham, Duffy, & Perry, 1992; Zahorik, 1995). It is the basis of numerous successful teaching models and approaches such as the Foxfire project, Renzulli's Enrichment Triad, and Hungerford's Investigation and Evaluation of Environmental Issues and Actions model (IEEIA, 1993). Studies that have evaluated these models credit their success to the active involvement of the learner in the learning process, the authentic context, the real-life problems that learners have to solve, and the creation of genuinely marketable products.

Similar characteristics underlie successful student authoring of multimedia materials. Data from studies on student authoring (Arnett, 1995; Bowman & Plaisir, 1996; Brown, 1993; Kramsch et al., 2000; Kubota, 1999; Milone, 1995; Turner & Dipinto, 1992) indicate that the process of creating learning materials is beneficial with respect to student motivation and attitude toward both the learning process and the subject matter. Even though the degree of creative involvement of the students in these projects varied, all of them showed evidence that students worked on their tasks with greater motivation.

Most studies reporting results from any type of creativity-based approaches to instruction, including student authoring of multimedia materials for learning, are primarily concerned with the affective aspects of the impact these approaches have on the students (exception Brown, 1993). Three of the studies (Arnett, 1995; Kramsch et al., 2000; Kubota, 1999) reviewed an authoring experience for students in CALL. However, these studies were based on a qualitative design. The present investigation, therefore, was undertaken in an attempt to acquire for the first time quantitative data from student participation in the authoring of foreign language multimedia materials.

L2 Vocabulary Acquisition

The importance of vocabulary for overall foreign language acquisition is the basis of a multitude of vocabulary acquisition studie s. Interesting for the present research are above all the studies concerned with reading and reading-related tasks, as well as studies focusing on the role of context, dictionaries, student involvement, and multimedia annotations in vocabulary acquisition.

Foreign language vocabulary is viewed as a primordial factor in successful communication (Levelt, 1989) and, to a great extent, in high-level reading ability and comprehension (Anderson & Freebody, 1981; Markham, 1989; Segalowitz, Watson, & Segalowitz, 1995). Furthermore, reading itself is frequently singled out as the most important vocabulary-building activity both for the first language (L1) and the second language (L2). The impact of reading on vocabulary acquisition outweighs by far the impact of aural language because of the relatively simple lexicon used in the spoken language (Krashen, 1989, p. 455). A large number of the studies in SLA (e.g., Horst, Cobb, & Meara, 1998; Knight, 1994; Krashen, 1989; Nagy, Herman, & Anderson, 1985; Nation & Coady, 1988) examine the role of context in vocabulary acquisition which takes place through reading or reading-associated tasks. Context plays a primordial role in this acquisition by supplying the necessary input. In many cases, vocabulary acquisition while reading occurs in an incidental way and is largely due to the learners' guesses (Krashen, 1989). However, numerous articles concerned with the controversy between guessing from context and the use of a dictionary or glosses (marginal or computerized) in L2 acquisition provide data in favor of dictionary/ gloss use in addition to vocabulary embedded in a natural context (Al-Seghayer, 2001; Groot, 2000; Hulstijn, 2000; Hulstijn, Hollander, and Greidanaus, 1996; Knight,1994; Krantz, 1991; Lomicka, 1998; Luppesku & Day, 1993; Lyman-Hager et al., 1993; Lyman-Hager & Davis, 1996; Summers, 1988).

Dictionaries are particularly helpful for rarely occurring, low-frequency words and for cases where the subjects do not have enough background for correct guesses. Moreover, even a correct guess, does not necessarily lead to acquisition (Mondria and Wit-de Boer, 1991). This conclusion can be explained by assuming that learners who guess words correctly either do not pay sufficient attention to the link between form and meaning in the learning stage or else thinking they know the words well, they do not study them.

A plausible explanation of the phenomena related in the present study is Channell's (1988) theory about the active role of the learner in the process of vocabulary acquisition. Unlike Krashen (1989), who sees acquisition (incidental learning) and learning (intentional learning) in opposition, Channell considers them to be a dynamic aspect -- process (learning) -- and a static aspect -- product (acquisition) -- of one and the same phenomenon. In her work she comes to several conclusions related to practical teaching issues. The most important one for this paper is the active role of the L2 learner. "Learners should be encouraged to make their own lexical associations when they are actively learning new vocabulary. (However, at present we do not know which kind of associations are the most useful in aiding retention)" (p. 94). The associations created by the learner between form and meaning while attending to the unknown lexical items either during attempts to guess, or checks of meaning in reference sources (marginal glosses or dictionary) lead to successful L2 vocabulary acquisition. Checking a guessed meaning in a dictionary brings positive reinforcement and also allows for a longer manipulation of the form and the correct meaning of the word, which most likely leads to the associations mentioned by Channell.

In line with Channell's ideas about the active role of the learner in vocabulary acquisition are a number of studies concerned with the noticing hypothesis (Fotos, 1993; Robinson, 1995; Schmidt, 1990). According to these studies, consciousness-raising strategies, through formal instruction or through performance of different tasks, promote the amount of noticing of a particular form, which in turn is an important step toward the acquisition of this form. These conclusions, made mainly with regard to grammar rules, are claimed valid also for second language vocabulary acquisition by Laufer and Hill (2000). These authors go on to suggest that "additional elaboration strategies will be necessary on the part of the learner before a memory trace for the noticed word is created" (p. 59).

The present study is concerned with vocabulary acquisition in a multimedia environment. Several fundamental research questions have been investigated regarding this issue. They include the effectiveness of annotations or glosses via different media for vocabulary acquisition, the attitude of students toward paper versus computer dictionaries/glosses, the gloss density in a text, the richness of glosses (the extent and type of information included in them), and the student look-up preferences. (Al-Seghayer, 2001; Aust et al., 1993; Chun & Plass, 1996; Davis & Lyman-Hager, 1997; Groot, 2000; Hulstijn, 2000; Kost, Foss, & Lenzini, 1999; Laufer & Hill, 2000; Lomicka, 1998; Lyman-Hager et al., 1993; Lyman-Hager & Davis, 1996; Nagata, 1999; Plass et al., 1998; Roby, 1999; Siribodhi, 1995).

Annotations that have been studied extensively include text, sound, pictures, and video. Even though research does not provide evidence as to a decisive advantage of one type of annotation over another, there are some data referring to a positive impact of image-based annotations on L2 vocabulary acquisition (Al-Seghayer, 2001; Chun & Plass, 1996; Kost et al., 1999; Plass et al., 1998; Siribodhi, 1995).

In general, the computerized format is preferred by students over the paper format for dictionaries and glosses and appears to be a more efficient way of vocabulary learning (Aust et al., 1993; Roby, 1999). Student look-up behavior is under close scrutiny in recent studies which show that the variety of learner look-up preferences should be matched by a variety of media presentations and types of information included in the computerized annotations (Laufer & Hill, 2000; Lomicka, 1998; Lyman-Hager & Davis, 1996; Plass et al., 1998).

Nagata (1999) suggests that interactive computerized glosses enhance second language vocabulary acquisition.

Context is another important issue in second language vocabulary acquisition. Not only does it supply the necessary input; but if carefully chosen, it can also offer additional affective benefits. Many studies have pointed out the beneficial effects of an Internet environment for language learners (Copen, 1995; Kost, 1999; Kramsch et al., 2000; Li & Hart, 1996; McCarty, 1995; Oliva & Pollastrini, 1995; Peterson, 1997; Silva, Meagher, Valenzuela, & Crenshaw, 1996). Even though these studies are mostly concerned with communicative tasks, the authenticity of an Internet-mediated context plays a positive motivational role also for texts downloaded from the net.

In summary, numerous research projects have been conducted in different subject matters in which the subjects were given the opportunity to create a finished product (computer-based or other) whose users were other students or the general public. The results of such projects usually showed high positive affective impact on the students as well as some cognitive benefits. There are, however, few quantitative data, particularly on the cognitive outcomes of these projects. In addition, only one such project (Brown, 1993) compared quantitatively the achievements of students working in a creative condition with the achievements of a control group.

Projects whose aim is production of computer-based learning materials are practically non-existent in CALL (exceptions Arnett, 1995; Kramsch et al., 2000; Kubota, 1999). Research has shown that second language vocabulary acquisition is enhanced if the verbal information is accompanied by pictorial information and if the learners are encouraged to manipulate the form of the unknown word in order to create their own associations between form and meaning. L2 vocabulary learning also improves through reading if the L2 words are presented in authentic contexts relevant to the learner.

One way of providing the learners with authentic and varied contexts is tapping the resources of the Internet. One way of encouraging the learners to manipulate the form of the unknown lexical items in order to create a link between form and meaning is asking them to prepare their own multimedia materials for vocabulary learning/teaching based on texts downloaded from the Internet. In addition, involvement in creating an authentic product has been shown to increase the level of motivation and enthusiasm and has been found conducive to enhancing content knowledge. The design of the present study was conceptualized with the purpose of combining the above-mentioned factors.

Hypotheses

The purpose of the study described in this paper was a comparison between two groups of students working with authentic French texts from the Internet in the framework of a multimedia environment. The experimental subjects had to participate in the creation of multimedia learning materials based on the French texts mentioned above, while the control subjects were asked to study a multimedia module created by the researcher on the basis of the same texts. The two types of treatment -- control (reading) and experimental (authoring) -- were the independent variables in the study. The dependent variable was acquisition of vocabulary (with and without time on task taken into account).

The hypotheses, which the study sought to test, are stated as follows:

1. If time on task is disregarded, acquisition of L2 words presented in a text via a multimedia instructional module is better when the students help create the instructional module rather than when they study the text containing the target words annotated with multimedia annotations by a teacher.
2. If time on task is taken into account as an additional variable, acquisition of L2 words presented in a text via a multimedia instructional module is better when the students help create the instructional module rather than when they study the text containing the target words annotated with multimedia annotations by a teacher.

The above-formulated hypotheses were based on results from studies discussed earlier (Channell, 1988, Fotos, 1993, Laufer & Hill, 2000; Robinson, 1995, Schmidt, 1990). Given that the experimental subjects had an ample opportunity to manipulate the target words and thus create a strong link between form and meaning, it was believed that they would retain the new vocabulary items better than the control group. This belief was expressed in the first hypothesis.

It was clear, however, from a common sense point of view as well as from the results of a pilot study, that the experimental subjects were going to spend more time on their tasks. There weren't any previous quantitative studies in this field to help the researcher make a prediction as to the impact of time as a additional variable. A pilot study also failed to give enough data to allow clarification of this issue. It was, therefore, assumed that the performance of the experimental subjects would be sufficiently stronger in order to compensate for the longer time spent on task. This assumption was expressed in the second hypothesis.

METHODOLOGY

Design and Subjects

This study followed a "randomized control-group pretest-posttest design" (Isaac & Michael, 1995, p. 72). All subjects in the study were first randomly assigned to two groups. Each group was then assigned at random to either the control or experimental treatment.

The target population for subject recruitment was all students from the second semester, first-year French class at a large research university in the Midwest. The sample of subjects participating in the study was formed by all the students who volunteered to take part. Out of a target population of 69 students, 62 participated in the study, thus forming one experimental and one control group of 31 each. All students were native speakers of English.

Materials

Lesson content (Appendix A) Eight two-line French jokes in the form of riddles were directly downloaded from the Internet (in 1997 from http://www.rigoler.com/). These riddles constituted the text, which was used as lesson content. There were several reasons for choosing the jokes as content. (a) They formed a unified, well-defined authentic context--the context of automobiles as viewed and used by native French speakers. The unity of context was thought to facilitate the subjects' learning. (b) Expert opinion (a panel of three French teachers in the Foreign Language Department) judged the jokes easy to understand for the subjects participating in the experiment except for 20 low-frequency words mostly related to automobiles (Appendix A). (c) Expert opinion judged these 20 words as appropriate target words to test vocabulary acquisition because they were most likely unfamiliar to the subjects (even though these words were not included in the vocabulary lists of the lessons these students had covered, a pretest was given to identify possible cases of previous knowledge). (d) Seventy percent of the target words (14 out of 20) could be annotated with pictures. (e) Twenty target words were considered to be a reasonable and frequently encountered number of unfamiliar lexical items for one instructional module in a college-level foreign language class.

Modern Language Aptitude Test (MLAT) In order to control the subjects' aptitude for language learning as a possible confounding variable, the students were asked to take the Modern Language Aptitude Test (Carrol & Sapon, 1959), a standardized test aimed at measuring aptitude for learning foreign languages. The results from this test were included in the analysis of the data concerning subjects' acquisition and retention of vocabulary. The MLAT is usually administered in two versions--full and short. Since the short version contains all sections relevant to vocabulary learning, it was the version selected for the current research.

Pretest/Posttest The pretest (Appendix B) consisted of the 20 target words and 10 distractors, randomly arranged. The students were asked to translate all the words from French into English. The distractors were used to limit possible carry-over effects of the pretest. The posttest was the same as the pretest as far as the lexical items were concerned and was administered twice: the first time immediately after the experiment and the second time 1 month after the experiment. Each time the posttest was given, the words in it were rearranged randomly.

SmarTText*[1] *Software SmarTText was chosen as the tool for annotating the text. This software package had been used successfully as teaching tool by faculty in the Department of Foreign Languages and Literatures prior to the experiment. The faculty's impression was that the software was user-friendly and students had a positive response to its usage.

French-English Dictionaries Copies of the relevant pages of a French-English dictionary were made available to all the students in the experimental group at the time of the experiment. The dictionary selected for use in the experiment was *The New Cassell's French Dictionary* which contains both French-English and English-French (Girard, 1970).

Target-Word Handout (see Appendix C) It was only needed for the experimental subjects. It consisted of a list of the target words and the names of the corresponding sound files (for all 20 words) and picture files (where applicable--only 14 words).

Time Log & Math Problem The start time and end time of the treatment for each participant was manually logged by the researcher. A simple math problem was given to the students after the treatment and before administration of the immediate posttest. The math problem was intended to help the students empty their short-term memory and direct their attention toward a different cognitive track.

Procedures

Orientation and Pilot The orientation and practice sessions were conducted by the researcher in the New Media Center at the university and were scheduled for regular class periods. A pilot test was run with the students from second-year French. The procedures were the same as for the experiment. However, the pilot-test subjects did not take the delayed posttest. Given the small number of participants in the pilot test (10), it was impossible to seek statistically significant differences in the variables. The most important conclusion of the pilot test was that there was a significant difference in the time on task between the groups.

Scheduling, Supervision, and Pretest A schedule with 16 time slots of 90 minutes each, spread out over 3 days was offered to the participants for sign-up. The experiment was held in the New Media Center where eight computers were reserved during the scheduled time slots. Upon arrival in the New Media Center, each subject was assigned to a computer station and was provided with a packet of materials according to his/her condition -- control or experimental.

Control Treatment The control group had to study the text in a multimedia module presented via computer. In this module the target words were "hot"; they were annotated by the researcher with text definitions (all 20 words), sound (all 20 words), and pictures (14 out of the 20 words) and appeared in boldface on the computer screen. By double-clicking on the "hot" word the subjects were able to see the text annotations (translation of the word). When a "hot" word was double-clicked in addition to the presentation of text annotations, which each word had, one or two of the icons in the right-hand column of the screen turned dark (Figure 1).
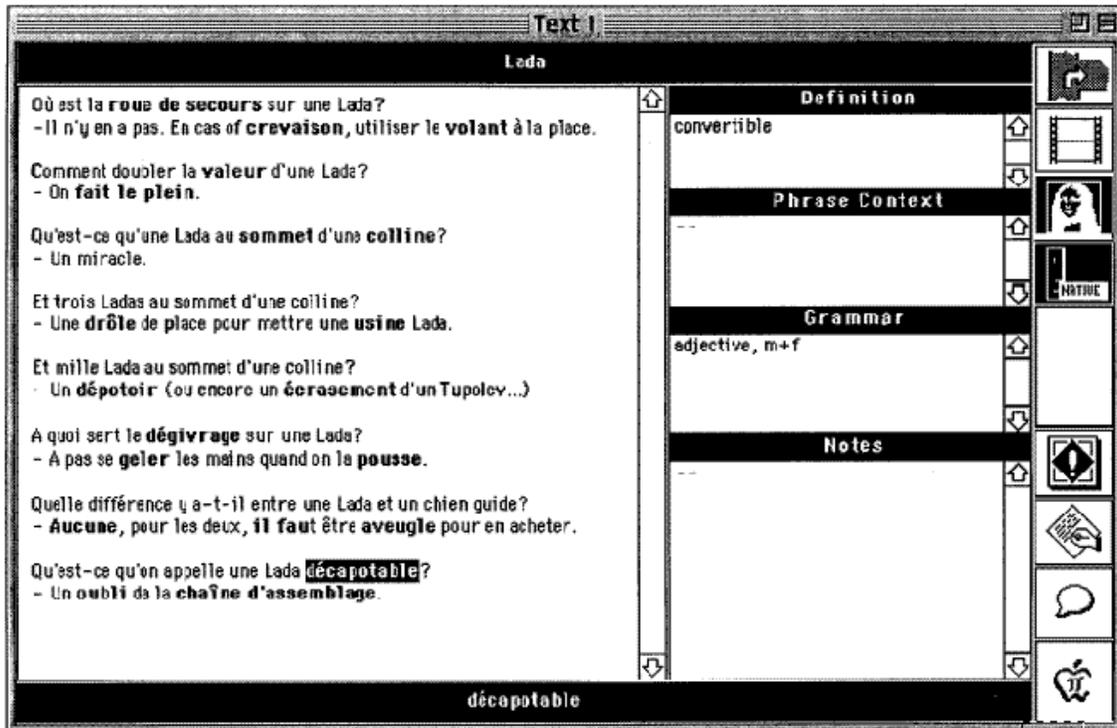
Figure 1. Computer screen with a hot word highlighted

Each dark icon indicated a link to a particular type of annotation -- sound or picture. All words had sound and text annotations, but only 14 out of the 20 words had picture annotations as well. For the word *décapotable* both the picture icon and the sound icon are dark. The word has, therefore, both picture and sound annotations. By double-clicking on the picture icon the students could see the picture annotation of the word. By double-clicking on the sound icon the students could hear a native speaker pronounce the word (Figure 2).
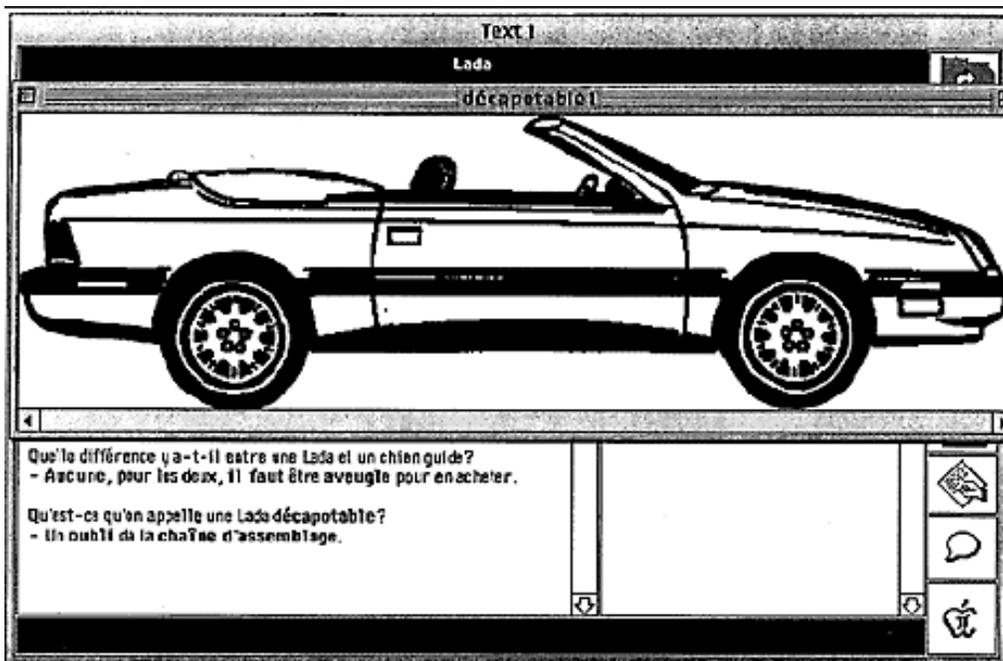

Figure 2. Picture annotation for the word *décapotable*

The students of the control group were allowed to spend as much time as they desired studying the text and using the annotations. They were instructed to ask for help if they needed any. Only two students asked questions pertaining to the context in which the target words were presented.

Experimental Treatment The experimental group had the same text as the control group. The text was presented via the same computer template, SmarTText. However, in the experimental setting, the target words in the module were not "hot"; they were not linked yet to their corresponding annotations. The experimental subjects had to link the target words with sound and picture files previously input in the computer by the researcher. For this purpose, they used the author mode of the SmarTText software. In addition, they had to write text annotations after looking up the meaning of the target words in a French-English dictionary and link these annotations to the target words.

Both the experimental and control subjects were encouraged to ask for help if needed. There were quite a few questions asked in the experimental group. Most of the questions were related to the context in which the target words were presented, but there were also questions pertaining to the software. All subjects worked with headphones throughout the entire experiment. Therefore, the questions asked and the answers given could be heard only by the researcher and the individual who asked the particular question.

At the end of the experiment, each experimental subject had to signal the researcher and his/her time out was logged in. In addition, the researcher examined the module produced by the subject. Despite several minor problems with the software, which required help from the researcher, all experimental subjects finished their modules and created correct hyperlinks for the annotations of the target words.

Posttests (Immediate and Delayed) After finishing the treatment, the subjects were asked to solve a simple math problem and were then given the immediate posttest. One month later, the delayed posttest was administered. It was identical to the immediate posttest with a different, random arrangement of the words. Three subjects from the control group and 3 subjects from the experimental group did not participate in the delayed posttest for various reasons (dropping the class, illness, etc.), thus reducing the experimental and control group to 28 participants each.

Testing the Hypotheses

The level of significance at which the hypotheses in the study were tested was $\alpha = .05$. The data, analyzed via the statistical package SPSS, Inc. (1996), were gathered through the following measurements (see Tables 1 and 2 below).[2]

Table 1. Descriptive Statistics for the Control Group

	n	Minimum	Maximum	*M*	*SD*
MLAT	31	24	80	50.13	13.86
Pretest	31	0	7	1.00	1.41
Immediate gain	31	2	19	13.00	3.64
Delayed gain	28	0	8	2.96	1.93
Immediate posttest	31	3	20	14.00	3.72
Delayed posttest	28	0	13	4.00	2.97
Computer proficiency	31	2	9	6.10	1.90
Time	31	12	18	14.55	1.73
Attitude	31	44	100	77.48	13.44

Table 2. Descriptive Statistics for the Experimental Group

	n	Minimum	Maximum	*M*	*SD*
MLAT	31	16	79	49.10	13.86
Pretest	31	0	2	.42	1.41
Immediate gain	31	7	20	14.94	3.64
Delayed gain	28	1	8	4.25	1.93
Immediate posttest	31	7	20	15.35	3.72
Delayed posttest	28	1	10	4.68	2.97
Computer proficiency	31	2	9	6.10	1.90
Time	31	31	54	38.29	5.63
Attitude	31	31	99	79.03	14.89

Hypothesis 1: Vocabulary Acquisition (without time on task) In order to test Hypothesis 1 (vocabulary acquisition without time on task), MANOVA was run with dependent variables the difference between the mean scores on the pretest and on the immediate and delayed posttests with covariate -- the score from the MLAT. MANOVA compared the means of the differences between pretest and immediate and delayed posttest scores for the control and the experimental groups adjusted with respect to the MLAT scores as a covariate.

Box's test of equality of covariance matrices shows that the assumption for homogeneous variances was met $F (3, 524880) = .397$, $p = .755$. The results from the MANOVA are reported in Tables 3 and 4.

Table 3. Multiple Analysis of Variance of Acquisition of Vocabulary with MLAT as Covariate

Effect	Value	*F*	Hypothesis *df*	Error *df*	*p*
GR Wilks' Lambda	.868	3.966	2.000	52.000	.025*

*$p < .05$

Wilks' lambda = .868 indicates that there is a statistically significant difference for the multivariate test. The values of $F (2,52) = 3.966$ and $p = .025$ show that there is a statistically significant difference between the two groups on the set of two dependent variables.

Table 4. Test of Between Subjects Effects for Acquisition of Vocabulary with MLAT as Covariate

Source Dependent Variable	*SS*	*df*	*MS*	*F*	*p*
GR Imm. Gain Del. Gain	49.703 23.017	1 1	49.703 23.017	4.088 5.247	.048* .026*
Error Imm. Gain Del. Gain	644.343 232.506	53 53	12.157 4.387		

*$p < .05$

The results in Table 4 for the immediate, $F (1,53) = 4.088$, $p = .048$, and for the delayed gain, $F (1,53) = 5.247$, $p = .026$, show that there is also a statistically significant difference between the groups on each of the dependent variables separately. Hypothesis 1 was, therefore, accepted. The experimental group acquired target language vocabulary as measured by the difference between the pretest and both the immediate and delayed posttests significantly better than the control group when controlled for MLAT, but not for time.

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Hypothesis #2: Vocabulary Acquisition (with control for time on task) In order to test Hypothesis #2, MANOVA was run with dependent variables the difference between the mean scores on the pretest and on the immediate and delayed posttests with covariates -- the score from the MLAT and time on task.

Box's test of equality of covariance matrices shows that the assumption for homogeneous variances was met, F (3,524880) = .397, p = .755. The results from the MANOVA are reported in Tables 5 and 6.

Table 5. Multiple Analysis of Variance of Acquisition of Vocabulary with MLAT and Time on Task as Covariates

Effect	Value	F	Hypothesis df	Error df	p
GR Wilks' Lambda	.985	.382[b]	2.000	51.000	.684

Wilks' lambda = .985 indicates that there is no statistically significant difference for the multivariate test. The values of F (2,51) = .382, p = .684 show that there is no statistically significant difference between the two groups on the set of two dependent variables.

Table 6. Test of Between Subjects Effects for Acquisition of Vocabulary with MLAT and Time on Task as Covariates

Source Dependent Variable	SS	df	MS	F	p
GR Imm. Gain	4.902	1	4.902	.396	.532
Del. Gain	23.017	1	23.017	5.247	.481
Error Imm. Gain	644.334	52	12.391		
Del. Gain	232.501	52	4.471		

The results in Table 6 for the immediate F (1,52) = .396, p = .532 and for the delayed gain F (1,52) = 504, p = .485 show that there is no statistically significant difference between the groups on either of the dependent variables separately. Hypothesis #2 was therefore rejected. When controlled for time and MLAT, there was no statistically significant difference between the vocabulary acquisition of the experimental and the control group.

In conclusion, the first hypothesis was accepted and the second rejected. If time on task was not taken into account, the experimental subjects acquired vocabulary significantly better. If time on task was considered, there was no statistically significant difference between the groups as far as their vocabulary acquisition was concerned.

A post-hoc item analysis was conducted. It aimed at clarifying the following issues: what type of words were easier for the students to recall, whether the type of annotation affected the recall of target words, and if so, how was this influence expressed.

Table 7 gives a summary of the correct answers per target word and rank-orders the target words from the ones that were most frequently recalled downwards.

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Table 7. Correct Recall of Individual Words

Type of posttest			Immediate		Delayed	
Group	Overall	C-l	Exper.	C-l	Exper.
1. une usine	78	18	28	14	18
2. une chaîne d'assemblage	77	23	26	14	14
2. le sommet	77	27	25	8	17
3. décapotable	68	26	27	5	10
4. drôle*	61	24	24	5	8
5. une colline	59	17	24	4	14
6. une roue de secours	57	26	27	2	2
7. faire le plein	54	23	26	6	2
7. un écrasement	54	20	25	2	7
7. pousser	54	21	25	6	2
8. geler*	53	21	22	4	6
9. un volant	47	17	20	6	4
10. la valeur*	46	19	22	3	2
11. le dégivrage	44	22	21	0	1
11. un dépotoir	44	16	23	1	4
12. il faut*	43	20	20	2	1
13. un oubli*	41	18	19	2	2
14. une crevaison	37	16	18	0	3
14. aveugle	37	15	20	1	1
14. aucune*	37	14	21	1	1

* only sound and text annotations for these words

Six words were found to share the first five positions in the overall category. Five of these words were concrete nouns and one *(drôle)* an adjective. Out of these six words, five were annotated with text, sound, and pictures, and one *(drôle)* with text and sound only.

Table 8 presents the number and percentages of correct answers for the control and experimental groups on both the immediate and delayed posttests. These numbers and percentages are broken down by type of annotation: with or without picture.

Table 8. Comparison of Correct Recall for Words with Different Types of Annotations

	Control group						**Experimental group**					
	Immediate			Delayed			Immediate			Delayed		
	X1	n1	%	X2	n2	%	X3	n3	%	X4	n4	%
With pictures	287	434	66%	66	392	17%	335	434	77%	99	392	25%
Without pictures	116	186	62%	17	168	10%	128	186	69%	20	168	12%

A z test of comparison of proportions was run to determine whether the differences in recall for items annotated with pictures vs. items annotated without pictures were significant within the particular groups for the different posttests (Table 9).

Table 9. Comparison of Proportions (z-test) for Words with Different Types of Annotations

Group/test	With pictures		Without pictures		z
	X1	n1	X2	n2	
C-l immediate	287	434	116	186	.90
C-l delayed	66	392	17	168	2.05*
Exp. immediate	335	434	128	186	2.20*
Exp. delayed	99	392	20	168	3.54**

*$p < .05$
**$p < .01$

In three out of four possible cases, namely within the control group for delayed posttest and within the experimental group both for delayed and immediate posttest, the recall of items annotated with pictures was significantly better than the recall of items annotated without pictures.

In conclusion, the students recalled better words annotated with pictures, sound, and text as opposed to words annotated with sound and text only. This was particularly clear in the delayed posttest.

DISCUSSION

No significant difference was found between the vocabulary acquisition of the two groups -- experimental and control -- when time on task was included in the analysis. Even though this finding rejected the second hypothesis, it was not very surprising, since inclusion of time on task emphasized the efficiency aspect of the experiment. The experimental group, which had to participate in putting together a whole module, did not surpass the efficiency of the control group, which had only to study the module. The conclusion from this is that authoring is not an efficient way of vocabulary teaching. Other aspects of this activity, however, such as effectiveness and amount of time spent on task (reasonable or not) were not explored. Answers to these questions should be considered before the overall usefulness and applicability of authoring is judged. In order to investigate the effectiveness of participation in authoring, the answers to the first research question were reviewed.

A very important aspect of the time issue in this research was whether the experimental subjects could finish their work in a reasonable amount of time. It is the researcher's contention that an average of 38.29 minutes is a reasonable amount of time for the experimental task and will not hinder application of this method in real classroom conditions.

The reason for attempting an analysis without time on task was manifold. First, as already mentioned, a longer time on task was an inherent aspect of the experimental treatment. It should not necessarily be viewed as a waste, but rather as a positive aspect of the experimental treatment, even at the risk of having the results of this treatment interpreted as a low-efficiency way of learning vocabulary. A longer time on task may be a desirable effect of a pedagogical treatment, since oftentimes it means that the subjects were motivated to stay longer on task and will eventually end up acquiring more knowledge. In the case of the current study, both groups were allowed to spend as much time as they wanted on their work. The experimental subjects were not told that they had to finish the module; on the contrary, they were informed that they may quit at any time. However, all of them remained until their modules were finished and functioning. From a pedagogical point of view, the importance of involving students in an activity that will lead them to better learning may outweigh to a great extent the relative lack of efficiency of this activity. The scores in this experiment should be compared per activity (treatment) and not per unit of time. The claim made in this paragraph would be better substantiated if the subjects had to work on longer

texts and were asked to perform this type of activity in at least several sessions. Such a treatment would have compensated for a possible novelty effect, which may have been at play in the present study.

Second, it was not clear how much time the subjects in the experimental group spent on occupations other than actually manipulating the target words and their annotations. Such other activities may have been trouble-shooting or organizing the work. It is, therefore, difficult to say to what extent it was the time that made the difference in the results of both groups. In other words the present study does not give an answer to the question: if the control group was forced to spend as much time on task as the experimental group, whose results would have been better? This question was not asked because the researcher aimed at keeping the conditions for both groups as close to real classroom conditions as possible. Forcing the control group to stay longer would not have been natural, since they were allowed to spend as much time as they thought they needed anyway. In addition, it might have not guaranteed the students' attention during the entire obligatory period of time and may have not necessarily resulted in better scores. The whole point of the experimental treatment was to allow for a naturally prolonged time on task as an inherent part of the authoring activity during which the students are engaged in a constant manipulation of the target words.

The question ultimately remains, why bother with authoring, since it proves to be time-consuming and not very efficient for vocabulary acquisition? It is the researcher's contention that an activity which results in engaging the students in putting together a final product in a reasonable amount of time and which leads to vocabulary acquisition significantly higher (even though numerically not very impressive) than vocabulary acquisition of students sitting with the intention for learning, should not be neglected. Therefore, the discussion that follows is concerned with scores and effects of vocabulary acquisition with time on task left out.

The study found that students have significantly higher rates of acquisition of L2 vocabulary if they participate in the authoring of a multimedia module than if they study one prepared by a teacher. The means of immediate vocabulary gain of the control group and the experimental group in the study were 13.00 and 14.94 words, respectively. The means of delayed vocabulary gain were 2.96 and 4.25 words, respectively. The answer to the research question concerning vocabulary acquisition is consistent with most findings reported in the review of the related literature, and more specifically with Beaton, Gruneberg, and Ellis (1995), Brown (1993), Channell (1988), Fotos (1993), Hulstijn et al. (1996), Joe (1995), Knight (1994), Krantz (1991), Krashen (1989), Laufer & Hill (2000), Mondria and Wit-de Boer (1991), Robinson (1995), Schmidt (1990), Stahl and Fairbanks (1986), and Summers (1988).

This study's findings confirmed Channell's (1988) ideas about the importance of the active role of learners during second language vocabulary acquisition. Manipulating the form of the vocabulary item and its meaning at the same time, as the experimental subjects did in the present study, is one way of encouraging creation of the above-mentioned associations. Creation of one's own lexical associations seems to be a plausible way of explaining the results of the experimental group in the study.

As Mondria and Wit-de Boer (1991) found, more attention toward the link between form and meaning leads to a better retention of the foreign word. Similar findings were reported by Beaton et al. (1995). Studies based on the noticing hypothesis (Fotos, 1993; Robinson, 1995; Schmidt, 1990) also emphasized the beneficial effects of increased attention toward and conscious awareness of the link between form and meaning. Improved attention in the present study was attained through a more active approach to L2 vocabulary acquisition, namely simultaneous manipulation of form and meaning of the target word. The subjects had to attend to the form of the word they were annotating in order to look for it in their dictionary pages. Once the word was found, an estimation of the context, in which the word occurred, of all meanings listed in the dictionary for the particular word, and finally of the possible fit of word meaning and context had to be performed in order to obtain the best match between the lexical item and its translation.

The use of a dictionary, even though shown to be beneficial for vocabulary learning by many studies (Aust et al., 1993; Hulstijn, 2000; Knight, 1994; Krantz, 1991; Krashen, 1989; Laufer & Hill, 2000; Luppesku & Day, 1993; Mondria & Wit-de Boer, 1991) is a controversial topic . One of the main problems with dictionary use (particularly a paper dictionary as it was in this study) is that it can become boring for the L2 learner and for this very reason is difficult to apply consistently. In the present study the subjects were motivated to use dictionary information in order to participate in the creation of a product for whose quality they were responsible. Their success -- the fact that all of them completed the task and finished a multimedia unit of high quality -- brings evidence that the boredom of dictionary use was somehow overcome. A speculation on the part of the researcher is that the subjects' main concern was putting together the unit. Therefore, the relatively boring dictionary consulting was perceived only as a tool in the accomplishment of a more interesting and a relatively more creative assignment. Diverting attention from a monotonous task thus succeeded in making dictionary use part of an overall more adventurous experience, which brought good results in vocabulary acquisition. It is necessary to admit, however, that the text which the students manipulated was relatively short (139 words). The claim that student participation in authoring is an effective way to counteract boredom from dictionary use would be better substantiated if experiments were conducted with longer texts and over several sessions, preferably as part of real class-work assignments.

The role of context in L2 vocabulary acquisition was another issue reported earlier (Hulstijn et al., 1996; Knight, 1994; Krantz, 1991; Krashen, 1989; Mondria & Wit-de Boer, 1991; Nation & Coady, 1988; Stahl & Fairbanks, 1986; Sternberg, 1987). Both groups in the present research studied or manipulated words embedded in the same authentic context. At first glance, this fact makes it difficult to draw conclusions from the results of the study regarding the role of contextual as opposed to definitional information for L2 vocabulary acquisition. However, the researcher observed substantial differences in the way students approached the context.

The study was designed so that both groups could take full advantage of combined contextual and definitional information with regard to the target words. The target words were presented in a natural context and were either annotated (for the control group) or a dictionary was provided (for the experimental group). Even though the context in which the target words were embedded was evaluated by expert opinion as familiar for the students, it turned out that some of the participants had difficulty understanding it. The researcher's observations revealed that control subjects did not attempt to clarify the context. Only two control subjects asked one question each with regard to the meaning of unfamiliar words, whereas experimental subjects frequently asked such questions. This fact sheds light on the ways both groups used the context in their L2 vocabulary acquisition. The control subjects apparently relied above all on the definitions in the annotations in order to learn the meaning of the target words and made less use of the context. The experimental subjects, on the other hand, had to first clarify the meaning of the context in order to select an appropriate definition for their annotations. The very essence of their treatment did not allow them to disregard the context in which the target words were presented. It seems logical, therefore, to draw a conclusion which stresses the beneficial effect of student participation in authoring on the usage students make of the context while acquiring L2 vocabulary as well as the beneficial role of context in L2 vocabulary acquisition in general.

The post-hoc analysis of items revealed that the words that were most frequently recalled correctly were concrete nouns (46%). There were five of them among the six words sharing the first five positions in the overall recall (see Table 7). The percentage for correct recall of nouns (abstract and concrete) was 44%, verbs 43%, adjectives 38%, and abstract nouns 36%. These differences in the means, however, were not statistically significant and, just as in the Smith, Miller, Grossman, & Valeri-Gold (1994) study, they did not support the idea of noun superiority, according to which nouns are easier to learn than other parts of speech.

Some other factors may have influenced the better recall of the words in the first positions. *Chaîne d'assemblage,* for example, is a partial cognate with the English "assembly line." Even though it harvested some unexpected translations in the posttests such as "hi-fi stereo" and "stereo system" (probably mostly because of contamination with *chaîne stéréo* [stereo system], a word that the subjects had studied), it still may have benefited from its closeness to the English word. *Colline* and *sommet* were both repeated in the text and, therefore, had a better chance of being remembered (see Hulstijn et al., 1996). *Décapotable,* on the other hand, may have impressed the students with its meaning "convertible," a very desirable object for young people, and the attractive picture that was used as annotation. The presence of the only adjective, *drôle,* in the top five positions could also be explained on the basis of emotional response. It is quite possible that its meaning "funny, weird" triggered a stronger emotional reaction in the subjects and thus made it more memorable for them.

The investigation of the impact the type of annotations had on recall yielded a significant advantage for annotations containing pictures versus annotations without pictures on the immediate posttest for the experimental group ($z = -2.2$, $p < .05$) and the delayed posttest for both the control ($z = 2.05$, $p < .05$) and the experimental ($z = 3.54$, $p < .01$) groups. These findings corroborated findings from previous studies (Chun & Plass, 1996; Davis & Lyman-Hager, 1997; Kost et al., 1999) according to which words with picture and text annotations are better remembered than words with text annotations only. In an earlier study by Smith et al. (1994) a similar phenomenon was observed favoring recall of words presented with visuals over words presented with text only. The results of the present study are in alignment with Paivio's (1971) dual-coding theory and the claim that the use of images improves vocabulary learning. Moreover, the fact that a statistically significant difference in the recall of picture versus non-picture annotations was demonstrated on the two delayed posttests, but only on one of the immediate posttests is an illustration of the phenomenon of hypermnesia, reported in other studies (Chun & Plass, 1996; Smith et al., 1994). Hypermnesia is a psychological effect, which explains the fact that pictures tend to be remembered better over time whereas words are more easily forgotten.

CONCLUSIONS, LIMITATIONS, AND RECOMMENDATIONS

The present study made an attempt to investigate for the first time some quantitative parameters of vocabulary learning for students participating in multimedia authoring. The novel character of this research and the relatively small sample size make it impossible to generalize the findings of the study beyond the conditions described in this article without replication of the experiment.

The study showed that students can successfully participate in authoring of multimedia instructional materials based on foreign language texts. All subjects accomplished their task in a reasonable time and helped create high-quality materials.

The main question of the study, whether students learn vocabulary better if they participate in multimedia authoring, was not answered in an unequivocal way. On one hand, if time on task was taken into account, the answer was negative. On the other hand, if time on task was disregarded, the authoring treatment yielded significantly better results in vocabulary acquisition. The researcher considered disregarding time on task because of the longer time being an inherent characteristic of the authoring treatment and generally a possible positive aspect of a learning activity from a pedagogical point of view. Even in this case, however, the results of the study should be interpreted cautiously because of the small numerical difference in the scores of the experimental and the control groups, the small sample size, and the fact that the authoring activity was performed only once. This short treatment could have been responsible for a novelty effect. In order to compensate for a possible novelty effect, a future study might be devised whereby students would be asked to work on longer texts in several sessions over a longer period of time. The students would also be given attitude questionnaires, which would monitor the level of their

motivation and their overall impressions from the treatment in order to study the long-term motivational aspect of the authoring activity.

The uncontrolled time on task in this study remains a controversial point and could be approached in several ways in a future study. As mentioned before, controlling time by simply forcing the control subjects to stay in front of the computer as long as the experimental subjects do and read the text over and over again will be highly unnatural and will most likely decrease motivation. Therefore, the control subjects could be given some exercises based on the presented text. Such a treatment would allow them to fill in the time gap between themselves and the experimental subjects in a more natural way. Thus a future experiment using such a design will help overcome another limitation of the present study, namely the lack of a well-defined goal in the control group activity. The somewhat vaguely defined task for the control group may have been responsible for weaker motivation on the part of the control subjects and may have been one of the reasons for this group's weaker performance.

The study shed some light on the very controversial debate over dictionary use. Engaging the students in some activity other than direct vocabulary learning may help overcome the usual boredom related to dictionary use. If the dictionary is perceived simply as a tool for the accomplishment of an interesting and relatively complex task, which requires evaluation and judgment of several factors, it becomes a necessary step in the process and the students use it consistently. However, it is unclear to what extent these conclusions were influenced by the relatively restricted length of the text.

Even though authoring of instructional materials can hardly be considered as an everyday activity in the foreign language classroom, the present research showed that it could be used to help introduce variety in learner tasks. It was found to be helpful for vocabulary acquisition and thus cannot be dismissed as a simple "waste of time." Moreover, there are potential benefits implied by student authoring of multimedia materials for FL learning which should be taken into account. If students successfully help create mediated learning materials for FL, these materials can be used by other students, by teachers in other classes, and even disseminated over the Internet. Teacher time for developing such materials can be drastically reduced, since teachers can function as consultants, supervisors, and quality control rather than as main executors of such projects.

The study also showed that foreign language texts downloaded from the Internet can be used without alteration for multimedia instructional units partially created by students. Creating such materials for FL learning using texts downloaded from the Internet will give the students opportunities to work in an authentic context. Exposure to unaltered texts in the target language is a very valuable experience for L2 learners with potential for important affective impact on them. Nevertheless, the level of sophistication of these authentic materials should not exceed drastically the level of student knowledge in order to avoid frustration and boredom.

In real life conditions, many alterations to the activities described in this paper can be undertaken. For example, students may be asked to find their own texts for annotation. They may also be encouraged to annotate texts and to link them to other Internet sites, create their own Web pages with annotated texts, and so forth.

The study demonstrated that a visual element in the annotations of target words significantly improves vocabulary learning, particularly long-term retention of words. Thus the present experiment supports findings from previous research about the importance of visuals in vocabulary teaching.

A better way to control for the difficulty level of each individual word would have been a between-subject design whereby one group is exposed to all words without pictures and the other group to all words with picture annotations. This was not done in the present study since a comparison of picture versus non-picture annotations was not part of the original design of the experiment. The idea of this comparison came up later when the data were collected and an interesting pattern emerged. A future study

might use a between-subjects design and use four groups -- two control (one with picture annotations and one without) and two experimental (one with picture annotations and one without). This design will call, of course, for a larger subject pool.

The pioneer character of the present study and its limitations leave room for replications and alterations in the design. In addition to the possibilities already discussed, different types of texts may be used and the impact of the nature of the text on student performance studied. Using different text types, multiple sessions, a more goal-oriented activity for the control group and controlled time on task will give the researchers the opportunity to collect more diverse data and attain more reliable results.

For practical purposes, a future study may be done to look at the benefits of authoring for subjects with different ability levels. Any differences in the response to treatment based on ability level should suggest a differentiated application of the authoring method in classroom conditions. A qualitative study in which the students are observed over a longer period of time, working in realistic classroom conditions on multimedia units (including creating picture and sound files) as part of their curriculum, would most likely bring more insightful information about the real-life application of the idea of student authoring.

Finally, it is our hope that the present study, by producing some evidence of the positive effects that student participation in authoring of multimedia materials has on vocabulary acquisition, will help orient researchers' attention toward this activity and its more thorough investigation. If the promising results of the present research are confirmed, a more sophisticated and complex activity using the wholesome potential of the Internet and with practical effect on saving teacher time might become part of the foreign language teacher arsenal.

APPENDIX A. LESSON CONTENT

Où est la **roue de secours** * sur une Lada?
- Il n'y en a pas. En cas de **crevaison**, utiliser le **volant** à la place.

Where is the **spare tire** in a Lada?
- There isn't any. In case of a **flat tire**, use the **steering wheel** instead.

Comment doubler la **valeur** d'une Lada?
- On **fait le plein**.

How can you double the **value** of a Lada?
- **Fill** it **up**

Qu'est-ce qu'une Lada au **sommet** d'une **colline**?
- Un miracle.

What is a Lada on **top** of a **hill**?
- A miracle.

Et trois Lada au **sommet** d'une **colline**?
- Une **drôle** de place pour mettre une **usine** Lada.

And three Ladas on **top** of a **hill**?
- A **weird** place for a Lada **factory**.

Et mille Lada au **sommet** d'une **colline**?
- Un **dépotoir** (ou encore un **écrasement** d'un Tupolev...)

And a thousand Ladas on **top** of a **hill**?
- A **junk yard** (or else the **crash** of a Tupolev...)

A quoi sert le **dégivrage** sur une Lada?
- A pas se **geler** les mains quand on la **pousse**.

What is the **defroster** on a Lada for?
- To keep your hands from **freezing** when you **push** the car.

Quelle est la différence entre la Lada et le chien guide?
- **Aucune**, pour les deux, **il faut** être **aveugle** pour en acheter.

What is the difference between a Lada and a guide dog?
- **None**, for both, you **have to** be **blind** to buy them.

Qu'est-ce qu'on appelle une Lada **décapotable**?
Un **oubli** de la **chaîne d'assemblage**.

What is a Lada **convertible** called?
- An **oversight** on the **assembly line**.

* The words in bold face are the target words.

APPENDIX B. PRETEST

(ID number _____)

Translate the following words in English:

1. utile

2. gens

3. une algue

4. un écrasement

5. une roue de secours

6. un collier

7. une usine

8. pousser

9. aucune

10. une écrevisse

11. un poisson

12. voler

13. la valeur

14. une crevaison

15. aveugle

16. un collant

17. geler

18. faire le plein

19. drôle

20. un pain

21. le dégivrage

22. un dépotoir

23. une chaîne d'assemblage

24. un oubli

25. décapotable

26. il faut

27. le sommet

28. une route

29. un volant

30. une colline

APPENDIX C. TARGET-WORD HANDOUT

Annotate with text, sound and pictures (where available) the following words which are part of the anecdotes on your screen.

Word to annotate	Sound file	Picture file
1. une roue de secours	roue	roue
2. une crevaison	crevaison	crevaison
3. un volant	volant	volant
4. la valeur	valeur	--------
5. faire le plein	plein	faire le plein
6. le sommet	sommet	sommet
7. une colline	colline	colline
8. drôle	drôle	--------
9. une usine	usine	usine
10. un dépotoir	dépotoir	dépotoir
11. un écrasement	écrasement	écrasement
12. le dégivrage	dégivrage	dégivrage
13. geler	geler	--------
14. pousse	pousse	pousse
15. décapotable	décapotable	décapotable
16. un oubli	oubli	-------
17. une chaîne d'assemblage	chaîne	chaîne
18. aucune	aucune	--------
19. il faut	il faut	--------
20. aveugle	aveugle	aveugle

NOTES

1. SmarTText is a hypertext-based computer program created for the needs of foreign language teaching. It can be downloaded from http://www.siu.edu/~nmc/smarttext.html.
2. Data about computer proficiency and attitude toward the subject matter were both collected from self reports of the subjects based on a Likert scale with numerical values from 1 to 10.
    Immediate and delayed gain as reported in these tables refer to the difference between the words recalled on the immediate and delayed posttests respectively, minus the words familiar for each student as shown on the pretest.

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