Poster Presentation

The Effect of Explicit VLS Instruction on the Vocabulary Learning Behaviors of Biology Majors

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A previous study on vocabulary learning strategies (VLS) instruction for Japanese life science majors found that they preferred shallower VLS to those involving deeper processing for learning general science terminology. It also found that VLS instruction positively affected the vocabulary learning behaviors of self-management and input-seeking. These findings supported those of earlier researchers on the value of explicit VLS training for humanities majors in increasing the use of self-management and input-seeking strategies. The present study seeks to clarify how explicit VLS instruction of deeper memory strategies can affect the vocabulary learning behaviors of Japanese biology majors when studying ESP vocabulary. Pre- and post-instruction surveys were used to measure the change in their vocabulary learning behaviors. Statistical analyses including split-plot design ANOVA revealed that the VLS instruction was effective regardless of the students' vocabulary size in self-management, input seeking, shallower memory strategies and intrinsic motivation.

Chamot (2005) defined learning strategies as "procedures that facilitate learning a task" (p. 112). She stressed the importance of teaching new strategies to assist less successful learners in becoming better language learners. Twenty years earlier, Nunan (1997) found incorporating learning strategy training into an academic English course significantly increased the learners' knowledge and perception of the value of strategies. He also found that it enhanced their motivation.

Regarding vocabulary learning strategies (VLS) specifically, studies by Mizumoto and Takeuchi (2008, 2009) showed explicit VLS training for humanities majors increased their use of self-management and input-seeking. Little and Kobayashi (2015) confirmed these findings with life science majors and also revealed they preferred shallower strategies to deeper strategies for learning general science words. Shallower strategies, such as oral rehearsal and writing rehearsal, are cognitive strategies that involve "repeatedly saying or writing a word" to learn vocabulary (Schmitt, 1997, p. 215). Deeper strategies, or memory strategies, on the other hand, require more elaborate mental processing as learners must link the word with knowledge they already have (Schmitt, 1997). According to the Depth of Processing Hypothesis (Craik & Lockhart, 1972), this type of processing is key for retaining words in long-term memory. ESP vocabulary is essential for learners to demonstrate understanding, "make meaning, and engage with disciplinary knowledge" (Woodward-Kron, 2008, p. 246). Thus, the present study seeks to clarify how explicit VLS instruction of deeper memory strategies affects the vocabulary learning behaviors of biology majors when studying ESP vocabulary.

Research Question

How does VLS instruction in deeper memory strategies using biology terms influence the vocabulary learning behaviors of biology majors of different vocabulary sizes?

Methodology

Participants

The participants were 109 second-year university students (41 males; 68 females), all biology majors and Japanese native speakers. The study took place in an English course on academic reading using science texts. Using Mochizuki's (1998) Vocabulary Size Test, the students were divided into two groups. Students with a smaller vocabulary size (5,000 words or less) were assigned to one group (SVS). Those with a larger vocabulary size (more than 5,000 words) were placed in the other group (LVS). The SVS group had 37 students (14 males; 23 females),

and the LVS group had 72 students (27 males; 45 females).

Vocabulary Learning Strategies Questionnaire

To evaluate the students' vocabulary learning behaviors before and after receiving deeper memory VLS instruction, a modified version of Mizumoto and Takeuchi's (2008) VLS questionnaire was used. We added one question each about affixes (Q25) and grouping (Q26) strategies. The questionnaire comprised a total of 35 items in six categories (Table 1; see Appendix A for the English translation of the questionnaire). The questionnaire used a 5-point Likert scale from 1 indicating "strongly disagree" to 5 indicating "strongly agree."

Strategy Instruction

The instructed strategies were all memory strategies involving deeper processing: imagery, association, affixes, and grouping (Table 2).

Table 1
Categories and Subcategories of VLS Questionnaire

Categories	Subcategories	Number of Items
Self-management		7
Input-seeking		4
Shallower VLS	Writing Rehearsal	3
	Oral Rehearsal	3
Deeper Memory VLS	Imagery	5
	Association	2
	Affix	1
	Grouping	1
Extrinsic Motivation		3
Intrinsic Motivation		6
Total		35

Table 2
Deeper Vocabulary Learning Strategies and Subcategories

Strategies	Subcategories
Imagery	Drawing a picture
	Using the student's mental image of the meaning
	Associating the meaning with the student's personal experience
	Creating a mental image using the orthographical form
	Keyword method
	Creating a negative/positive image based on the meaning
Association	Associating the item with synonymy, antonymy and hyponymy
	Creating a semantic network
Affix	Dividing the item into prefix, root and suffix
Grouping	Grouping the new items according to their meanings
	Making a sentence/story using the new item(s)

Vocabulary List and Strategy Handouts

The target words were 30 biology terms (Appendix B) selected from the *Life Science English-Japanese Japanese-English Dictionary* (Life Science Dictionary Project, 2012). A pilot test confirmed all words were unknown to participants. The words were divided into five sets of six words. Each set listed the words and gave sample sentences with a biology context. Each memory strategy had a handout that explained why it is useful, examples of how to use it with a few sample words, and a practice guide. For example, the association strategy handout first explained how we can retain words well by making associations in our minds. Then, it showed several examples of association networks (e.g., semantic network, synonyms and antonyms, and hyponymy) centered on some sample words. Finally, it provided a step-by-step guide for practicing the strategy.

Procedure

In Week 1, the students answered the questionnaire (pre-VLS). In Week 2, the students were given explicit instruction on the first memory strategy and hands-on experience using it to learn the first vocabulary set. In the following week, the students took a quiz on the first set. This two-week procedure was repeated three times until the students were introduced to the fourth memory strategy in Week 8 and took a quiz on the fourth set of vocabulary in Week 9. In Week 10, the students were given the fifth set of vocabulary items and were told to learn the items using any strategy they liked. In Week 11, the students took a quiz on the fifth set, and answered the same questionnaire (post-VLS).

Results

Data Analysis

1. The mean and SD of the total Likert scale scores of all items in the same category were calculated for the pre- and post-VLS questionnaires. The pre/post gain between the two questionnaires for each category was also calculated.
2. A split-plot design ANOVA was conducted with the students' pre- and post-VLS questionnaire scores as a within-factor and their vocabulary size as a between-factor. This was done to see if there was an interaction between the two factors. The effect sizes for the pre/post gains were also calculated. JMP Version 13 was used for statistical analyses.

Gain in VLS Categories for Each Group after VLS Instruction

Tables 3 and 4 show the descriptive statistics of each category and the pre/post gains for the SVS group and the LVS group, respectively.

Figures 1-6 show the pre/post gain of each group for each VLS category.

Significance of Gains

The results of the split-plot design ANOVA are given in Table 5. As shown in Table 5, the interaction effect between the two factors (namely, vocabulary size and VLS instruction) was not significant for any category: $F(1, 107) = .27$, $p = .6070$, n.s. for self-management; $F(1, 107) = .22$, $p = .64$, n.s. for input seeking; F

Table 3
Descriptive Statistics for VLS Categories and Pre-Post Gain for SVS Group (n = 37)

	Pre-VLS Questionnaire		Post-VLS Questionnaire		
Strategies	Mean	(SD)	Mean	(SD)	Gain
Self-management 1-7	1.73	(0.66)	2.02	(0.83)	0.29
Input Seeking 8-11	2.22	(1.03)	2.41	(1.00)	0.19
Shallower Strategies 12-17	3.26	(1.06)	3.49	(0.77)	0.23
Deeper Strategies 18-26	2.57	(0.72)	2.6	(0.69)	0.04
Extrinsic Motivation 27-29	3.55	(0.77)	3.64	(0.67)	0.09
Intrinsic Motivation 30-35	2.55	(0.93)	2.75	(0.87)	0.19

Table 4
Descriptive Statistics for VLS Categories and Pre-Post Gain for LVS Group (n = 72)

	Pre-VLS Questionnaire		Post-VLS Questionnaire		
Strategies	Mean	(SD)	Mean	(SD)	Gain
Self-management 1-7	2.18	(0.86)	2.4	(0.80)	0.22
Input Seeking 8-11	2.38	(1.08)	2.66	(1.02)	0.27
Shallower Strategies 12-17	3.35	(0.86)	3.5	(0.71)	0.15
Deeper Strategies 18-26	2.88	(0.66)	2.9	(0.61)	0.03
Extrinsic Motivation 27-29	3.79	(0.73)	3.89	(0.68)	0.11
Intrinsic Motivation 30-35	2.91	(0.93)	3.06	(0.87)	0.15

(1, 107) = .34, p = .56, n.s. for shallower strategies; F (1, 107) = .00, p = .95, n.s. for deeper strategies; F (1, 107) = .02, p = .90, n.s. for extrinsic motivation; F (1, 107) = .09, p = .76, n.s. for intrinsic motivation. This makes it possible for us to discuss the influence of the two factors independently.

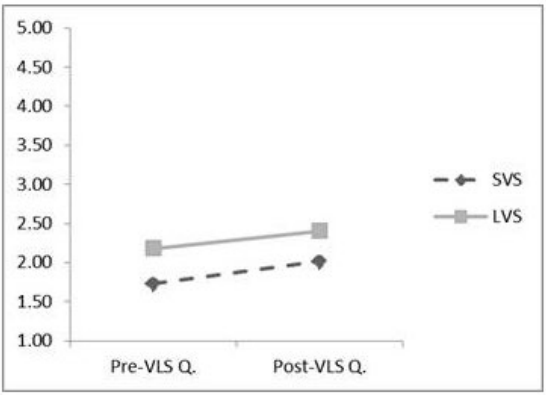

*Figure 1.*Self-management.

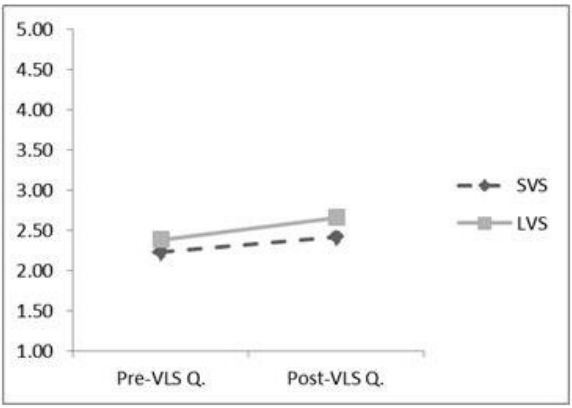

Figure 2. Input seeking.

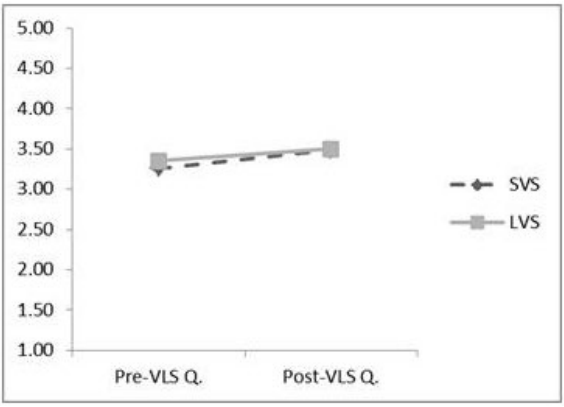

Figure 3. Shallower strategies.

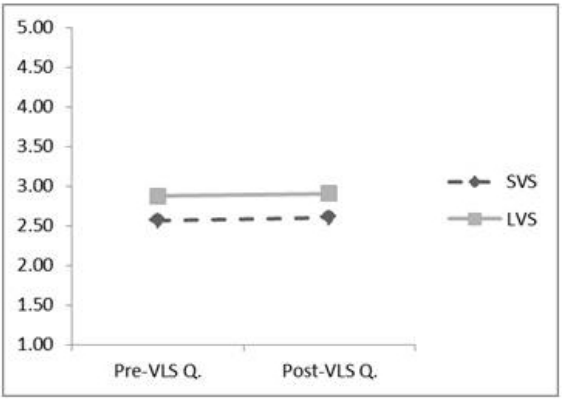

Figure 4. Deeper strategies.

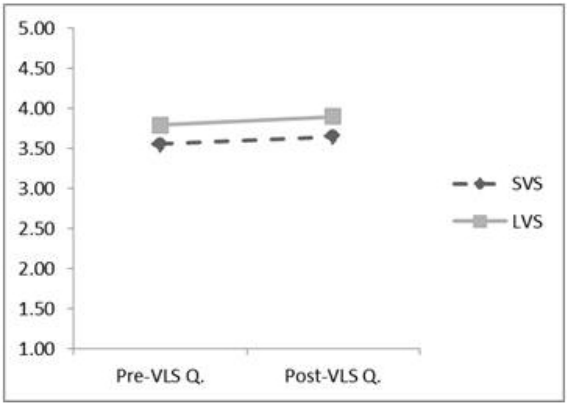

Figure 5. Extrinsic motivation.

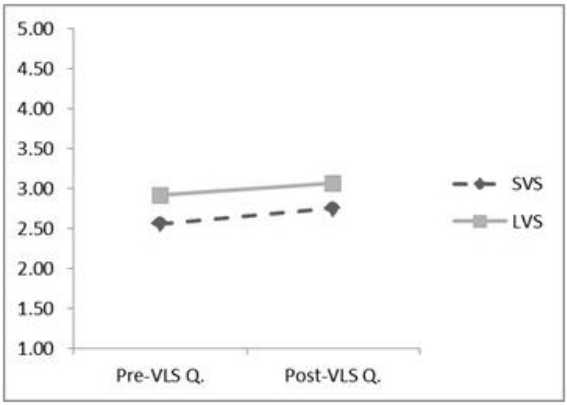

Figure 6. Intrinsic motivation.

Table 5
Results of Split-Plot Design ANOVA (p Values)

	Vocabulary Size	Post VLS Q. Scores	Vocabulary Size x Pre-Post VLS Q. Scores
Self-Management	0.0059*	0.0001*	0.6070
Input Seeking	0.2895	0.0121*	0.6401
Shallower Strategies	0.7265	0.0074*	0.5603
Deeper Strategies	0.0100*	0.6304	0.9522
Extrinsic Motivation	0.0586	0.1393	0.9025
Intrinsic Motivation	0.0453*	0.0248*	0.7637

Note 1. Vocabulary Size x Pre-Post Survey Scores indicates the interaction between vocabulary size and pre-post survey scores.
Note 2. * = $p \leq .05$

The *p* values for the pre- and post-VLS questionnaire scores show that VLS instruction had a positive effect for self-management, input seeking, shallower strategies, and intrinsic motivation as follows: self-management, $F(1, 107) = 15.8575$, $p = .0001$, $d = .3453$ for LVS and $d = .4861$ for SVS; input seeking, $F(1, 107) = 6.5177$, $p = .0121$, $d = .3278$ for LVS and $d = .1884$ for SVS; shallower strategies, $F(1,107) = 7.4459$, $p = .0074$, $d = .2225$ for LVS and $d = .3513$ for SVS; and intrinsic motivation, $F(1,107) = 5.1821$, $p = .0248$, $d = .2118$ for LVS and $d = .2374$ for SVS.

Table 6 shows the effect sizes for the pre/post gains. Based on Cohen's categorization (small ≥ .20, medium ≥ .50, large ≥ .80), the effect sizes are considered rather small, ranging from .1884 to .3513. The only exception was for self-management for SVS (0.4861), which was close to medium size.

Discussion and Pedagogical Implications

Overall, the results show explicit VLS instruction has a positive impact on vocabulary learning behaviors regardless of vocabulary size except for the use of deeper strategies and extrinsic motivation. This finding was unexpected as

Table 6
Effect Size (d)

	SVS	LVS
Self-Management	0.4861	0.3453
Input Seeking	0.1884	0.3278
Shallower Strategies	0.3513	0.2225
Deeper Strategies	0.0534	0.0434
Extrinsic Motivation	0.1360	0.1653
Intrinsic Motivation	0.2374	0.2118

Mizumoto and Takeuchi (2009) found VLS instruction is most effective for less proficient learners, while Little and Kobayashi (2015) found more proficient learners benefited most. Nonetheless, the results in this study for each strategy were variable.

Metacognitive Behavior

As Chamot (2005) stresses, explicit strategy instruction fosters metacognition, thereby enabling students to understand their own thinking and learning processes. In this study, it appears explicit VLS training increased the students' awareness of their own cognitive processes and enhanced their strategy use in input-seeking and self-management, regardless of vocabulary size.

Motivation

The present study found explicit VLS instruction had a positive impact on each learner's intrinsic motivation but not on their extrinsic motivation. Rasekh and Ranjbary (2003) observed learner motivation rises as they begin to understand the connection between their own strategy use and language learning successes. However, we need to be cautious in attributing this increase in motivation to strategy instruction. Learning biology terms related to their majors may also have positively influenced the students' motivation.

Strategy Use

Shallower strategy use increased for all students, whereas deeper strategy use remained unchanged. This was unexpected because the training focused on deeper strategies. There are two possible explanations. First, as Pressley, Goodchild, Fleet, Zajchowski, and Evans (1989) noted, learners can only actively transfer strategies to new learning situations when they have metacognitive knowledge of the strategy. Ten weeks was probably insufficient for this, particularly as the students only had limited class time to practice them. Second, strategy use is influenced by the learner's culture (Chamot, 2005). It is well-known many Japanese learners prefer shallower strategies (Schmitt, 1997).

Implications

Given vocabulary learning's importance and the essential nature of ESP vocabulary for making meaning and identifying with a discourse community, it is worthwhile for teachers to provide some VLS training. VLS training not only raises learners' metacognitive awareness and intrinsic motivation but has also been found to strongly correlate with higher TOEIC scores (Mizumoto & Takeuchi, 2008). Explicit VLS instruction should include training both in shallower as well as deeper memory strategies. This will expose learners to strategies that may be unfamiliar to them as well as to ones they are avoiding. It will also help them to see what works best for different types of vocabulary while revealing their own strategy preferences (Mizumoto & Takeuchi, 2008). Finally, strategy training should be an ongoing part of classes and not limited to one semester as it takes time for learners to acquire a strategy.

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Vocabulary Learning Behavior Questionnaire (Adapted from the questionnaire originally developed by Mizumoto and Takeuchi, 2008)

Instruction: For each statement, please indicate if you strongly agree (5), agree (4), neither agree nor disagree (3), disagree (2), or strongly disagree (1).

Self-management

1. I regularly review the vocabulary I learned to check if I remember it.
2. I keep a vocabulary book or word list to check the vocabulary anytime I wish.
3. I try to make it a rule to memorize a certain number of words in a specific time period.
   Example: *I will memorize 10 words a day.*
4. I try to learn extra vocabulary in addition to what I am taught in class.
5. I try to take time for vocabulary learning.
6. I consciously set aside time to study vocabulary in order to prepare for tests (such as TOEIC, TOEFL, or Eiken: English Proficiency Test).
7. I use my own methods for remembering, checking, or reviewing vocabulary.

Input-seeking

8. I try to expose myself to English vocabulary by reading or listening a lot.
9. I try to manage the learning environment so as to expose myself to English vocabulary.
10. I try to make use of the media (TV, radio, Internet, mobile phone, or movies) to learn vocabulary.
11. I study vocabulary with the intention of using it.

Shallower Strategies

Writing Rehearsal

12. When I try to remember vocabulary, I write it repeatedly.
13. When I try to remember vocabulary, I write it on a note or a card.
14. When I try to remember vocabulary, I remember not only the meaning but also the spelling of the word by writing it.

Oral Rehearsal

15. When I try to remember vocabulary, I say it aloud repeatedly.
16. When I try to remember vocabulary, I vocalize it to remember not only the meaning but also the pronunciation of the word.
17. When I try to remember vocabulary, I say the sample sentence aloud.

Deeper Memory Strategies

Imagery

18. When I try to remember vocabulary, I pair the term with a picture of its actual meaning, or create a picture in my mind. Example: *monkey* => 
19. When I try to remember vocabulary, I link my personal experiences to it. Example: *zoo* => My grandparents took me to "*Zurashia* (a zoo in Yokohama)" when I was small.
20. When I try to remember vocabulary, I create an image of the spellings or orthographic forms. Example: 
21. When I try to remember vocabulary, I use the keyword method (keyword mnemonic technique). Example: *math* => "*hyakumasu keisan*" (100-cell calculation, a type of arithmetic drills)
22. When I try to remember vocabulary, I imagine whether the meaning of the word is negative or positive. Example: *bacteria* => negative, *medicine* => positive

Association

23. When I try to remember vocabulary, I associate it with the synonyms (e.g. begin and start) or antonyms (e.g. positive and negative) I already know.
24. When I try to remember vocabulary, I try to associate it with related words. Example: *pathogen* plus *disease*, *antibody*, *virus*, *bacteria*

Affix

25. When I try to remember vocabulary, I associate it with other words with the same affix or root. Example: *biology* = "bio" (prefix meaning "relating to life") + "logy" (suffix meaning "the study of")

Grouping

26. When I try to remember vocabulary, I make a sentence using the word.

Extrinsic Motivation

I study English…

32. Because I require school credits to graduate.
33. In order to get a prestigious job in the future.
34. In order to receive a better salary later on.

Intrinsic Motivation

I study English…

35. For the pleasure I experience when I surpass myself in my English studies.
36. For the enjoyment I experience when I can grasp the meaning of words if I keep studying.
37. For the satisfaction I feel when I am in the process of accomplishing difficult exercises in English.
38. For the 'high' I feel when hearing English spoken.
39. For the 'high' feeling that I experience while speaking English.
40. For the pleasure I get from hearing English spoken by native speakers of English.

The Effect of Explicit VLS, OnCUE Journal, 11(2), pages 164-178

Appendix B

List of Target Vocabulary Items in Alphabetical Order

1	amphibian	9	dissection	17	hydrophobicity	24	oocyte
2	anemia	10	electrolysis	18	immunodeficiency	25	ovulation
3	antigen	11	endoscopy	19	intoxication	26	permeability
4	carcinogen	12	erythrocyte	20	invertebrate	27	precursor
5	carnivore	13	excretion	21	leucocyte	28	proteolysis
6	centrosome	14	gastritis	22	metastasis	29	solubility
7	decomposition	15	germination	23	neonate	30	specimen
8	dermatology	16	hemorrhage				