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Research Article

The Effects of Task-induced Involvement Load on Word Learning and Confidence Judgments Mediated by Knowledge and Regulation of Cognition

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Abstract

The relationships between knowledge and regulation of cognition and how they interact to mediate the effects of task-induced involvement load on word learning and confidence judgments were investigated. The participants were 77 undergraduate English majors. They were required to complete a checklist on metacognition. Subsequently, they were assigned to complete three tasks with varying degree of involvement load. They were then required to rate their confidence in learning and using the target words. Pre- and post-study vocabulary tests were administered to measure improvement in word learning. According to the checklist on metacognition, the learners were assigned to four different ability groups. The results showed that knowledge of cognition is a good predictor of the confidence judgments, in the same way that regulation of cognition is a good predictor of the confidence judgments. In terms of learners' actual word learning performance, task-induced involvement load is mediated significantly by the regulatory competence but not by the knowledge of cognition. There is a discrepancy between learners' self-assessment and actual performance. Relevant educational implications are discussed.

Keywords

Metacognition • Knowledge of cognition • Regulation of cognition • Involvement • Word learning

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It is acknowledged that students profit more from learning when they are active in self-regulating their learning. Self-regulated learning (SRL) is regarded as an educational goal. Self-regulated learners often exhibit a high sense of self-efficacy. They are also likely to be cognizant of their strength and weakness in the academic learning (Pintrich & Schunk, 2002). SRL entails taking control of one's own learning and behavior (Ziegler, Stoeger, & Grassinger, 2011). It refers to the extent to which learners participate metacognitively, motivationally, and behaviorally in their own learning process (Zimmerman & Schunk, 2001). We need to guide our students in building awareness of how to identify a topic, set reasonable goals, adopt appropriate strategies, and evaluate and modify these strategies as a deeper understanding of subject matter is developed. This requires a dynamic interaction with and a sensitivity to the influences of one's social environments. This suggests that SRL is determined not only by personal processes but also by environmental and behavioral events in a reciprocal fashion.

In addition, our students need a wide range of metacognitive skills for self-regulated learning of any cognitive task assigned to them. These skills include planning, controlling strategies, and evaluative methods (Carvalho & Yuzawa, 2001). Such skills are important dimensions of metacognition. Metacognition refers to the knowledge of one's own cognitive system and regulation of one's metacognitive skills (Flavell, 1979). Metacognition includes two components: Knowledge of cognition and regulation of cognition (Brown, 1987). The knowledge of cognition refers to an individual's awareness of cognitive processes. It includes three sub-processes that facilitate the reflective aspect of metacognition: Declarative knowledge, procedural knowledge, and conditional knowledge. Declarative knowledge refers to the information about one's own cognitive processes and the factors influencing one's academic success. Procedural knowledge refers to the knowledge about how to implement learning procedures. Conditional knowledge refers to the knowledge about when and where to use strategies (Schraw, 1994). The regulation of cognition refers to regulation of one's own learning processes and metacognitive skills. It consists of three types of skills that facilitate the control aspect of learning: Planning, monitoring, and evaluating (Schraw, 1994). Planning refers to a skill in appropriately selecting strategies and correctly allocating resources to complete a task. Monitoring refers to a skill in observing task comprehension and performance targets. Evaluating refers to a skill in appraising the efficiency at which the task is performed.

The important role of metacognitive knowledge in academic learning has been recognized in previous studies (e.g., Blankson & Blair, 2016; Cornoldi, Carretti, Drusi, & Tencati, 2015). Likewise, regulation of metacognitive skills is a decisive factor in the successful completion of any cognitive task (e.g., Teng, 2016). For example, when a student receives a reading task, he or she may plan study time, set reasonable goals, select appropriate strategies, and allocate resources to approach the material. During this process, the learner may assess the application of strategies and task performance. Subsequently, after study, the learner may evaluate whether he or she has performed well. Based on the evaluation, he or she may decide whether to terminate the learning or to consider a change in the strategies to correct comprehension and performance errors. Later on, after a learning episode, the student may probe into the analysis of performance and strategy effectiveness. Some students, on the other hand, may perform poorly in their academic studies because they are neither prone nor instructed to effectively use their metacognitive skills. As suggested by Callan, Marchant, Finch, and German (2016), metacognitive strategies remained a significant predictor of achievement. Therefore, there is a need to examine how metacognitive dimensions influence our students' academic performance. The purpose of the present study was to examine how metacognition mediates the task-induced involvement load on learners' word learning and confidence judgments.

Involvement Load Hypothesis (ILH) was proposed by Laufer and Hulstijn (2001). According to ILH, an effective learning of new words is contingent upon the amount of mental effort or involvement while processing these words. Task-induced involvement load is a motivational-cognitive construct. It consists of three dimensions: Need, Search, and Evaluation. Need is the motivational but non-cognitive dimension of the involvement. It refers to whether the prior knowledge of new words is required to complete a task. Need is moderate if imposed by the task, and strong if by the learner. Search and Evaluation are the cognitive dimensions of involvement. Search is an attempt that individuals make to determine the meaning of unknown words, encountered during a task, through a dictionary or by consulting a teacher. Search is absent when such an effort is not required. For example, when a text is accompanied by marginal glosses for unknown words. Evaluation refers to the comparison of a new word with already known, or when deducing a particular meaning of the word among other meanings, or assessing its suitability in a given context. Evaluation is moderate when a learner is required to recognize differences between words provided in a given context, such as a fill-in-the-blank exercise. Evaluation is strong when a learner is required to make decisions about the meaning of unknown words and combine them with known words in an original context, such as writing a sentence or composition. Task-induced involvement load is derived from the combinations of Need, Search, and Evaluation. A task may not involve all the dimensions. A task where a factor is completely absent is scored as 0, if moderately present as 1, and if strongly present as 2. A task with all the dimensions stronger has a higher level of an involvement load. A task with a higher involvement load is deemed to be more effective for word learning (Laufer & Hulsijin, 2001).

A lot of previous studies have been conducted to validate ILH. Some of the findings support ILH. For example, Keating (2008) and Teng (2015) documented that using new words in original sentences (strong evaluation) results in the greatest word knowledge, followed by reading plus fill-in-blank (moderate evaluation), and the reading comprehension task (evaluation is absent). Some of the findings partially support ILH. For example, Teng and Zhang (2015) showed that word learning is better when learners read aloud target words and write a composition based on these words (strong evaluation) compared to when the word meaning is explained by the teachers (moderate evaluation). However, when the same tasks were repeated, task-induced involvement load is not related to further improvement. Independently, Huang, Eslami, and Willson (2012) revealed that word leaning is better in the learners who read a combination of expository and narrative texts than those who read either of an expository or narrative text. However, when time spent on the tasks is considered, the benefits connected to a higher degree of task-induced involvement load faded. All these studies reveal that the task-induced involvement load has a substantial effect on word learning. However, due to the contradictory results about the role of task-induced involvement load on vocabulary learning, we are still in need of further research to explore why this difference occurred. As suggested by Keating (2008), ILH in its current form has not made fine-grained differentiations between the relative load of each involvement. Factors that may have mediated the ILH need to be considered. The present study focuses on learners' metacognitive factors.

Rationales for the present study are illuminated by previous findings. For example, Schraw (1994) showed that the learners with a higher level of knowledge of cognition performed better than their counterparts with a lower level of knowledge of cognition. Likewise, the learners with a higher level of regulation of cognition performed better than those with a lower level of regulation of cognition. Overall, these two aspects of metacognition interact with each other to produce the individual differences in academic performance, as well as in the susceptibility to comply with the embedded information in a task. Independently, Swanson (1990) showed that high levels of metacognitive knowledge about problem solving could compensate for low overall aptitude. This suggests that higher metacognitive learners performed better than the lower metacognitive learners. In contrast, as claimed by Cornoldi et al. (2015), learners with low regulatory skills may not have explicit learning goals. They may fail to effectively plan, monitor, and evaluate their learning, and deploy appropriate strategies to the learning setting. A common theme in the above studies is that metacognition is related to a student's learning performance.

However, there is no study in the cognitive psychology literature examining how knowledge and regulation of cognition mediate the effects of involvement load on word learning. As noted above, metacognition is related to SRL, and task-induced involvement load is deemed to regulate self-learning. It is reasonably assumed that knowledge and regulation of cognition mediate the effects of the task-induced involvement load on word learning. Although it has already been proposed that these two components are distinct but related (Brown & Kinshuk, 2016; Schraw, 2009), a further clarification on the mutual relationship of the two components is still needed. Armed with the above knowledge, we need to assess how these two constructs mediate the effects of task-induced involvement load on individuals' word learning.

Likewise, in terms of learners' confidence judgments, Carvalho and Yuzawa (2001) investigated whether informational social cues affect learners' confidence judgments. The results reveal that students with higher levels of knowledge of cognition and regulation of cognition are more confident in their performance. Independently, Schraw (1997) investigated the effects of metacognitive knowledge on learners' confidence judgments. The results showed that learners who score higher on the monitoring checklist have less biased confidence judgments than those who score lower on the checklist. General metacognitive knowledge leads to more accurate confidence judgments. These studies demonstrated the substantial effects of metacognition on learners' confidence judgments. However, we still do not know how metacognitive knowledge and regulation mediate the effects of task-induced involvement load on confidence judgments.

Following hypothesis were proposed for the objectives of the present study. First, participants with a higher level of knowledge of cognition would perform better in terms of confidence judgments and word learning than those with a lower one. Likewise, participants with a higher level of regulation of cognition would perform better than those with a lower one. Second, it is predicted that a high degree of involvement load would lead to better performance in the word learning. However, task-induced involvement load would affect word learning as a function of participants' metacognitive knowledge and regulatory skills.

Method

Design

We adopted a 2 × 2 × 3 (Knowledge of cognition: high vs. low × Regulation of cognition: high vs. low × Task-induced Involvement: strong, moderate, and low) factorial design. Knowledge of cognition and Regulation of cognition were between-subjects factor. Task-induced involvement load was varied within participants.

Participants

The participants were 77 undergraduate students majoring in English. There were 18 men and 59 females. The mean age was 19.02 years. They had learned English as a Foreign Language (EFL) for at least six years. They participated in this study in order to receive extra course credits.

Materials

Materials were three texts taken from a textbook, which was not used in their normal class. Each text contained around 800 words. Eight words were selected as target words from each text. The target words were of 9-11 letters (e.g., consummate, aggressive).

Tasks

The three tasks differed from one another in terms of the degree of involvement load. Each task included the same three texts, but presented in different ways. Task 1 required learners to read a text. Task 2 required learners to read a text and fill in some blanks. The text in Task 2 was designed in a way that the eight target words were replaced by equally-sized blanks. The target words, along with some distracter words, were presented in a separate word list. Task 3 required learners to read a text and write a composition with the target words.

The details of the task-induced involvement index are presented in Table 1. As shown in Table 1, all the three tasks had a moderate need, as the necessity to understand an unfamiliar word was imposed by the tasks. Search was present in all the three tasks because learners were allowed to search the meaning of the unknown words through a dictionary. Evaluation was systematically manipulated across the three tasks. First, evaluation was absent in Task 1. Second, evaluation was moderate in Task 2, as the word meanings were supposed to be selected from a word list. Third, evaluation was strong in Task 3, as the learners were required to evaluate the words via writing a composition. Thus, the involvement load index is 4 in Task 3, 3 in Task 2, and 2 in Task 1.

Table 1
Task-Induced Involvement Index

Involvement load	Task 1	Task 2	Task 3
Need	Moderate (1)	Moderate (1)	Moderate (1)
Search	Present (1)	Present (1)	Present (1)
Evaluation	Absent (0)	Moderate (1)	Strong (2)
Involvement load index	2	3	4

Measures

Metacognitive Questionnaire. A questionnaire, modified from the Metacognitive Awareness Inventory (Schraw & Dennison, 1994), was used to assess metacognition in task-based learning. Items that loaded strongly on the knowledge and regulation of cognition were examined and selected. Each item was checked for relevance to our participants. For example, an item from the MAI (I understand my intellectual strengths and weaknesses), was less appropriate for our participants' English learning. Second, most items were reworded to represent language understandable to our participants. To do this, a pilot study with 70 learners who were not involved in the study was conducted. For example, an item related to regulation factor stated, *I ask myself how well I accomplished my goals once I'm finished*. This item was reworded as, *I ask myself if I learned as much as I could have when I finish a task.* Items for assessing metacognitive strategies are concluded in Table 2.

Table 2
Items for Metacognitive Cues Checklist

Item	Metacognition checklist	Item conceptual affiliation
1	I learn more when I am interested in the topic.	K
2	I know what the teacher expects me to learn.	K
3	I can motivate myself to learn when I need to.	K
4	I am a good judge of how well I understand something.	K
5	I find myself using helpful learning strategies automatically.	K
6	I always know when each strategy I use is most effective.	K
7	I learn best when I already know something about the topic.	K
8	I am aware of what strategies I use in my task-based learning.	K
9	I try to use strategies that have worked in the past.	K
10	I have a specific purpose for each strategy I use when I study.	K
11	I ask myself questions about how well I am learning while I am learning something new.	R
12	I consciously focus my attention on important parts of the task.	R
13	I use different learning strategies depending on the task.	R
14	I periodically check if I am doing well while performing a certain task.	R
15	I ask myself if there is an easier way to do things after I finish a task.	R
16	I set specific goals before I conduct a task.	R
17	I change strategies when I fail to understand a problem.	R
18	I ask myself periodically if I am meeting my goals.	R
19	I ask myself if I learned as much as I could have once I finish a task.	R
20	I ask myself if I have considered all options when solving a task.	R

Note. K = Knowledge of cognition R = Regulation of cognition.

This questionnaire includes two subscales: The knowledge of cognition and the regulation of cognition. Both MAI subscales have been shown to be reliable (Händel, Artelt, & Weinert, 2013). Each subscale contained 10 items. The internal consistency, using Cronbach's Alpha, was .76 and .79 for knowledge and regulation of cognition, respectively.

The participants were instructed to indicate whether each statement in the checklist was applicable to their daily academic routine on a 4-point Likert-type scale ranging from I totally disagree (0) to I totally agree (4). We computed scores by summing the individual's scores on the items. The knowledge-of-cognition scores could range from a minimum of 0 to a maximum of 40 points. The higher the score, the higher level of metacognition. The participants' mean score was 23.22 (SD = 5.35). The participants were assigned to two distinct groups. For example, 33 participants who scored below the mean score formed the low knowledge-of-cognition group

(M = 16.51, SD = 3.91). 44 participants who scored above the mean score formed the high-knowledge-of-cognition group (M = 27.26, SD = 3.11). The students in the high-knowledge-of-cognition group scored significantly higher than those in the low-knowledge-of-group, t (85) = 12.13, $p < .05$.

In a similar vein, the regulation-of-cognition scores could also range from a minimum of 0 to a maximum of 40 points. The participants' mean score was 22.67 (SD = 5.31). 33 participants who scored below the mean score formed the low regulation-of-cognition group (M = 16.58, SD = 3.59). 44 participants who scored above the mean score formed the high-regulation-of-cognition group (M = 29.51, SD = 3.41). The students in the high-regulation-of-cognition group scored significantly higher than those in the low-regulation-of-group, t (85) = 13.14, $p < .05$.

We combined the knowledge-of-cognition scores with the regulation-of-cognition scores. The participants were divided into high knowledge-high regulation (HK/HR), high knowledge-low regulation (HK/LR), low knowledge-high regulation (LK/HR), and low knowledge-low regulation (LK/ LR) ability groups. The cell sizes were n = 18 for the HK/HR group, n = 20 for the HK/LR group and LK/HR group, and n = 19 for the LK/LR group.

Pre- and Post-study Word Test. The Vocabulary Knowledge Scale (VKS) developed by Wesche and Paribakht (1996) was adapted in the present study to measure participants' improvement in word leaning. The same VKS was administered twice. At first, VKS was administered four weeks before the study to test the prior knowledge of the target words among the participants. In order to divert the learners' extra attention on the target words, 100 high frequency words were intermixed with the target words. It was presumed that after a four-week break, the learners would not retain the target words into memory. The learners were found to have no prior knowledge of the target words. Immediately after the study, the participants were tested for their command over the target words through the same VKS test.

The VKS scoring system was slightly different from Wesche and Paribakht (1996). In the present study, zero point was given if a learner reported that he or she had never seen the target words. A score of one was given if a learner could provide an acceptable correct English synonym or a Chinese translation. A score of two was given when a learner could produce a grammatically correct sentence via using the word. There were 24 items. The possible maximum score was 48 points.

Confidence judgments. Individuals recorded their confidence judgment for knowing and using each target words on a 100-mm line that followed each word (Schraw, 1997). The left end of the line corresponded to no confidence and was labeled 0% Confidence. The right end corresponded to total confidence and was labeled 100% Confidence. The participants were instructed to respond to a test item and then draw a slash through the portion of the line that best corresponded to their perceived confidence in their answer to this item.

Procedures

The participants were tested individually and were free to work at their own pace. The researcher informed them verbally that the experiment concerned reading comprehension and some exercises. The specific aims were not disclosed in detail. The experiment was conducted during the regular class time of the participants. The whole study lasted for nine weeks, with two hours per week. The participants completed pre-test (VKS) in the first week. At the fifth week, the participants completed the MAI. The participants undertook the reading treatment for three consecutive weeks (week 6-8). To eliminate the effects of individual differences, the study used a within-subject design, in which all students were exposed to the three tasks. The participants took a scale on confidence judgments and a post-test (VKS) at the ninth week. There was no time limit assigned to any of the tasks, and the learners performed them at their own pace.

Data Analysis

To analyze the relationship between the two aspects of metacognition and how they mediate the task-induced involvement load, we performed analyses of variance (ANOVAs). Significance level was set at .05.

Results

Confidence Judgments

Table 3 presents the means and standard deviations of confidence judgments. The ANOVA on the magnitude of confidence judgments showed a significant main effect of knowledge of cognition, $F\ (2, 85) = 7.05$, $p < .05$, $\eta^2 = 0.06$. This is evidence that high-knowledge students were significantly more confident in their judgments than low-knowledge students. Likewise, the ANOVA showed a significant main effect of regulation of cognition, $F\ (2, 85) = 6.15$, $p < .05$, $\eta^2 = 0.08$. This is evidence that high-regulation students were significantly more confident in their judgments than low regulation students. Together, these findings reveal that students with higher levels of metacognition have more confidence in their word-learning performance.

Table 3
General Effects of Task-Induced Involvement Load on Confidence Judgments (N = 77)

Group	Low load		Moderate load		Strong load		Total	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
LK	55.21	7.29	61.89	7.86	65.52	8.02	60.87	12.05
HK	60.05	6.15	67.34	6.78	71.56	6.98	66.31	13.08
LR	49.56	7.89	55.95	7.85	60.23	8.99	55.24	13.56
HR	65.16	4.86	72.36	4.98	77.45	5.01	71.65	13.98
Total	57.49	12.56	64.39	13.52	68.69	13.62	63.52	13.53

Note. n = 33 for the LK (low-knowledge) and LR (low-regulation) groups: n = 44 for the HK (high-knowledge) and HR (high-regulation) groups.

The results were qualified by the Knowledge X Regulotion of Cognition interaction, F (2, 85) = 7.12, $p < .05$, $\eta^2 = 0.08$. Simple effect analyses revealed that regulation of cognition greatly affected confidence judgments among low-knowledge participants, F (2, 85) = 7.35, $p < .05$, $\eta^2 = 0.06$. However, there was no significant effect of regulation of cognition among high-knowledge participants, F (1, 73) = 11.05, $p > .05$. Knowledge of cognition affected performance among low regulators, F (2, 85) = 8.52, $p < .05$, $\eta^2 = 0.09$. However, there was no significant effect of knowledge of cognition among high regulators, F (1, 73) = 10.84, $p > .05$. This is evidence that high performance in one of the two aspects of metacognition seemed to compensate for deficits in the other aspect (see Table 4).

Table 4
Knowledge X Regulation of Cognition Interaction on Confidence Judgments (n = 77)

Group	Low load		Moderate load		Strong load		Total	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
LK/LR	60.21	12.95	64.25	12.31	69.51	12.01	64.65	14.52
LK/HR	75.35	14.58	70.12	13.56	79.81	13.02	75.09	16.23
HK/LR	68.52	14.95	64.31	12.54	74.12	12.59	68.98	16.02
HK/HR	81.02	14.51	76.11	13.59	85.35	14.56	80.82	17.52
Total	71.27	19.85	68.69	18.92	77.19	18.51	72.83	20.12

Note. LK/LR = low knowledge/low regulators (n = 19); LK/HR = low knowledge/high regulators (n = 20); HK/LR = high knowledge/low regulators (n = 20); HK/HR = high knowledge/high regulators (n = 18).

Word Learning

Table 5 summarizes the results of word learning. The means and standard deviations for the word learning are presented according to the groups and the involvement load in each task.

Table 5
General Effects of Task-Induced Involvement Load on Word Learning

Group	Low load		Moderate load		Strong load		Total	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
LK	31.15	9.01	34.65	8.86	37.52	8.56	34.44	10.12
HK	35.21	9.15	37.27	8.78	41.56	9.98	38.01	11.21
LR	33.56	7.81	37.95	7.85	40.23	6.99	37.24	10.65
HR	44.13	6.75	45.01	6.98	46.12	6.51	45.08	11.23
Total	36.01	13.56	38.72	11.84	41.35	12.89	38.69	14.25

Table 5 shows that word learning was greatly affected by the two constituent aspects of metacognition. The main differences observed were that high-knowledge group students performed much better than low-knowledge group students, t (85) = 4.21, $p < .05$, $\eta^2 = 0.06$. In addition, high regulation group students performed better than low regulation group students, t (85) = 4.26, $p < .05$, $\eta^2 = 0.07$. These results indicate that knowledge about one's own cognitive processes and effective regulation of metacognitive skills are essential for improved performance in learning new words.

The results of repeated ANOVA showed that word learning is significantly affected by the knowledge of cognition, F (2, 85) = 9.41, $p < .05$, $\eta^2 = 0.06$. This is evident that the high-knowledge students were significantly better in learning new words than the low-knowledge students. Similarly, the effect of the regulation of cognition was also significant, F (1, 85) = 8.15, $p < .05$, $\eta^2 = 0.06$. This suggests that the students in the high-regulation group outperformed their counterparts in the low-regulation group. Together, these results revealed that the learners with higher levels of knowledge about their own cognitive processes and effective regulation of that knowledge performed better in the word learning.

However, the results seem to be influenced by the Knowledge × Regulation of Cognition interaction. Simple effect analyses indicate that the regulation of cognition significantly affected low-knowledge learners' word learning, F (1, 85) = 9.15, $p < .05$, $\eta^2 = 0.11$. Similarly, regulation of cognition also had a significant effect on high-knowledge learners' word learning, F (1, 73) = 11.31, $p < .05$, $\eta^2 = 0.10$. The knowledge of cognition resulted in different outcomes with the regulation of cognition. The knowledge of cognition did not significantly affect low regulators' word learning, F (4, 22) = 15.16, $p > .05$. Likewise, the knowledge of cognition did not show a significant effect on the high regulators' word learning, F (4, 22) = 12.22, $p > .05$. High performance in regulation of cognition seemed to compensate for deficits in the knowledge of cognition (Table 6).

Table 6
Knowledge X Regulation of Cognition Interaction on Word Learning

Group	Low load		Moderate load		Strong load		Total	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
LK/LR	32.22	6.96	36.35	7.32	41.51	6.21	36.69	11.12
LK/HR	44.31	7.59	45.13	7.58	46.82	7.21	45.42	12.35
HK/LR	32.12	7.95	37.38	8.54	42.22	6.55	37.24	11.65
HK/HR	44.11	5.54	45.22	5.59	46.55	5.51	45.29	10.25
Total	38.19	10.55	41.02	10.54	44.27	10.54	41.16	13.12

Effects of task-induced involvement load on word learning. The results of repeated ANOVA revealed that the task-induced involvement load has a significant effect on the word learning performance, F (2, 85) = 8.95, $p < .05$, $\eta^2 = 0.10$. This effect was depicted by the Regulation of Cognition × Involvement Loads interaction. Simple effects and post hoc analyses indicated that task-induced involvement load greatly influenced low regulators, F (2, 85) = 9.28, $p < .05$, $\eta^2 = 0.10$. However, no significant effect of involvement load was found for the high regulators, F (2, 146) = 3.15, $p > .05$. This is evident that low regulators were more likely to significantly increase their word learning efficiency when sufficed with strong involvement load and significantly decrease it when sufficed with low involvement load. However, this variance was not significant among the high regulators. Furthermore, the Knowledge of Cognition × Involvement Load interaction was not significant ($p > .05$). Overall, differences in the effects of task-induced involvement loads emerged as a function of the regulation of cognition, but not knowledge of cognition. Figure 1 presents the means of word learning for the different ability groups.

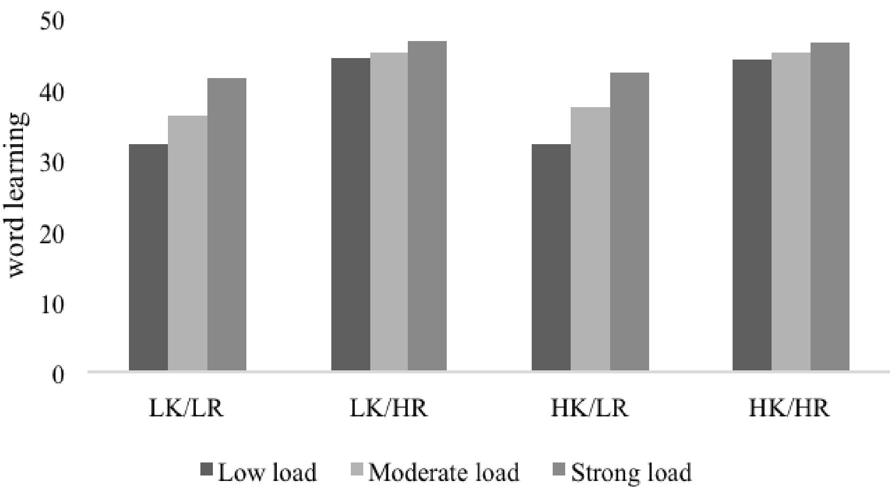

Figure 1. Effects of involvement load on word learning across different ability groups.

Discussion

Hypothesis 1: Participants with a higher level of knowledge of cognition would perform better in terms of confidence judgments and word learning than those with a lower one. Likewise, participants with a higher level of regulation of cognition would perform better than those with a lower one.

Our findings indicate that learners significantly differed from each other based on the classification as high or low in knowledge and regulation of cognition. This suggests that although the two main components of cognition are independent constructs, they are closely and significantly correlated in many ways. This is in line with earlier studies (Brown & Kinshuk, 2016; Sperling, Howard, Miller, & Murphy, 2002; Trainin & Swanson, 2005), wherein learners differed from each other due to their high or low performance in the knowledge and regulation of cognition. In addition, a high level of knowledge of cognition could compensate for low regulatory ability in the same way that high regulatory ability can compensate for low level of knowledge of cognition (Carvalho & Yuzawa, 2001).

One observed difference concerned with learners' level of confidence and actual performance in word learning. First, students with a high level of knowledge of cognition were more confident in their test answers than students with a low level of knowledge of cognition. In addition, high regulators were also more confident in their word learning. This suggests that the presence of the two constituent aspects of metacognition, or at least one of them, leads to greater confidence. One possible explanation is that students high in knowledge and regulation of cognition may partly base their judgments of past successful experiences on their metacognitive knowledge and regulatory skills (Schraw, 1997). In addition, learners' awareness of one's own knowledge and of ways of monitoring it (i.e., knowledge of cognition) and of more effective ways of using regulatory skills mutually compensated for the deficits of one another. This could be observed in relatively better results among the LK/HR, HK/LR, and HK/HR groups. However, the absence of both features had negative effects in the LK/LR group (Table 4).

Second, the findings suggest that learners with a higher level of knowledge of cognition and regulation of cognition performed better in word learning. This suggests that metacognition is a strong predictor of high-quality learning and effective problem-solving. It may be as explained by Blankson and Blair (2016), metacognition enables learners to better manage their cognitive skills, and to determine weaknesses that can be corrected by constructing new metacognitive skills. Another possible explanation is that these learners were more active in applying their past successful experiences, and were more sensitive to new information. This indeed helped them acquire new words. Therefore, it can be argued that students with a wide range of metacognitive skills are able to utilize the appropriate strategies for their learning or modify the existing learning strategies according to their awareness of effectiveness. This is an important step in picking up new words.

A quite unexpected finding not found in previous studies is that high regulatory competence can compensate for deficits in the knowledge of cognition. However, the high level of knowledge of cognition seem not to compensate for low regulatory skills. This is apparently observable in the similar word learning results between the LK/HR and HK/HR groups. However, the absence of high regulatory ability has negative effects on word learning results in the LK/LR and HK/LR group (Table 6). This supports the idea that high regulatory ability, but not knowledge of cognition, yields better word learning. This is in line with Schraw (1994), but contradicts Carvalho and Yuzawa's (2001) findings that the knowledge of cognition is a strong predictor of learning performance, in the same way that regulation of cognition is a strong predictor of learning results. Another finding is that there is a discrepancy between learners' self-assessment and actual performance. This suggests that some students were not confident with themselves while some learners were overconfident about themselves. As argued by He and Teng (2015), this may be related to students' psychological and personality traits. However, one issue to bear in mind is that level of confidence in the present study does not indicate the accuracy but the magnitude of confidence judgments.

To sum up, the findings concerning the relationship between knowledge and regulation of cognition confirmed our predictions. The findings related to the separateness of the two constructs and their mutually compensatory characteristic also confirmed our predictions. The knowledge and regulation of cognition played a conjoined role in predicting learners' level of confidence. In terms of learners' actual word learning performance, high regulatory competence can compensate for deficits in the knowledge of cognition. However, a high level of knowledge of cognition seem not to compensate for low regulatory skills for learning new words. Learners may not be able to reliably and efficiently assess their ability of word learning.

Hypothesis 2: A high degree of involvement load would lead to better performance in the word learning. However, task-induced involvement load would affect word learning as a function of participants' metacognitive knowledge and regulatory skills.

To answer how knowledge of cognition and regulation of cognition mediate the effects of task-induced involvement load on word learning among learners, the findings reveal that word learning is significantly affected by task-induced involvement load. This outcome is an important extension of Keating (2008), wherein word learning is highest in the sentence writing task (strong load), lower in the reading plus fill-in task (moderate load), and lowest in the reading comprehension task (low load). In line with prior research focusing on tasks with varying degrees of involvement load (Laufer & Hulstijn, 2001; Teng & Zhang, 2015), the results of the present study indicate that learners benefit most from engaging in a task of the highest involvement load.

A different but interesting finding in the present study is that low regulators were especially susceptible to task-induced involvement load. This was validated by the results showing significant effects of task-induced involvement load in those low regulators. However, high regulators were not significantly affected by the effect of task-induced involvement load. One possible explanation is that learners with a high level of regulatory skills may be more efficient in avoiding a distraction, perceiving responsibility for monitoring and reflecting their learning, setting goals, and managing time (Barbara, Nadia, Chiara, & Cesare, 2014). This may help them attain success in word learning regardless of the varying degrees of involvement load in the tasks. As discussed earlier, involvement load can be operationalized as the sum of different levels of need (motivational component), search and evaluation (cognitive component). Regulation operates through three components: Cognition, motivation, and metacognition (Hong, Peng, & Rowell, 2009). This indicates that high regulators possess a high level of cognitive and metacognitive awareness, and motivational domain. This is in line with previous findings that task completion is significantly influenced by students' self-regulatory behaviors and motivational beliefs (Bembenutty, 2009). As the tasks were completed independently, the motivational domain of high regulators might invoke them to value the task and have high self-efficacy for the task. This might enhance students' persistence when faced with difficulties, thus compensate for the deficits of low involvement load of the tasks.

The analytical results also suggest that the effects of task-induced involvement load on word learning are mediated by the regulation but not the knowledge of cognition. The pattern found for the intensity of the task-induced involvement load from the most to the least affected group was in order of LK/LR > HK/LR > LK/HR > HK/HR, similar to that found by Carvalho and Yuzawa (2001). This could be explained as that the knowledge of cognition is connected with the declarative knowledge, which affects learners' knowledge about themselves, tasks, and strategies but not how strategies are appropriately selected, resources are correctly allocated, and task performance is monitored and evaluated through which the word learning is made (Schraw, 1994). In contrast, the task-induced involvement load affects word learning as a function of the regulatory skills of learners, perhaps because a high level of regulation of cognition is essential to selection of task information that may help them attain better word learning success.

To sum up, empirical evidence provided in the present study supports that metacognitive awareness can interfere with task-induced involvement load.

Particularly, task-induced involvement load is mediated significantly by the regulatory competence but not by the knowledge of cognition. This corroborates the idea that the two components of cognition, although complementary, are independent and may play different roles in the cognitive processes (Callan et al., 2016).

Limitations

The limitations of this study include the methodological difficulties of assessing metacognition. The results of the present study were based on a self-report questionnaire. The self-report questionnaire in particular might not have been sensitive enough to accurately measure learners' metacognition because the output was based only on the students' recall of their academic routine. For further research, it is essential to apply multi-method designs, preferably combining multiple concurrent instruments to get a full and accurate portrayal of students' metacognition (Händel et al., 2013). Furthermore, future studies involving a larger sample of participants, preferably with different background, would make the findings more convincing.

Educational Implications

Some important educational implications can be concluded from the findings. First, as evaluation component is systematically controlled in the three tasks, this indicates that the evaluation component is crucial to word learning (Teng, 2015). This suggests that, in future teaching, vocabulary instruction should include word-focused tasks that require high degrees of evaluation.

Second, attention needs to be paid to the development of learners' regulatory ability in future teaching. This is because learners with high-regulatory skills are more likely to set their reasonable learning goals, plan accordingly based on their appropriate selection of the strategies and correct allocation of resources, monitor their learning performance, and evaluate the final product of their learning (Ziegler et al., 2011). Learners with low regulatory skills, in contrast, may not have explicit learning goals, and fail to effectively plan, monitor, and evaluate their learning, and deploy appropriate strategies to the situation (Cornoldi et al., 2015).

Finally, differences in metacognitive ability seem to mediate the effects of task-induced involvement load on one's confidence judgments and word learning. Since the monitoring processes are essential to complete any cognitive task, it is of importance that educators effectively show the importance of self-awareness to students. The role of knowledge construction should be emphasized in various learning settings, particularly to those with lower levels of metacognitive abilities.

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