Self-Explanation Strategies in Undergraduate Students

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ABSTRACT

This study aimed to investigate self-explanation strategies used by undergraduate students via a questionnaire method. This study aimed to examine the self-explanation construct and the relationship between self-explanation strategies and transfer performance. 353 undergraduate students participated this investigation. They studies a novice economic documentation, rated the SE instrument developed in this study, and took a transfer posttest. The result reveals that self-explanation construct has three dimensions: ‘rationale-based explanation’, ‘principle-based explanation’, and ‘monitoring negative understanding’. The three dimensions were positively interrelated and were statistically significant predictors of transfer performance. Both successful and unsuccessful generally tended to monitor their understanding deficiencies, but the successful problem solvers self-explained to-be-learnt material more frequently from the perspectives of central rationales and principles than did unsuccessful problem solvers.

INTRODUCTION

Self-explanation (SE) is known to be an effective metacognitive strategy of explaining to-be-learnt material to oneself in order to understand the material (Chi, Bassok, Lewis, Reimann, & Glaser, 1989). The SE would mediate an individual’s thinking to fulfill gaps between the internal mental model and external information presented, make sense of understanding impasses, and revise flaws of mental model (Chi, 2000). Consequently, self-explaining enhances schema development and transfer performance. For examples, a great number of empirical studies have shown that students who frequently explain to-be-learnt material to themselves outperform those who do not in transfer tests (e.g., Bielaczyc, Pirolli and Brown, 1995; Chi et al., 1989; Chi, de Leeuw, Chiu and LaVancher, 1994; Neuman and Schwarz, 1998). This phenomenon is called “SE effect” initially by Chi et al. (1989). The SE effect indicates that the amount of SEs generated during learning correlated to later transfer performance (e.g., Bielaczyz et al., 1995; Chi et al., 1989; Pirolli & Bielaczyz, 1989; Pirolli & Recher, 1994) and are important predictors of later problem-solving transfer performance (e.g. Neuman, Leibowitz, & Schwarz., 2000; Wong, Lawson, & Keeves, 2002)

However, Neuman and Schwarz (1998) demonstrated that SEs do not enhance learning in all cases. Self-explanations reflecting superficial information processing (such as paraphrase and reread) will not deepen an understanding of to-be-learned material. Therefore, identifying effective SE strategies related to schema construction is a worthy endeavor. Additionally, many theoretical relations are still unclear in SE literature, such as dimensionality of SE construct, interrelations between SE strategies, and the extent to which SE contributes to knowledge-transfer success.

Most previous studies on SE strategy have applied think-aloud measures (e.g., Bielaczyz et al., 1995; Chi et al., 1989; Chi et al., 1994; Neuman & Schwarz, 1998; Renkl, 1997a, 1997b; Reimann & Neubert, 2000; Wong et al., 2002). Administering, analyzing and rating students’ think-aloud protocols
require professionally trained observers and considerable time and effort. Therefore, investigating large sample sizes is extremely difficult, and hence researchers must accurately generalize data based on smaller sample sizes. Replicating investigations of students’ use of SE strategies with larger study populations is therefore necessary. Furthermore, SE may involve both thinking internally and overtly speaking to oneself (Chi et al., 1989; Chi, 2000). Self-explanation processes may not always reflect to think-aloud protocols which can be directly observed by investigators. Therefore, self-assessment by students may be a useful method for examining how students utilize SE strategies while reading and problem-solving. Questionnaire approaches have been adopted extensively in educational research. Although subject to the usual cautions of self-reporting techniques, rejecting self-reported data as a research tool in education would be inappropriate. As Silverman (1993) noted, a type of data is not intrinsically better than others. Students’ self-reported learning behaviors can complement data collected by think-aloud protocols and interviews. This study, therefore, used a questionnaire approach to assess the extent to which undergraduate students use SE strategies.

Current theoretical conception of SE awaits further validation, and undergraduate students’ own views of their SE strategies have not been explored. Therefore, this study primarily investigates the SE strategies employed by undergraduate students based on their own reports. The second goal is to examine whether the self-reported SE strategies are valid predictors of students’ problem-solving transfer performance. This study attempts to answer three questions: first, is the SE a multidimensional construct? If so, what are the dimensions? Second, what are the relationships between SE dimensions? And, third, can patterns of SE strategies be identified?

**Definition of Self-Explanation**

The first step in exploring the nature of SE was to devise a measure of SE strategies. The measure used in the current study was based on several previous studies which attempted to define the scope of SE and have devised coding categories for measuring students’ SE protocols. (Ainsworth & Loizou, 2003; Bielaczyc et al., 1995; Chi et al., 1989; Chi et al., 1994; Chiu, 1995; Mangari & Sweller, 1998; Nathan, Mertz & Ryan, 1994; Neuman et al., 2000; Renkl, 1997a, 1997b; Reimann & Neubert, 2000; Wong et al., 2002).

According to Chi et al. (Chi, 2000; Chi et al., 1989; Chi et al., 1994), SEs are considered inferences in which new pieces of knowledge are generated beyond the given material to comprehend the given material. Notably, SE differs from paraphrases and nonsensical statements in which no new knowledge is produced (Chi, 2000).

In the context of learning from expository text, explanations typically involve inferences that make connections between sentences, create relationships between concepts and words and link the newly learned material with existing knowledge. These inferences help create multiple meaningful relationships between knowledge elements and a coherent knowledge representation, which improves memory and allows retrieval for future application (Anderson, 1990; Chi, 2000).

In the context of procedural learning, explanations involve inferences about if-then conditional rules (Chi et al., 1989) such as refining and expanding the conditions under which an action is taken, explicating the sequences of an action, providing a goal for a series of actions, relating the consequences of one action to another, explaining the meaning of a set of operators and quantitative equations and relating a set of actions to the principles and concepts on the domain (Chi et al., 1994).

In a further refinement of Chi et al.’s proposal, Neuman et al. (2000) suggested that the SE construct may include other dimensions in addition to inference. Neuman proposed that SEs involve not
only inferences of new knowledge but also clarification of the problem and justification of actions that took place during the problem-solving process. The results of Neuman et al.’s (2000) study indicates that SE can accurately predict problem-solving performance, with inference and clarification the most important SE categories.

The definition of SE by Chi et al. (Chi, 2000; Chi et al., 1989; Chi et al., 1994) excludes metastrategic statements. However, Renkl (1997a) defined SE as the strategy of both inference and monitoring understanding. Based on this definition, Renkl (1997b) classified students’ SE protocols into seven categories: (1) Anticipative reasoning: explanations using reasoning to predict the next action; (2) Principle-based explanation: explanations referring to domain principles related to actions, operators and the solution; (3) Goal-action combinations: explanations concerning associations between the goal and actions; (4) Elaboration of problem situations: explanations concerning the problem space and conditions under which solution actions take place; (5) Noticing coherence: explanations about the coherence of relationships between texts, examples and problems; (6) Negative understanding monitoring: explanations regarding content locations of understanding failures; and (7) Positive understanding monitoring: explanations regarding understood material. The results of Renkl’s study revealed that principle-based explanations, anticipative reasoning and goal-action combinations contribute to students’ problem-solving performance; however, negative monitoring statements associate negatively to problem-solving performance.

Although monitoring negative understanding is inversely related to problem-solving performance, negative understanding guides learners to generate necessary SEs. Chi et al. (1994) and Bielaczyc et al. (1995) found that SEs are highly tied to metastrategic statements about detected failures of understanding. Learning is enhanced when statements of monitoring understanding difficulties, in general, are followed by further necessary explanations.

In sum, protocol studies have generated a wide range of SE strategies. Self-explanation is a complex process, and the SE construct may be multi-dimensional (Renkl, 1997b). Based on the above studies, a list of twenty representative SE strategies was compiled to serve as an initial item pool for the preliminary SE questionnaire.

**METHOD**

**Self-Explanation Measure Item Generation**

The preliminary questionnaire was reviewed, approved and verified by a panel of four professors who are experts in specializing in cognitive science and instruction. All panelists agreed that the twenty items measuring the desired scope and important SE strategies should not be omitted. Next, ten university students were invited to test the clarity of each item on the questionnaire. Comments from the students facilitated refinement and improved the precision of the questionnaire. The above procedures established the face validity and content validity of the 20-item SE instrument.

Each of the twenty-seven items required respondents to rate the extent to which they actually engaged in SE behavior while studying learning materials and solving problems. The response for each item was based on a 7-point Likert-type scale, with a frequency range from 1 = “never” to 7 = “always”.

**Pilot Testing**

The reliability of each item was tested by a pilot study involving fifty undergraduate students. Item-total correlation analyses and reliability tests were performed. Cronbach’s alpha reliability
coefficient for the twenty-item instrument was .94, and each of the twenty-seven items had a corrected item total correlation above .60, ranging from .60 to .87.

**Participants**

Participants were recruited from four universities in Taiwan. Study announcements were posted on university bulletin boards. Undergraduate students who had never previously taken an economics course were invited to participate. In total, 353 undergraduate students participated in this study. Each student received a $5 fee for participating. The distribution of participants’ majors was: business education, 18.00%; counselling psychology, 12.46%; finance and banking, 11.07%; physics, 10.37%; accounting, 10.00%; information management, 9.92%; computer science, 9.91%; chemistry, 9.67%; and English 8.60%. Of all participants, 28% were sophomores, 34% were juniors, 17% were freshmen and 21% were seniors; 50.4% were female and 49.6% were male. Participants ranged in age from 18 to 27 years old, with mean age of 21 years.

**Materials – The study website**

The study website contained content regarding the goal of the study, an economics course, The Logic of Consumer Choice, an economics knowledge posttest and the SE questionnaire. The content was separated into four sections. Sections were presented sequentially. The learners were not allowed to review the content of previous sections but could freely peruse any web page in the current section. The study was introduced in the first section, and the economics course was presented in the second section. The economics course was comprised of 11 web pages. Ten web pages were related to fundamental economic concepts regarding utility, indifference curve analysis and budget constraints; one web page illustrated a worked example of indifference curve analysis to explain consumer choice. The posttest consisting of one near-transfer question and one far-transfer question was administered in the third section. The near-transfer question was analogous to the worked example. The far-transfer question differed from the problem schema of the worked example. To solve the far-transfer question, students needed to have adequate comprehension of the website’s contents. After completing the posttest, the learners clicked the next button to complete the fourth section of the questionnaire.

The economics course and post-test were refined and validated by three economics professors with at least ten years of teaching experience. Additionally, the economics course was scheduled for 1 hour, and the posttest was scheduled for 30 minutes. The SE questionnaire had no time limit.

**Data Collection**

The investigation was conducted in a state-of-the-art computer laboratory equipped with fifty IBM PCs. Approximately fifty participants were allowed to work in the computer laboratory at one time, and all participants were instructed to work individually. Researchers were present throughout the course and post-test to answer any questions regarding software operation. Participants received a brief overview of the study and were told that their comprehension of the online course would be subsequently tested. Participants were also instructed to respond to the SE questionnaire honestly based on their behavior during the course and test sections. Participants were then instructed to log on to the website and sequentially follow all instructions. All participants completed the posttest within the 30-minute time limit. However, all participants were required to spend equal time (1 hour) studying the course content. The investigation lasted approximately 2 hours.
To determine posttest scores, students completed a series of ten items selected from the range of near-transfer and far-transfer questions. Each correct response received a score of 1. The full score for each question was 10. A total transfer score was calculated for each student by summing correct responses to the two questions.

RESULTS AND DISCUSSION

Item Analysis and Reliability Estimates

To purify the 20-item instrument, we first calculated the coefficient alpha and the item-total correlations. The 20-item SE instrument had a reliability coefficient (Cronbach’s alpha) of .93. The correlations with the corrected item-total ranged from .46 to .76. Items were excluded if their correlation with the corrected item-total was below .50 or their correlations produced a substantial drop in the plotted pattern. Based on this criterion, the 20 items were reduced to 17. The reliability coefficient for the remaining 17 items remained at .93.

Factor Structure of Self-Explanation

Exploratory factor analysis was conducted to examine the factor structure of the reduced 17-item instrument. The sample data of 353 responses was examined using principal axis factoring analysis as the extraction technique and oblique approach as rotation method. Bartlett’s test of sphericity had a chi-square value of 2655.72 and a significance level, p < .001 suggesting that the inter-correlation matrix contains sufficient common variance to make factor analysis worthwhile.

Without specifying the number of factors, four factors with eigenvalues greater than one emerged. Three items had multiple loadings of > .5 on other (non-primary) factors. In order to improve the distinction between factors, these three items which had factor loadings greater than .5 on other factors were excluded from the instrument. After several iterations of factor analysis and item deletions, 11 items representing three distinct factors emerged as explaining 67.30% of the variance in perceived SE ability. These factors were interpreted as ‘rationale-based explanation’, ‘principle-based explanation’, and ‘monitoring negative understanding’. Table 1 summarizes the factor loading for the condensed 11-item instrument.

### Table 1. Factor loadings of the 11 items of the SE measure

<table>
<thead>
<tr>
<th></th>
<th>Principle-based explanation</th>
<th>Rationale-based explanation</th>
<th>Monitoring negative understanding</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Principle-based explanation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indicate what concepts or principles applied</td>
<td>.78</td>
<td>.48</td>
<td>.36</td>
</tr>
<tr>
<td>Explain the causal relationship between solution operations and the problem goal</td>
<td>.95</td>
<td>.48</td>
<td>.41</td>
</tr>
<tr>
<td>Explain how the principle supports the solution</td>
<td>.89</td>
<td>.47</td>
<td>.39</td>
</tr>
<tr>
<td>Name out solution operations (steps)</td>
<td>.68</td>
<td>.30</td>
<td>.39</td>
</tr>
<tr>
<td><strong>Rationale-based explanation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explain the relationship between problem situation and solution rationale</td>
<td>.41</td>
<td>.77</td>
<td>.42</td>
</tr>
<tr>
<td>Explain the problem goal</td>
<td>.42</td>
<td>.83</td>
<td>.31</td>
</tr>
</tbody>
</table>
Explain the principal ideas of the material.  
Clarify the new learnt material with similar or relevant concepts.

<table>
<thead>
<tr>
<th>Monitoring negative understanding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indicate what did not understand</td>
</tr>
<tr>
<td>Clarify why my predicting solution differs from the correct solution presented</td>
</tr>
<tr>
<td>Indicate what learning goals were not attained</td>
</tr>
</tbody>
</table>

Reliability (α)  
Eigenvalue  
% of variances explained

<table>
<thead>
<tr>
<th>Variables</th>
<th>PE</th>
<th>RE</th>
<th>MNU</th>
<th>SE</th>
<th>TP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principle-based explanation (PE)</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rationale-based explanation (RE)</td>
<td>0.50*</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monitoring negative understanding (MNU)</td>
<td>0.38*</td>
<td>0.44*</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall SE (SE)</td>
<td>0.78*</td>
<td>0.82*</td>
<td>0.78*</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>transfer performance (TP)</td>
<td>0.50*</td>
<td>0.48*</td>
<td>0.17*</td>
<td>0.48*</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(0.36**)</td>
<td>(0.33**)</td>
<td>(-0.14*)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Partial correlation coefficients are in parentheses.

*p < 0.01; **p = 0.00

Internal Consistency

Reliability was evaluated by assessing the internal consistency of the items representing each factor using Cronbach’s alpha. The overall reliability of the condensed 11-items instrument was .89. The reliability alpha scores were .88, .89 and .84, for ‘rationale-based explanation’, ‘principle-based explanation’, and ‘Monitoring negative understanding’, respectively. These scores exceeded the reliability cut-off points suggested by Nunnally (1978) demonstrating good internal consistency.

Moreover, corrected item-total correlations for the 11-item instrument ranged from (.56-.75), whilst the individual factors for these were as follows: ‘rationale-based explanation’ (.71-79), ‘principle-based explanation’ (.63-.87), and ‘monitoring negative understanding’ (.67-.74). These coefficients show that all of the individual items are associated with their respective factors and the full instrument.

Correlations between Self-Explanation Dimensions and Problem-Solving Performance

Table 2 presents a 5 × 5 matrix of Pearson product-moment correlation coefficients for mean scores for the three SE factors, overall SE and the transfer test. The result revealed that (1) the three underlying factors of SE, namely, principle-based explanation, rationale-based explanation, and monitoring negative understanding, were significantly associated with each other (r(353) = .50, p < .01, r(353) = .38, p < .01, and r(353) = .44, p < .01, respectively); (2) students’ transfer performance had a moderate, positive correlation with their overall SE strategy (r(353) = 0.48, p < 0.01); (3) the three factors of SE strategies had a significantly positive correlation with students’ transfer performance (r(353) = 0.50, p < 0.01, r(353) = 0.48, p < 0.01, and r(353) = 0.17, p < 0.01, respectively). The result was accorded with other studies (e.g., Bielaczyz et al., 1995; Chi et al., 1989; Pirolli & Bielaczyz, 1989; Pirolli & Recher, 1994), SEs positively correlated with students’ problem-solving performance.
The significant correlations between the three SE factors suggest that students who tend to infer central rationale of the material are also likely to clarify underlying principles for the solution, as well as students who monitored their understanding also tend to engage in rationale-based and principle-based explanation.

However, past analytical studies reveals ambiguous relationship between monitoring understanding and transfer performance (e.g., Ainsworth & Burcham, 2007; Chi et al., 1989; Renkl, 1997b). In Chi et al.’s study, monitoring negative understanding was followed by necessary explanations that led to improved understanding and transfer performance. In contrast, a monitoring negative understanding associated negatively with transfer performance in Ainsworth and Burcham’s (2007) and Renkl’s (1997b) studies. Consequently, this study infers that the positive association observed in the current investigation between monitoring negative understanding and transfer performance might be due to the significant correlation among transfer performance and principle-based explanation and rationale-based explanation.

A partial correlation analysis, therefore, was conducted to investigate the simple relationship between monitoring negative understanding and transfer performance. After controlling the effects of principle-based explanation and rationale-based explanation, monitoring negative understanding revealed a significant negative association with problem-solving performance (r(353) = -0.14, p<0.01). This negative relationship is consistent with the findings of Ainsworth and Burcham’s (2007) and Renkl (1997b). One interpretation of this result is that if monitoring negative understanding does not initiate enough rationale-based and principle-based explanations, the students’ understanding difficulties will subsequently hinder their transfer performance. Conversely, principle-based explanation and rationale-based explanation still associated positively with PS performance when controlling the effects of SE factors other than the factor in question ((r(353) = 0.36, p <0.01 and r(353) = 0.33, p <0.01, respectively).

Predicted Self-Explanation Factors in Problem-Solving Performance

A linear regression equation was conducted to compute the standardized coefficients for predicting transfer performance with principle-based explanation, rationale-based explanation and monitoring negative understanding. The result showed that the three predictors together explained much of the variance in transfer performance: R² = 0.33, Adjusted R² = 0.33, F(3, 344) = 57.69, p < .01. The regression analysis indicated that principle-based explanation (standardized β = 0.37, p < .01) and rationale-based explanation (standardized β = 0.35, p < .01) were positive predictors, while monitoring negative understanding (standardized β = -0.13, p < .01) was a negative predictor.

Cluster Analysis and Different Types of Learners

An exploratory cluster analysis (Ward procedure with squared Euclidean distances) was conducted to investigate the possibility of different types of learners. More specifically, learners were grouped according to similarities in the transfer performance score and SE values of rationale-based explanation, principle-based explanation, and monitoring negative understanding. In order to give variables the same weight and to prevent the influence of certain variables over others due to larger variances, all variables used in this analysis were computed into z-standardized values.

The resulting dendrogram favored a two-cluster solution. Figure 1 shows the profiles of the two groups. The learners in Cluster 1 actively monitored their understanding difficulties and productively generated rationale-based and principle-based explanations, as well as performed well in the transfer posttest. This Cluster was called ‘successful, active self-explainer’. Learners in Cluster 2 generally

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disinclined to self-explain. Though they detected their understanding difficulties at times, they seldom conducted rationale-based explanations, and principle-based explanations. Thus, the learners of this group were labeled as ‘unsuccessful, passive self-explainer’.

Figure 1. Profiles of the self-explanation clusters

CONCLUSION

Implications for Research

This study contributes to the literature on instruction and learning strategies by demonstrating (1) three-factor structure of the SE construct, (2) positive associations between SE strategies and transfer performance and (3) the differences in self-reported SE strategy uses between successful and unsuccessful transfer-performance undergraduate students.

The three factors of SE construct are rationale-based explanation, principle-based explanation, and monitoring negative understanding. The three factors are significantly and positively related. As predictors of students’ transfer performance, rationale-based explanation and principle-based explanation have a moderate positive effect, whereas monitoring negative understanding has a weak negative effect. Combined, these three predictors account for 33% of the variance in students’ problem-solving performance. Overall, self-reported SE strategy use associated positively with transfer performance.

In terms of differences in SE strategy use between successful and unsuccessful students, the great difference was related to rationale-based explanation and principle-based explanation, and a small difference was observed in monitoring negative understanding. This finding suggests that rationale-based explanation and principle-based explanation are key strategies used by successful learners. Though both successful and unsuccessful students monitored their understanding difficulties, the successful students would further elaborate the material by referring central rationale and principles to resolve their understanding flaws, whereas the unsuccessful students did not. It might be difficult for unsuccessful students to generate rationale-based explanations and principle-based explanations without external instructional supports.

Implications for Education practice

The findings of the present study have two main implications for educational practice. First, the eleven SE strategies suggested in the present study have implications for strategy-based instruction design.
Research has shown that explicit instruction in the application of SE strategies enhances learning (Bielaczyc et al., 1995; Chi et al., 1994). However, too many strategy-based instructional interventions produce expertise reversal effect which may interfere with schema development (Kalyuga, Ayres, Chandler and Sweller, 2003). However, insufficient instruction is not an effective guide for students to utilize SE strategies. The concern for educators is to identify which strategies contribute to deep learning and which are redundant; that is, their interventions may produce a greater expertise reversal effect than the effect on learning produced by SE. Accordingly, the eleven SE strategies suggested in the present study can serve as reference indicators for teachers designing strategy-based instruction, which involves teaching students to apply SE strategies to their learning process.

Second, self measures of SE use have implications for students. Metacognitive awareness is important for success in a self-directed learning context, particularly in virtual open learning environments. Strategy assessment by students can foster their metacognitive awareness, which can help students assess their acquisition of knowledge and cognitive skills. Accordingly, the SE measure can aid self-regulation, which in turn increases students’ control over their understanding of materials in their own learning process.

Limitations and Future Studies

Several limitations should be considered when interpreting the results of this study. The generalizability of the SE factor structure and corresponding strategies as well as the extent to which SE strategies are used by students concluded in the present study is limited due to the use of a convenience sample. Further study is required to validate the present findings by using probability sampling for data analysis. The findings of the present study require further validation by data analysis of think-aloud protocols and interviews.

The same is true for generalizing across diverse complexities and structure-types of materials. According to Quilici and Mayer (1996), learners employ more frequently learning strategies when they study a more explicit-structure task than when they study content with vague structure. In addition, Wong et al. (2002) concluded that learners utilize SE strategies more frequently when they study more difficult material. In this study, the example studies and problems in the posttest were well-structured in nature. An investigation of dimensions and extent to which SE strategies are used within the context of ill-structured material may yield a different result. Therefore, future studies are still necessary to examine dimensions and extent of use to which SE strategies across learning content with differences in complexity and structure explicitness.

Although such limitations do qualify the results of the present study, this study takes an initial step toward understanding how undergraduate students self-assess their use of SE strategies. The strategies identified by self-reported data in this study are consistent with successful SE strategies revealed by prior studies using think-aloud measures. In addition, this study demonstrated that students’ self-reported strategies can be useful predictors of their problem-solving performance, which is consistent with Neuman et al.’s (2000) findings based on student think-aloud protocol data. We hope that the SE factor structure, correlations between SE factors and the extent to which each SE factor predict problem-solving performance identified in the present study might stimulate further development of SE theory. To further our understanding of the SE effect, future research need examine the effect of individual SE factors on different learning measures. In addition, identifying associations between personal traits and SE strategy use can enhance our understanding of SE strategy preferences in different groups of students. Such personal traits may include learning attitudes, motivation, personality type, learning style, learning
experience, gender, and age. Hence, these interactions between SE strategy use and various personal traits require further research.

REFERENCES


