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Self-efficacy as a mediator in computer learning

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This study focused on a mediational role of self-efficacy in educational setting. Ninety-four students who participated in computer class completed the questionnaires of goal orientation, computer anxiety and perceived control. After the estimation of their sense of efficacy toward computer manipulation, they were assigned an achievement test which was conducted on every week. Path analysis was used to investigate the effects of goal orientation, computer anxiety, perceived control and self-efficacy on achievement score. Results indicated that goal orientation and computer anxiety had the significant relationships to perceived control. Moreover, perceived control showed an effect on self-efficacy and self-efficacy revealed a significant positive path to achievement score. Motivational variables and anxiety had the indirect effects on achievement score mediated by self-efficacy. Further, subjects who had high self-efficacy showed well organized structure of task related knowledge.

Bandura (1977) proposed the concept of self-efficacy, which is known as a expectation of performing an activity to get a favorable results, and the importance of this concept was mentioned in various settings (e.g., clinical setting, school, sport). Self-efficacy is strongly related to performance. It is a predictor of performance and the improvement of performance produces higher self-efficacy. Thus, self-efficacy has a reciprocal relationship with performance. Examining the relationship between these variables, the baseline performance should be controlled and the both variables should be assessed successively.

Self-Efficacy is a task-specific concept and it is constructed through the task completion. When one has not much experience in performing the task, it is suggested that self-efficacy is predicted by global perceived control beyond the task. Kambara & Yamaji (1992) developed the inventory of perceived control in the learning setting. It is classified into three aspects: (1) perceived contingency is the expected correspondence between one's response and outcome in the environment, (2) perceived efficacy is the judgment of the required action being in one's behavior repertoire, (3) perceived autonomy is the perception of being the initiating agent of a given behavior.

Recently, goal orientation is regarded as the factor that constructs the perceived control. Dweck (1986) induced the theory of intelligence as a explanation of maladaptive motivational patterns in the research of learned helplessness. The theory of intelligence is one's belief toward the intelligence and it is categorized into two theories. Entity theory is based on the belief that the intelligence is fixed, whereas incremental theory is the idea that the intelligence is malleable. The latter drives the learning goal, in which individual seeks to increase one's competence, to understand or master something new, and the former induces the performance goal, in which one seeks to gain favorable judgments of one's competence or avoid negative judgments of one's competence.

There were studies that examined the relationship between self-efficacy and performance based on the theory of intelligence. Wood & Bandura (1989) conducted the experiment of managerial decision making. They revealed that the decrease of self-efficacy was shown in entity theory, however, self-efficacy sustained in incremental theory. This result received support from the study of Martocchio (1994), who examined the effect of theory of intelligence on computer self-efficacy and indicated the mediating role of self-efficacy between goal orientation and performance.

There are some discrepancy in word usage, however, goal orientation usually appear to fall into two classes of learning goal and performance goal (Ames, 1984; Dweck, 1986; Nicholls, 1984). Contrary to this suggestion, Hayamizu et al., (1989) revealed two performance goal (task-related outcome orientation and approval orientation) and three categories were emerged in total. In this study, we use the items based on three goal orientations.

On the computer research, there are many studies which pay attention to computer anxiety (e.g., Bandalos et al., 1995; Coovert & Goldstein, 1980; Igbaria & Parasurama, 1989). Igbaria & Parasurama (1989), for example, indicated that anxiety had an indirect effect on behavior toward computer. In the study which examined the relationship between perceived control and computer behavior, it was clarified that person high in perceived control regarded computer as a useful tool (Coovert & Goldstein, 1980). There was not any study which explored the relation of computer anxiety to self-efficacy, however, Bandalos et al. (1995) investigated the relationships between test anxiety, self-efficacy and causal attribution at a class of statistics. The find-

ing revealed a negative relation between self-efficacy and anxiety for statistics. Therefore, it is considered that the higher computer anxiety, the higher resistance to computer manipulation. We postulate that computer anxiety has an indirect effect on performance mediated by perceived efficacy or self-efficacy.

Basically, anxiety disturbs the acquisition of knowledge, while self-efficacy promotes it (Martocchio, 1994). Darke (1988) indicated that high test anxiety deteriorated performance, because the short-term memory was occupied with the information unrelated to a task, which disturbed the information processing necessary for executing a task. In this view, the high self-efficacy will make the information processing properly, and the construction of knowledge will be sophisticated. With regard to the construction of knowledge, Cachapuz & Maskill (1987) used the association test. This study also uses this method to investigate the relationship between self-efficacy and construction of knowledge.

The purposes of this study are (1) to examine the reciprocal relationships between self-efficacy and performance based on the hypothesized model presented in Figure 1, and (2) to investigate the effects of self-efficacy on the construction of SAS knowledge.

METHOD

Subjects. The subjects were ninety-five undergraduates who enrolled in the psychological computer course (using SAS: Statistical Analysis System).

Measures. Goal Orientation for Computer Learning. A questionnaire, which based on Hayamizu et al. (1989), asked the reason for learning a computer and it contained the concepts of three goal orientation: learning goal, performance goal of seeking other's approval and performance goal of seeking a good grade. The students were instructed to respond to the items on a five-point scale ranging from 5 (agree) to 1 (disagree).

Computer Anxiety. The measure was based on Hirata (1990) and Heinssen et al. (1987) and it contained the items related to anxiety of computer operation and wish for computer access. The respondent was made on 5 point scale same as Goal Orientation.

Perceived Control in Computer Learning. Kambara & Yamaji (1992) designed the inventory of perceived control in learning of high school students and this was modified to compatible with computer learning of undergraduates. This questionnaire is supposed to comprise of three subscales: 1) perceived efficacy, which meant the judgement of behavior, 2) perceived contingency between behavior and result, 3) perceived autonomy for behavior. The five-point scale was used in respondent.

Self-Efficacy for SAS Program (SE). An inventory consisted of 30 items included the self-efficacy for the basic computer operation (e.g., "copy and delete a file") and SAS program (e.g., "conduct a ttest"). The respondent was made on 5 point scale ranging from 5 (I can do it well) to 1 (I can't do it at all).

Performance (PER). The tests administered at the end of every class were used as performance. The questions of these tests included the completion of SAS program and the explanation of the outputs of SAS analyses.

Association Test. The test was conducted to examine the construction of knowledge of SAS concept. The subjects were induced to associate the words based the following 12 target words in three categories: (A) computer term: file, program, disk, data, error; (B) statistical term: distribution, mean, scale, test; (C) middle term of (A) and (B): SAS, variable, table.

Contents of Course. The psychological computer course took place during the 12 weeks in the half of the year. The contents of course were as follows:

1) Basic computer operation: Log in and log off of Windows and some applications, usage of mouse, manipulation of window and file.
2) Basic SAS operation: Log in and log off of SAS, submit of program, file and recall of program.
3) Making a data file and basic SAS program.
4) Reading a data file in SAS and output of its content, computation of simple statistics (mean etc.).
5) Output of frequency.
6) Computation of total sum, making of histogram, computation of univariate statistics.
7) Sorting and ranking the groups, chi-squared test.
8) Computation of correlation, plotting of correlational data, making of a title.
9) Univariate regression analysis, multivariate regression analysis, plotting of three-dimensional correlational data.
10) ttest, univariate analysis of variance, making of tabulate.
11) Analysis of variance (two factors), making of line graph.
12) Factor analysis.

Procedure. Before the course began, the questionnaires of computer learning (goal orientation, computer anxiety, perceived control) were administered to the subjects. Self-efficacy was assessed and the tests were conducted at the end of every class. Also, at the end of the course, the association test and the program test (PER3) included the whole contents of SAS analyses were conducted.

Prior to the analysis, the course was divided into two terms. The first term ranged from week 1 to week 6 (SE1 and PER1), and the second term was from week 7 to week 12 (SE2 and PER2). The test in

week 1 and week 4 could not be administered because of the class proceedings.

RESULTS

1. Factor Analysis.

In order to explore the construction of the items of computer learning, a factor analysis was performed on goal orientation, computer anxiety and perceived control.

In goal orientation, three factors were emerged. Factor 1 was loaded on seven items (e.g., "I want to be praised by friends and teachers.", "I want to show others how I can manipulate a computer.", "I want to improve my grade.") These items represented the performance goal, which contained the notions of both gaining a high grade and approval from others. Factor 2 showed high loadings on five items such as "It is fun to manipulate a computer well.", "I can learn the new things.", "A computer is interesting.", and it was the reflection of learning goal. Factor 3 was loaded on the two items; "I want to get a good job or enter to the graduate school that I prefer.", "I can get a good job if I can handle the computer.". These items included the orientation to learn a computer for the future. The result of factor analysis was not congruent with that of Hayamizu et al. (1989). It was indicated that outcome orientation of undergraduates was related to taking a job and was different from that of junior high school students, who have a high involvement in grade. According to the result, three subscales were comprised of summing the seven items of the first factor (α =.85), the five items of the second factor (α =.81) and two items of the third factor (α =.71). These scales were called approval orientation, learning orientation and outcome orientation, respectively, based on Kambara et al. (1994).

In computer anxiety, two factors were revealed, as expected. Factor 1 was loaded on nine items (e.g., "I hesitate about using a computer because of making a mistake.", "It's anxious for me to use a computer."), while factor 2 showed high loadings on six items (e.g., "I eager to manipulate a computer when I saw such a person.", "I want to know more about computer."). Two subscales were composed of items which highly loaded on each factor, and these scales were named anxiety of computer operation (α =.92) and wish for computer access (α =.72).

Kambara & Yamaji (1992) revealed the three subscales (perceived efficacy, perceived contingency, perceived autonomy) on perceived control in learning at high school. But in this study, perceived autonomy was not shown independently and was included in perceived efficacy. The result indicated that two factors were valid for the items related to computer learning in undergraduates. The reason for this discrepancy was considered as the difference of control over studying or learning. The undergraduates are substantially self-determined in studying, while junior-high or high school students have a sense of compulsion in learning. Perceived efficacy subscale was consisted of eight items (e.g., "I' m not anxious about using a computer.", "I learn a computer of one's own will.","I don't know the concrete method of computer learning. (reversed)") and perceived contingency subscale was composed of four items (e.g., "If I learn the computer eagerly, I would get a good result.", "The harder I learn a computer, the more I can do anything using it.", "If I learn a computer eagerly, I would become a bigger person.", "Whenever I learn a computer eagerly, my grade would not go up.(reversed)"). The alpha coefficients were .90 and .69, respectively.

2. Path Analysis.

Path analysis was conducted on the hypothesized model (Figure 1). As preliminary analysis revealed that performance orientation and wish for computer access showed no significant path, these variables were excluded from the analysis. Also it was hypothesized that goal orientation and computer anxiety had no direct effect on self efficacy and performance. The significant paths ($p<.05$) were presented on Figure 2. It was considered that the indices of goodness of fit on model met appropriate standard (GFI=0.96; AGFI=0.84; $\chi^2=12.5$, $p>0.30$). The findings of analysis showed the significant paths from goal orientation (learning orientation) and computer anxiety (anxiety of computer operation) to perceived control. Perceived efficacy, which was a subscale of perceived control, revealed the positive effect on self-efficacy 1 (SE1) as expected. On the contrary perceived contingency did not show the significant effect on self-efficacy 1, but showed a week direct effect on the later self-efficacy (SE2). It was suggested that perceived contingency might contribute to the increase of self-efficacy. Performance was determined by the former self-efficacy

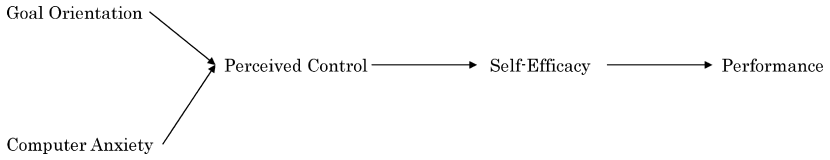


Figure 1 Hypothesized model in computer learning process.

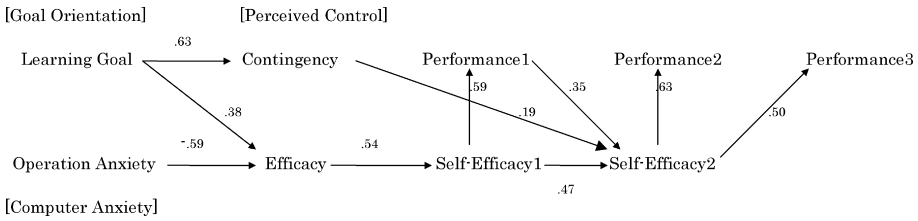
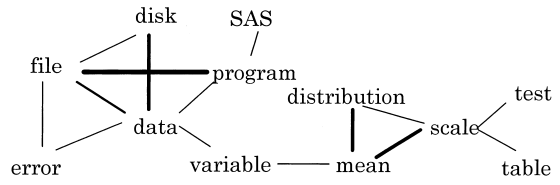


Figure 2　The paths between goal orientation, computer anxiety, perceived control, self–efficacy and performance. ***Only the significant paths are drawn.***

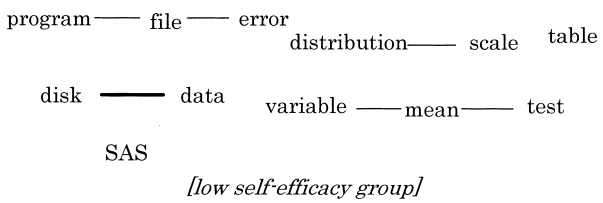
rather than the previous performance, though self–efficacy 2 (SE2) was predicted by both the former self–efficacy (SE1) and performance (PER1). In sum, it was suggested that the goal orientation for computer learning, computer anxiety and perceived control had the indirect effects on performance mediated by self–efficacy.

3．The construction of SAS knowledge.

The subjects were divided into 4 groups according to the score of self–efficacy on third term. The upper 25% were assigned to the high self–efficacy group, while the lower 25% were allocated to the low self–efficacy group. The target words were connected with lines if there were more than three common association words between the based terms. As seen in Figure 3, the lines were stronger in high self–efficacy group and it meant that the concepts of each word related closely. Whereas these were weak in the low self–efficacy group, and it was suggested that the relationships between the concepts were discrete. In high group, the computer terms "file", "data", "disk" and "program" were linked tightly and the three statistic terms "distribution", "mean" and "scale" had the reciprocal relations. These words were related through a word "variable", which classified into the middle term



[high self-efficacy group]



[low self-efficacy group]

Figure 3　Concept network in high and low self–efficacy group.

of computer and statistic. That is, twelve all words connected in some way. In low group, to the contrary, only the diffuse relations between words were shown and complex structure like the high group was not revealed.

DISCUSSION

In this study, the relationship between self–efficacy and performance was investigated by taking the successive data on usual computer class. The results showed that self–efficacy was a significant predictor of performance in each term and self–efficacy rather than the former performance predicted performance itself. These findings indicated that the importance of cognitive variable such as self–efficacy on performance. The task used in this study was SAS program and it was novel for subjects. The pre–performance was controled in that everybody could not operate SAS program. Therefore, at the first step of learning, the performance level will be explained well by self–efficacy. When one gains experience, however, self–efficacy will be affected by performance. This reciprocal relationship revealed that self–efficacy predicted performance and in turn, performance predicted self–efficacy.

The degree of influence of past performance on future performance is affected by the criterion of performance (George, 1994). In this study, the every test was limited to a content learned at that time. Because the difficulty of test was varied in every class, it did not have continuity like the measure of self–efficacy. This seemed one reason for the insignificant path from PER1 to PER2. In either case, the correlation of self–efficacy to performance was strong in various situations (e.g., Fitzsimmons et al., 1991), and it is predicted that this relationship is stable rather than the relationship between performances, which are vulnerable to the criterion of measurement.

In order to investigate the relation of self–efficacy to performance from distinct aspect, subjects were split into 4 groups according to the final test score (PER3). Examined the change of self–efficacy, it was increased gradually at each class in every group (Figure 4, $F(3, 192) = 1040.5$, $p < .01$). This is the case, that self–efficacy was measured in 30 items and each scale re-

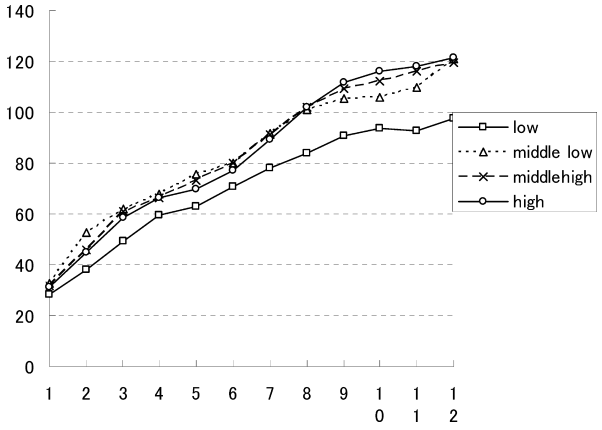


Figure 4 Changes of Self Efficacy

flected the sum of items, which was learned in class from then. Compared the change of self-efficacy between 4 groups, the least achievement group was low in self-efficacy consistently ($F(3, 64) = 5.75$, $p < .01$). Particularly in the latter half period, self-efficacy increased rather gently in this group compared to upper achievement groups ($F(9, 192) = 3.42$, $p < .01$). In the first half period, programming of SAS was centered in class and students had many occasions of reviewing basic programming of DATA step. In the latter half period, statistical content was emphasized rather than programming. It is considered that the least achievement group keeps holding the feeling of incapability toward basic programming, therefore, they cannot make a preparation for learning the statistic. As a result, they were low in final test, which included the content of programming and statistics. Made reference to the time of manipulating a computer in a week, least group decreased it from the latter period on, even not handling it for a week. Although lesser achievement group was also lower in test score, this group revealed high self-efficacy as upper groups and operated a computer to some extent, though the manipulating time was shorter in this group than upper groups. In brief, they were familiar with computer. The measure of the time of manipulating a computer was not limited to SAS; in fact, it included the time they spent on a game. But it is said that when you want to be familiar with a computer, play a game. Through taking hours in handling a computer, one can learn how to manipulate it. At the early stage of learning, the time spent on a computer handling leads to a high confidence toward operating a computer, and these raise self-efficacy.

At the early stage of learning, we postulated goal orientation and computer anxiety as the indicators of perceived control, further, it was assumed that the perceived control was the predictor of self-efficacy. As predicted, results of the relationships between these variables revealed that learning goal promoted perceived control. Also, anxiety toward computer operation depressed perceived efficacy. The positive path was revealed from perceived efficacy to self-efficacy at the first stage (SE1) and it was suggested that the lower a psychological cost for learning behavior, the higher self-efficacy at the early stage. As already mentioned, self-efficacy was predictive of performance and the results showed the indirect effects of goal orientation and computer anxiety to performance mediated by perceived control and self-efficacy. The attitudes toward learning, that one thinks of learning as the methods of taking a class unit or finding a job, or as knowing new things are the reflection of students' interests and teacher cannot control it. In contrast, anxiety for computer operation or groundless low efficacy (learned helplessness) can be managed by teacher and these factors would take an important role in task performance.

The construction of knowledge in learning a computer was examined in regard to self-efficacy using an association test. Result indicated the difference of construction at the level of self-efficacy, that high self-efficacy group (upper 25%) revealed the complex structure compared to low group (lower 25%). The number of associated words itself did not make any significant difference between 4 groups, which divided according to the score of self-efficacy ($F(3, 72) = 1.82$, n.s.). It is suggested that the ability of making association words does not differ in the level of self-efficacy. And also, the number of common association words between the target words was not revealed any difference between groups ($F(3, 72) = 2.06$, n.s.). This mentioned that association words were divergent in low group, while in high group, these were concentrated in target words and knowledge was constructed precisely. On the concept network in high group, two structures were clarified and one of them included the basic computer concept, the alternative comprised of the words with regard to statistics. Moreover, these two structures were linked by variable, which is the term related to both structures. This construction reflected the postulated category, at the time when we selected the target words. In the construction of low group, the relations between only two words were shown and the concrete structure between multiple words were not shown. All target words were linked in some way in high group, whereas in low group, the construction was divided in 4 parts and there were 2 target words which had not any relation to other words. In sum, the constructions of knowledge were clearly different at the level of self-efficacy and the importance of the cognitive factor is indicated on the construction of information. Further research is needed to explore how self-efficacy promotes the construction of information.

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