

Investigating effects of intelligence and stress mindsets on system engineer's mental health and learning motivations

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This study examined whether intelligence and stress mindsets moderate the influence of difficulties inherent in obtaining qualifications on learning motivation and mental health among system engineers. Questionnaires were completed by 188 Japanese system engineers working in a large IT company. The survey revealed that (a) individuals with an intelligence mindset tend to exhibit higher learning motivation for obtaining qualifications, while individuals with a fixed mindset exhibit equal learning motivation based on the degree of setback experienced (b) individuals with a "stress-is-debilitating" mindset exhibit more mental illness when they perceive higher setback, while individuals with a "stress-is-harmless" mindset equally exhibit mental illness based on the degree of setback experienced. These results suggest that mindsets regarding intelligence and stress may be useful references for system engineers, who are required to continuously adapt to new technologies in busy environments while acquiring qualifications in a healthy and challenging manner.

Keywords: Mindset, Motivation, Stress, Mental Health

¹ Crum et al. (2013) evaluated the stress mindset as a one-dimensional scale, with low scores "stress-is-debilitating mindset" and high scores "stress-is-enhancing mindset".

² Mental health was worse in women than in men. This result is consistent with findings in previous studies that revealed women are more likely than men to harm their mental health. (see review by Nolen-Hoeksema, 2001)

In the IT industry, where advancements in technology are remarkably fast, workers in the field (i.e., system engineers; SE) are always required to acquire new knowledge and skills. For SE employees, acquiring qualifications is an evidence of knowledge and skills in technology. A survey carried out by the Japanese Ministry of Economy, Trade and Industry in 2017 found that almost 70% of enterprises regarded qualifications as important, indicating that challenging qualification tests are necessary for SE careers. Companies also provide training and financial support in order to encourage employees obtain qualifications for their own SE positions, and some companies list such qualifications as one of the requirements for receiving promotions. As such, the burden of obtaining qualifications may become quite challenging. In this study, we focused on the psychological factors that continue to challenge the acquisition of qualifications and, simultaneously, mental health.

Research has demonstrated that job stressors are associated with employees' health. In several cross-sectional studies, an association was found between job stress and depressive symptoms or disorders (Karasek, 1979; Kawakami et al, 1990). In fact, SE employees have many job stressors, thus, their mental

health is poor. The average number of overtime hours per month for SE positions exceeds 30 hours (Persol Career, 2018). Therefore, the treatment rate and number of labor accident applications for mental disorders are higher among system engineers than other occupations (Sugisawa et al., 1993; Ministry of Health, Labor and Welfare, 2018).

In this study, we focused on intelligence and stress mindsets as potential moderators in the influence of difficulties inherent in obtaining qualifications on learning motivation and mental health. A mindset is defined as a mental frame or lens that selectively organizes and encodes information, thereby orienting an individual towards a unique way of understanding an experience and towards corresponding actions and responses (Crum, Salovey, & Achor, 2013). In fact, previous research suggests that mindsets moderate the negative effects of stressors faced in goal pursuit (e.g., Crum et al., 2013; Dweck, 2012).

Although several types of mindsets have been proposed by theorists, the most researched ones seem to be regarding intelligence. Research suggests that individuals hold one of two explanatory mindsets of intelligence: a fixed mindset or a growth mindset (Dweck & Leggett, 1988). The fixed mindset describes

intelligence as stable and asserts that individuals have little control over their intelligence; on the other hand, the growth mindset portrays intelligence as fluid and within an individual's control. Growth mindset leads to improvement action (Hong, Chiu, Dweck, Lin, & Wan, 1999) and persistent motivation (Nussbaum & Dweck, 2008) when faced with difficulty. Further, meta-analysis suggests that individuals with fixed mindsets show more pronounced mental health problems (Schleider, Abel, & Weisz, 2015). Thus, the intelligence mindset is one of the potential factors that may have moderating effects on difficulty in supporting the mental health of employees.

Interestingly, recent studies have proposed new mindsets about the nature of stress and examined their relationships with mental health. In a survey of about 30,000 Americans, individuals who reported higher stress levels showed increased mortality at 8 years of follow-up only when they had a "stress-is-debilitating" mindset, as opposed to individuals with higher stress levels but a "stress-is-harmless" mindset (Keller et al., 2012). Later, Crum et al. (2013) conducted a survey on employees working at a bank that was dramatically downsizing and restructuring because of a recession, and found that "stress-is-enhancing" mindset is significantly associated with mental health, work performance, and life satisfaction.¹ However, no research has been conducted on stress mindsets among systems engineers, or on the relationship between stress mindset and learning motivation.

In this study, a survey was conducted among IT engineers, in order to examine whether intelligence and stress mindsets moderate the influence of difficulties while obtaining qualifications on learning motivation and mental health. The hypotheses are as follows:

Hypothesis 1. In a person with a fixed mindset, learning motivation lowers as a difficulty of obtaining qualifications is perceived. However, a lowering of learning motivation by a perception of difficulty is not observed in a person with the growth mindset.

Hypothesis 2. In a person with a fixed mindset, mental health lowers as a difficulty of obtaining qualifications is perceived. However, a lowering of mental health by a perception of difficulty is not observed in a person with the growth mindset.

Hypothesis 3. In a person with a "stress-is-debilitating" mindset, mental health lowers as a

difficulty of obtaining qualifications is perceived. However, a lowering of mental health by a perception of difficulty is not observed in a person with the "stress-is-harmless" mindset.

In addition, this study was an exploratory investigation of the relationship between stress mindset and learning motivation for obtaining qualifications, especially in a situation where it was difficult to get qualified. In the present study, we measured perception of usefulness for qualification learning as an index of learning motivation, and subjective mental illness as an index of mental health.

Method

Respondents

Respondents were 188 Japanese system engineers (117 men and 71 women) working in a large IT company. Respondents were recruited via snowball sampling. The age composition of the respondents was as follows: 33 persons from ages 20 to 24, 51 persons from ages 25 to 29, 57 persons from ages 30 to 34, 37 persons from ages 35 to 39, and 10 persons from ages 40 to 49. Among respondents, the length of service in the company was as follows: 105 persons under 3 years, 30 persons from 4 to 6 years, 36 persons from 7 to 9 years, and 17 persons over 10 years. Respondents were 138 general members, 24 core members, 15 leaders, and 11 managers. In the company, it was recommended to obtain qualifications related to work, as it was one of the requirements for promotion. In conducting the survey, staff from the human resource department and some SE members supervised and approved the survey content. Participants were informed that their cooperation in the survey was voluntary and they should provide answers only if they agreed with the survey objectives. Further, an explanatory meeting on the investigation result was held after the investigation ended.

Procedures

The survey was conducted anonymously in December 2015. First, respondents chose answer choices from 1 (completely disagree) to 6 (completely agree) to survey items. Next, they provided their age, gender, job role, and length of service.

To measure respondents' perception of the usefulness of qualification learning, we listed two items: "Studying for the qualification exam will help you improve your specialization" and "Studying for a qualification will

help you improve your work ability.” These items were designed to measure the value placed on obtaining qualifications that typically appear in interviews at the surveyed enterprises. The internal consistency of this measure was good; $r = .73$ ($p < .01$).

To measure respondents’ subjective mental illness, we listed two original items based on a questionnaire used in psychiatry: “I feel that I tend to feel sick these days” and “I feel depressed these days.” The internal consistency of this measure was good; $r = .60$ ($p < .01$).

To measure respondents’ perception of the difficulties involved in obtaining qualifications, we listed two original items: “If you try to get a qualification, you will be burdened with a lack of time” and “If you try to get a qualification, you will be burdened mentally.” The internal consistency of this measure was good; $r = .63$ ($p < .01$).

To measure respondents’ intelligence mindset, we used the three-items measure in Hong et al. (1999), as translated by Oikawa (2005). These items were: “You have a certain amount of intelligence and you really can’t do much to change it,” “Your intelligence is something about you that you can’t change very much,” and “You can learn new things, but you can’t really change your basic intelligence.” The higher the scores, the greater the belief that intelligence is a fixed entity. The lower the scores, the greater the belief that intelligence is incremental. The internal consistency of this measure was good; $\alpha = .83$.

To measure respondents’ stress mindset, we listed two original items based on Keller et al.’s study (2012): “In my experience, having a lot of work causes bad effects on my health,” and “In my experience, working

hard causes bad effects on my health.” The higher the scores, the greater the belief that stress is debilitating; the lower the scores, the greater the belief that stress is harmless. The internal consistency of this measure was good; $r = .75$ ($p < .01$).

Result

Software

Data analysis was conducted using HAD (Shimizu, 2016) version 16.0.

Descriptive statistics and correlations

Table 1 presents descriptive statistics and correlations for the variables used in this study. The intelligence mindset has no correlation with perceptions of qualification learning’s usefulness (*n.s.*). However, the intelligence mindset is weakly correlated with a perception of difficulty in obtaining qualifications ($r = .18$, $p < .05$) and subjective mental illness ($r = .19$, $p < .01$). The results suggest that the more an individual has a fixed mindset for intelligence, the more the individual experience difficulty in obtaining qualifications, and the more mental illness is experienced. Meanwhile, the stress mindset was weakly correlated with a subjective mental illness ($r = .35$, $p < .01$) and perception of difficulty in obtaining qualifications ($r = .36$, $p < .01$), which means that the greater an individual has a “stress-is-debilitating” mindset, the more the individual experiences mental illness and perceives difficulty in obtaining qualifications.

Table 1. Descriptive Statistics, Correlations

	Mean	SD	1	2	3	4
1 Perception of usefulness for qualification learning	4.55	0.96	-			
2 Subjective mental illness	3.44	1.24	-.03	-		
3 Perception of difficulty in obtaining qualifications	4.34	1.03	.05	.20 **	-	
4 Mindset about intelligence	3.42	1.00	.05	.19 **	.18 *	-
5 Mindset about stress	3.60	1.17	.04	.35 **	.36 **	.26 **

** $p < .01$, * $p < .05$, + $p < .10$

Hierarchical multiple regression analysis

The results of the hierarchical multiple regression analysis for perception of qualification learning's usefulness and subjective mental illness are presented below. The standardized betas and R-Squared values regarding two models are

presented in Table 2. Variables such as sex, age, length of service, role, perception of difficulty in obtaining qualifications, and intelligence and stress mindsets, were entered at step 1. Interaction terms (regarding mindsets and the perception of difficulty in obtaining qualifications) were entered at step 2.

Table 2. Coefficients of hierarchical Multiple Regression Analysis

	Perception of usefulness for qualification learning		Subjective mental illness	
	step1 β	step2 β	step1 β	step2 β
sex	-.014	-.014	.171 *	.160 *
age	-.134	-.123	-.074	-.117
length of service	-.023	-.015	-.002	-.016
member	-.175	-.055	.179	.176
core-member	-.129	-.059	.143	.162
leader	-.206 +	-.140	.072	.068
Perception of difficulty in obtaining qualifications	.050	.028	.028	.154 *
mindset about intelligence	.029	.059	.123 +	.127 *
mindset about stress	.026	.034	.307 **	.256 **
Mindset about intelligence * Perception of difficulty in obtaining qualifications		-.208 **		-.264 **
Mindset about stress * Perception of difficulty in obtaining qualifications		-.182 *		.321 **
R_2	.039	.137 **	.203 **	.300 **
ΔR_2		.098 **		.097 **

Note. The following dummy-coded variables were used in this analysis. For sex, (0 was used as a factor for men, while 1 was for women); for age, (1 was used as a factor for ages 20 to 24, 2 for ages 25 to 29, 3 for ages 30 to 34, 4 for ages 35 to 39, and 5 for ages 40 to 50); for length of service (1 was used as a factor for 3 years and below, 2 for 4 to 6 years, 3 for 7 to 9 years, and 4 for 10 years and above). The variable of manager was not entered into the model because multicollinearity occurred.

** $p < .01$, * $p < .05$, + $p < .10$

First, we focused on the analysis in which the perception of qualification learning's usefulness is the objective variable. The interaction between intelligence mindset and the perception of difficulty in obtaining qualifications is significantly negatively associated with perception of usefulness for qualification learning ($\beta = -.208, p < .01$). For the growth mindset on intelligence, the slope is positive with a significant trend (Figure 1). The results suggest that individuals with a growth mindset tend to be more perceptive

of the usefulness of qualification learning when they perceive higher setback, while individuals with a fixed mindset are equally perceptive of the usefulness of qualification learning based on the degree of setback experienced. Hence, H1 is partially supported. Further, the interaction between stress mindset and perception of difficulty in obtaining qualifications is significantly negatively associated with the perception of qualification learning's usefulness ($\beta = -.182, p < .05$). For the "stress-is-harmless" mindset on intelligence,

the slope is positive and a significant trend (Figure 1). This means that individuals with the “stress-is-harmless” mindset are more perceptive of qualification learning’s usefulness when they perceive higher

setback, while individuals with a “stress-is-debilitating” mindset are equally perceptive of qualification learning’s usefulness based on the degree of setback experienced.

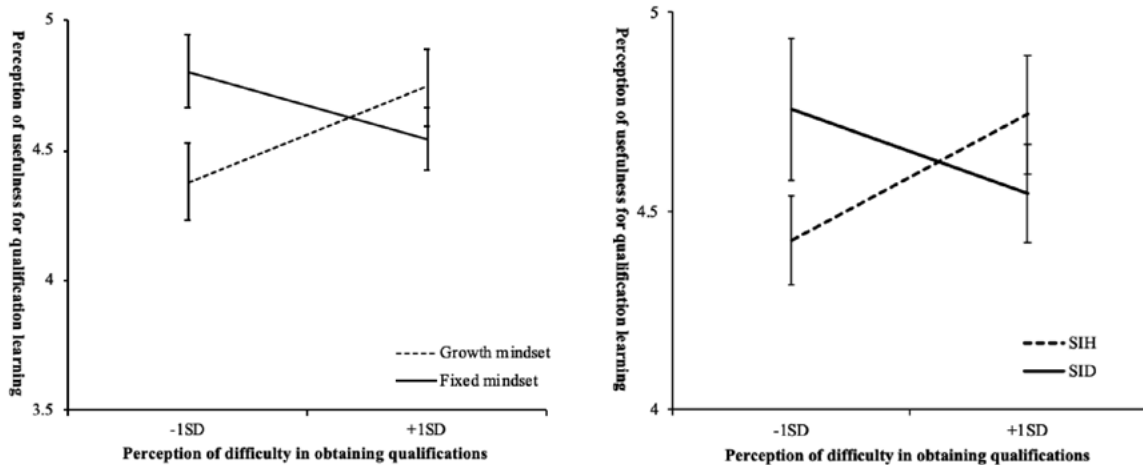


Figure 1. The interaction between mindsets and perception of difficulty in obtaining qualifications in terms of perception of qualification learning’s usefulness.

Secondly, we focused on an analysis in which subjective mental illness was the objective variable. In step 1, sex and stress mindset are significantly positively associated with subjective mental illness ($p < .05$).² In step 2, in addition to step 1, perception of difficulty in obtaining qualifications, intelligence mindset, and the interaction terms (regarding which mindsets and the perception of difficulty in obtaining qualifications) are all significantly associated with subjective mental illness ($p < .05$). The interaction between intelligence mindset and the perception of difficulty in obtaining qualifications is significantly negatively associated with subjective mental illness ($\beta = -.264, p < .01$). For the growth mindset on intelligence, the slope is positive and significant. This means that individuals with a growth mindset tend to have better subjective mental health when they perceive lower setback, while individuals with a fixed mindset have equal subjective mental health based on the degree of setback (Figure 2). Hence, H2 is not supported. Further, the interaction between stress mindset and the perception of difficulty in obtaining qualifications is significantly positively associated with subjective mental illness ($\beta = .321, p < .01$). For the stress-is-debilitating mindset, the slope is positive

and significant. This means that individuals who have a stress-is-debilitating mindset tend to have worse subjective mental health when they perceive higher setbacks, while individuals who have a stress-is-harmless mindset are of equal subjective mental health based on the degree of setback. Therefore, H3 is supported.

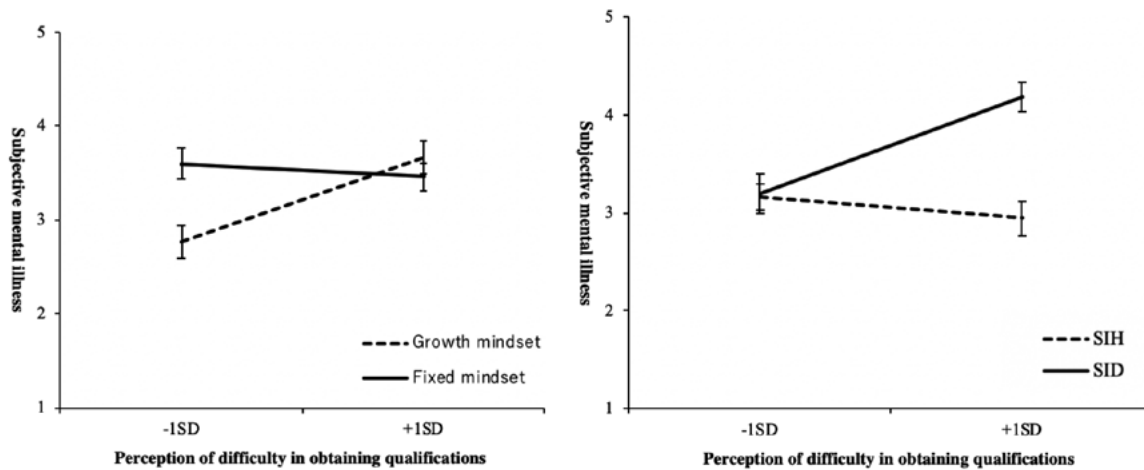


Figure 2. The interaction between mindsets and the perception of difficulty in obtaining qualifications in terms of subjective mental illness

Discussion

The purpose of this study was to examine whether intelligence and stress mindsets moderate the influence of the difficulties involved in obtaining qualifications on learning motivation and mental health among system engineers. The survey revealed that (a) individuals with a growth mindset of intelligence tend to exhibit higher learning motivation in regards to obtaining qualifications, while individuals with a fixed mindset have equal learning motivation based on the degree of setback experienced (b) individuals with a “stress-is-debilitating” mindset exhibit more mental illness when they perceive higher setback, while individuals with a stress-is-harmless mindset equally exhibit mental illness based on the degree of setback. These results suggest that intelligence and stress mindsets may be useful for system engineers, who are required to continuously adapt to new technologies in a busy environment while acquiring qualifications in a healthy and challenging manner.

This study expands the literature on mindsets by demonstrating that mindset may also matter in the domain of employees’ learning. Previous studies have investigated the role of intelligence mindset on students’ learning motivation (e.g., Hong et al., 1999), and investigated the role of stress mindset on bank employees who ultimately are affected by financial crisis (e.g., Crum et al., 2013). In this study, we examined the association between the intelligence mindset and employees’ learning motivation; also, we

examined the association between the stress mindset of SE employees and mental health. Furthermore, this study also provided new insights by indicating that a growth mindset cannot protect health. The mental health of respondents with a growth mindset was worse in situations where the burden of obtaining qualifications was relatively high compared to low—although it was not particularly compared to respondents with the fixed mindset.

This study has several limitations that should be addressed by future research. First, this study was conducted using a survey design at a single point in time and all data in this study were correlational. To test the causal relationships assumed in this study, future research should test the model using an experimental study design. Second, data were collected from only one company, where obtaining qualifications is recommended. It is necessary to include employees from various enterprises as respondents in future research. Third, only the relationship between mindset and value perception was clarified because it deals with the recognition of usefulness as an index to measure motivation. In future research, it is necessary to clarify these relations with performance testing. Fourth, based on Keller’s mindset index, this study measured stress mindset in the dimension of whether stress is debilitating or harmless. It has been pointed out that stress mindsets range from debilitating to enhancing (e.g., Crum et al., 2013). Future research should examine how “stress-is-enhancing” affects motivation and health protection in obtaining qualifications.

References

- Crum, A. J., Salovey, P., & Achor, S. (2013). Rethinking stress: The role of mindsets in determining the stress response. *Journal of Personality and Social Psychology, 104*, 716–733.
- Dweck, C. S. (2012). Implicit theories. In P. M. Van Lange, A. W. Kruglanski, & E. Higgins (Eds.), *Handbook of theories of social psychology* (Vol 2, pp. 43–61). Thousand Oaks, CA: Sage.
- Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychological Review, 95*, 256–273.
- Hong, Y., Chiu, C., Dweck, C. S., Lin, D. M. S., & Wan, W. (1999). Implicit theories, attributions, and coping: A meaning system approach. *Journal of Personality and Social Psychology, 77*, 588–599.
- Karasek, R. A. (1979). Job demands, job decision latitude, and mental strain: implications for job design. *Administrative Science Quarterly, 24*, 298–308.
- Kawakami, N., Araki, S., & Kawashima, M. (1990). Effects of job stress on occurrence of major depression in Japanese industry: a case-control study nested in a cohort study. *Journal of Occupational Medicine, 32*, 722–725.
- Keller, A., Litzelman, K., Wisk, L. E., Maddox, T., Cheng, E.R., Creswell, P. D., & Witt, W. P. (2012). Does the perception that stress affects health matter? The association with health and mortality. *Health Psychology, 31*, 677–684.
- Ministry of Economy, Trade and Industry (2017). *Results of the Survey on the Remuneration of IT-related Industries*. Retrieved November 27, 2019, from <https://www.meti.go.jp/press/2017/08/20170821001/20170821001-1.pdf>
- Ministry of Health, Labour and Welfare (2018). *FY 2018 "Compensation for industrial accidents such as death from overwork"*. Retrieved November 27, 2019, from https://www.mhlw.go.jp/stf/newpage_05400.html
- Nussbaum, A. D., & Dweck, C. S. (2008). Defensiveness versus remediation: Self-theories and modes of self-esteem maintenance. *Personality and Social Psychology Bulletin, 34*, 599–612.
- Nolen-Hoeksema, S. (2001). Gender differences in depression. *Current Directions in Psychological Science, 10*, 173–176.
- Oikawa, M. (2005). Participants' Theories of Intelligence and Pursuit of Nonconscious Goals. *Japanese Journal of Educational Psychology, 53*, 14–25.
- Persol Career (2018). *A big survey of 15,000 businessmen on "doda" a career change service! Ranking of job satisfaction in all 118 occupations 2019*. Retrieved November 27, 2019, from https://www.persol-career.co.jp/pressroom/news/research/2019/20190909_02/
- Schleider, J. L., Abel, M. R., & Weisz, J. R. (2015). Implicit theories and youth mental health problems: A random-effects meta-analysis. *Clinical Psychology Review, 35*, 1–9.
- Shimizu, H. (2016). An introduction to the statistical free software HAD: Suggestions to improve teaching, learning and practice data analysis. *Journal of Media, Information and Communication, 1*, 59–73.
- Sugisawa, A., Uehata, T., Pin, H., Sekiya, E., Chida, T., Ishihara, S., Yamzaki, Y., Sakano, J., Abe, M., Hasagawa, Y., Saitoh, Y., Tsuchiya, Y., Oikawa, S., & Ueda, A. (1993). Mental health, work environment, and health practices among middle-aged male workers. *Japanese Journal of Industrial Health Ind Health, 35*, 7–18.

日本語まとめ

本研究では、システム・エンジニア (SE) を対象に、知能とストレスに関するマインドセット (MS) が、資格取得の困難さが学びへの動機づけと精神的健康に与える影響を調整しうるかについて検討した。188名のSEを対象に調査を実施したところ、まず、知能について増大的MSを持つ者では、資格取得の困難さを知覚するほど学びへの動機づけが高いが、固定的MSを持つ者では、困難さの知覚に関わらず動機づけが一定であった。また、ストレス有害MSを持つ者では、資格取得の困難さを知覚するほどに精神的健康が損なわれたが、無害MSを持つ者では困難さの知覚にかかわらず精神的健康が一定であった。

キーワード：マインドセット、モチベーション、ストレス、精神的健康

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