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A Study of Necessary Beliefs Regarding Learning that Improve the Learning Outcomes of Dentistry College Students

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ABSTRACT

Learning activities are influenced by views and understanding of learning, which are collectively termed as learning beliefs. These beliefs are created by individuals from their experiences, and they influence learning in many ways. However, no adequate scales for the comprehensive measurement of learning beliefs to create effective learning methods and heighten learning outcomes have been developed. We have previously considered strategies to improve learning outcomes in dentistry colleges, reporting that it is necessary for learning strategies including deep processing to take root in students. However, in educational psychology, it is understood that learning beliefs are factors that precede the use of learning strategies.

Focusing on learning beliefs (ideas regarding effective learning and learning methods) in dentistry college education, we carried out a maximum likelihood method-based factor analysis of 24 learning belief scales, investigating the correlations of their subscales in students with learning outcomes in the top and bottom 25%. Our results can be used to understand the abilities and characteristics of dentistry college students and to provide school support.

INTRODUCTION

It has recently become main stream to consider learners not as the passive recipients of classroom learning, instruction, and education but rather as active agents, who engage in learning, acquire knowledge, and choose their own actions [1]. It has emerged that learners' ways of thinking and views of learning influence their behaviors and attitudes in relation to learning. Beliefs regarding factors such as ability and effort [2-4] intelligence [5] and learning [6,7] have been foregrounded as influencing not only learners' educational behaviors but those of educators as well. It has also been found that the extent to which learners are active is influenced by their motivation for learning as well as differences in their patterns of orientation on the learning belief subscale [8].

To date, we have investigated necessary study for dentistry faculty education, and the learning perspective and strategies researched within educational psychology, and we have found that specific subscale orientations influence learning outcomes [9]. Therefore, in this study, we administered a questionnaire on learning beliefs and examined the relationship between the results obtained and educational outcomes. The present study aimed to determine whether learning beliefs influence new learning upon

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dentistry college entrance and learning achievements upon graduation.

SUBJECTS AND METHODS

During the orientation period for the academic year starting from 2018, we explained to the participants-verbally and in writing-about the survey and that it would use the school's data. Written consent was obtained from participants. This study adopted the principles of the Helsinki Declaration and received approval from Fukuoka Dental College's Ethics Committee.

Subjects

A questionnaire was administered to dental students at the time of academic orientation in April 2017. The questionnaire was given to 612 subjects, and responses were collected from 592 (96.7%). Respondents comprised 85 first-years (96.6%), 102 second-year (96.2%), 97 third-year (99.0%), 113 fourth-year (96.6%), 85 fifth-year (95.5%), and 110 sixth-year students (96.5%).

Analysis of Learning Beliefs

Our questionnaire on learning included 24 questions measuring learning beliefs, using Ichikawa's psychological subscales [10]. It was distributed randomly to students, employing a table of random numbers and is shown in **Table 1**. A five-point scale was used for the questions, with the following definitions: 1=definitely not applicable, 2=not applicable, 3=neither, 4=applicable and 5=very applicable.

Data used in the study

For the second-year to sixth-year students, the previous year's grade point average (GPA) was used as the most recent academic record. For the first-year students, the scores on the general academic ability test administered at the beginning of the first year of dental school were used. After these academic data were linked to the survey results using student registration numbers, the registration numbers were deleted to de-identify the results.

RESULTS

Scale Analysis

Use of learning beliefs: For the answer choices, respondents were asked to choose the response that matched the frequency of an action or activity ranging from 1 never to 5 always. Higher numerical value was assigned to more positive responses.

Analysis of Learning Belief Subscales

We carried out a maximum likelihood method-based factor analysis of the 24 learning-belief questions. The eigenvalues were altered as follows: 5.00, 3.00, 1.32, 1.24, 1.18, 1.08, 1.05, 0.86 and 0.82. We assumed a seven-factor structure. We carried out a maximum likelihood method/Promax rotation-based factor analysis. We then eliminated two questions that did not have adequate factor loading, again carrying out a maximum likelihood method/Promax rotation-based factor analysis. The eigenvalue changes were as follows: 4.77, 2.85, 1.31, 1.24, 1.18, 1.08, 0.92 and 0.78. We assumed a six-factor structure. We carried out a maximum likelihood method/Promax rotation-based factor analysis. The final factor pattern matrix and factor correlations after Promax rotation are shown in **Tables 1 and 2**. Out of the 22 six-factor questions, 56.45% explained total variance.

Factor 1 included seven items and represents the tendency to value thinking over results (with items such as "I don't just memorize but try to remember things after having understood them," and "I think that it is important to not just say an answer but also to think things through correctly"). We named this the Process Emphasis factor.

Factor 2 included five questions, all of which were negatively scored to show a tendency that was the opposite of the scales' expressed meaning. Questions which exhibited high loading were those which related to not simply seeking results but results accompanied by understanding (items such as "Often I memorize without understanding the reasoning behind something," and "I think that even if I don't understand why something is the case, it is fine if my answer is correct"). Therefore, we named this the Understanding Emphasis factor.

Factor 3 included four items, of which those relating to learning method had a high load (such as "When I score badly on a test, I review the method I had applied while studying rather than how much I had studied" and "I like coming up with various methods to study"). We named it the Strategy Emphasis factor.

Factor 4 included two items, both of which were negatively scored to show a tendency that was the opposite of the scales' expressed meanings (these were "When I fail, I tend to get sad right away" and "When I make a mistake, I feel embarrassed"). These were related to failure, and therefore we named it the Failure Tolerance factor.

Factor 5 included two items, both of which were negatively scored to show a tendency that was the opposite of the scales' expressed meaning (these were "The only way to improve grades is by working hard and studying a lot" and "I get used to questions of the same pattern by doing them over and over again"). This factor was related to learning content, and so, we named this the Learning Content factor.

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Factor 6 included two questions, both of which were negatively scored to show a tendency that was the opposite of scales' expressed meanings (these were "It's a bother to change learning methods" and "I think changing study methods doesn't have a big effect"). These were related to changing learning methods, and so, we named this the Learning Method Changes factor.

Table 1. Results of the factor analysis on learning belief scales (Factor pattern matrix after promax rotation).

	Question items	1	2	3	4	5	6
14	You make a point of accumulating information upon understanding it rather than learning by rote.	0.709	0.192	0.004	0.05	0.005	-0.047
9	Regarding problems which you could not solve on a test, you want to know the solution even after the test is complete.	0.528	0.027	0.154	0.008	-0.079	-0.036
2	You believe that it is fine to gradually perfect things while experiencing repeated failures.	0.511	-0.044	-0.073	0.098	-0.061	0.051
20	You believe that it is important to not only find the answer to the problem but also have the correct way of thinking.	0.504	0.008	0.107	-0.031	0.05	-0.018
10	You attempt to grasp the relationship between things that you have learned.	0.484	0.166	0.189	-0.046	0.043	-0.106
17	When things do not go as expected, you attempt to determine the cause.	0.476	0.067	0.187	-0.044	-0.032	0.066
11	You are interested in how successful people study.	0.37	-0.276	0.049	-0.062	-0.1	0.304
24	You often memorize answers without thinking too much about how you got the answer※	0.182	0.815	-0.202	-0.059	0.069	0.069
6	You believe that it is fine to not understand how you came to the answer, as long as the answer is correct※	0.112	0.618	-0.143	-0.099	-0.073	0.116
27	Thinking about a solution in various ways on your own is too much work※	-0.101	0.591	0.18	0.07	-0.119	0.053
34	For tests, you are more interested in whether or not the answer is correct than the way of thinking en route to getting the answer※	-0.03	0.374	0.14	0.06	0.248	0.01
31	You immediately lose your motivation when you feel that things do not appear to be going well※	-0.05	0.312	0.166	0.301	-0.038	0.041
25	Even after having solved a problem, you may look for alternative solutions.	0.093	0.028	0.53	0.061	-0.033	-0.243
8	You attempt to reevaluate the method rather than the quantity of study when the results of a test are poor.	0.076	-0.163	0.515	-0.064	0.093	0.238
32	You like to devise ways of studying.	0.129	-0.003	0.501	-0.03	0.056	-0.007
28	You study by organizing information using diagrams, tables, etc.	0.154	-0.079	0.444	-0.012	-0.02	0.029
12	You tend to immediately feel disappointed if you fail※	0.154	-0.123	-0.098	0.905	0.043	0.058
1	You feel embarrassed when you make a mistake※	-0.129	0.087	0.062	0.446	-0.048	-0.02
21	In order to improve performance, you feel you must strive to study more※	0.005	-0.037	0.072	0.012	0.736	0.076
22	You get used to problems having the same pattern by repeating them many times※	-0.102	-0.009	-0.028	-0.019	0.622	-0.019
16	You find it troublesome to change your learning method※	-0.216	0.278	0.146	0.033	-0.066	0.626
13	You believe that the end results will not change too much even if you change your study methods※	0.14	0.113	-0.176	0.038	0.102	0.589
※is a reversal item indicating a reverse trend to the meaning represented by the scale.							

Table 2. Factor analysis results of learning belief scales (factor correlation).

Factor	1	2	3	4	5	6
1	—	0.227	0.477	-0.154	-0.242	0.387
2		—	0.453	0.439	0.271	0.22
3			—	0.118	-0.088	0.362

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4				—	0.358	0.055
5					—	-0.081
6						—

Connections between Subscales

We calculated the average values of the questions corresponding to the six subscales of the learning belief scale. Subscale scores were set as follows: Process Emphasis (average 26.6, SD=3.85), Understanding Emphasis (average 15.0, SD=3.38), Strategy Emphasis (average 12.7, SD=2.48), Failure Tolerance (average 5.3, SD=1.68), Learning Content (4.5, SD=1.41), and Learning Method Changes (average 6.8, SD=1.53). To verify internal consistency, we calculated α coefficient of the subscales (α=0.61). **Table 3** shows the correlations between the learning belief subscales. Process emphasis was significantly positively correlated with understanding emphasis, strategy emphasis, and learning method changes and significantly negatively correlated with failure tolerance. Understanding emphasis was significantly positively correlated with strategy emphasis, failure tolerance, learning content, and learning method changes. Strategy emphasis was significantly positively correlated with learning method changes. Failure tolerance was significantly positively correlated with learning content and learning method changes. Correlations were not found for other combinations.

Table 3. Subscale correlation of learning beliefs.

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Average	Standard deviation	α
Factor 1	—	0.320**	0.585**	-0.123*	-0.245**	0.315**	26.5	4.25	0.59
Factor 2		—	0.388**	0.330**	0.211**	0.530**	15.1	3.57	0.44
Factor 3			—	-0.003	-0.073	0.318**	12.7	2.61	0.48
Factor 4				—	0.244**	0.214**	5.2	1.68	0.62
Factor 5					—	0.1	4.6	1.44	0.65
Factor 6						—	6.9	1.56	0.54
**p<0.01, *p<0.05									

Examining Average Differences

To examine differences between students whose grades were in the top 25% and those whose grades were in the bottom 25%, we carried out a t-test on the scores of the learning belief subscales. The results are shown in **Table 4**. For process emphasis, understanding emphasis, strategy emphasis, and learning method changes, students whose grades were in the top 25% had significantly higher scores than students whose grades were in the bottom 25%. For learning, students whose grades were in the bottom 25% had a significantly higher score than students whose grades were in the top 25%. No significant difference was found for Failure Tolerance.

Table 4. The mean, standard deviation, t-test results of students in the top 25% and those in the bottom 25%.

	Top 25%		Bottom 25%		
	Average	Standard deviation	Average	Standard deviation	T value
Factor 1	27.5	4.32	25.5	3.94	4.19**
Factor 2	15.9	3.65	14.3	3.29	4.04**
Factor 3	13.1	2.86	12.2	2.26	2.81**
Factor 4	5.1	1.62	5.3	1.75	-0.56
Factor 5	4.4	1.48	4.8	1.37	-2.55*
Factor 6	7.2	1.52	6.6	1.55	3.59**
**p<0.01, *p<0.05					

Correlations between the learning belief subscales of students whose grades were in the Top 25% and bottom 25%

Tables 5 and 6 show coefficients of correlation for learning belief subscales of students whose grades were in the top 25% and students whose grades were in the bottom 25%. In the case of those whose grades were in the top 25%, process emphasis was significantly positively correlated with understanding emphasis, strategy emphasis, and learning method changes; understanding emphasis was significantly positively correlated with strategy emphasis, failure tolerance, learning content, and learning method changes; and strategy emphasis was significantly positively correlated with learning method changes. No correlations were found for other combinations.

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In the case of students whose grades were in the bottom 25%, process emphasis was significantly positively correlated with strategy emphasis; understanding emphasis was significantly positively correlated with failure tolerance, learning content, and learning method changes; and failure tolerance was significantly positively correlated with learning content and learning method changes. Process emphasis was also significantly negatively correlated with failure tolerance and learning content. Strategy emphasis was significantly negatively correlated with learning content. No correlations were found for other combinations.

Table 5. Correlation of the learning belief subscale with students in the top 25%.

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
Factor 1	—	0.506**	0.630**	0.008	-0.002	0.463**
Factor 2		—	0.515**	0.349**	0.262**	0.480**
Factor 3			—	0.002	0.092	0.519**
Factor 4				—	0.185*	0.136
Factor 5					—	0.182*
Factor 6						—

Table 6. Correlation of the learning belief subscale with students in the bottom 25%.

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
Factor 1	—	0.006	0.490**	-0.249**	-0.474**	0.081
Factor 2		—	0.156	0.347**	0.246**	0.538**
Factor 3			—	0.004	-0.244**	0.02
Factor 4				—	0.299**	0.308**
Factor 5					—	0.086
Factor 6						—
**p<0.01, *p<0.05						

DISCUSSION

We have previously examined the learning beliefs and strategies that are needed at dentistry college [9] as well as investigating learning strategies necessary for improving learning outcomes, finding that learning strategies, including deep processing, must take root in students [11]. Learning beliefs are ideas on how learning happens and how to make learning more effective. Educational psychology sees them as antecedent factors for the use of learning strategies [12,13]. Previous research has reported that cognitivist learning beliefs, which emphasize learning methods and understanding the content of what is to be learned, determine learning behavior and academic performance. A positive correlation has been found between certain subscales of cognitivist learning beliefs and grades, and a negative correlation with grades has been found between some non-cognitivist learning-belief subscales, which emphasize quantity and environmental factors over internal cognitive processes [14].

In this study we focused on learning beliefs, carrying out a factor analysis of learning beliefs, resulting in a six-factor subscale: process emphasis (the tendency to attach more importance to the process than the result), understanding emphasis (seeking results accompanied by understanding), strategy emphasis (related to learning methods), failure tolerance (related to failure), learning content (study amount, repetition), and learning method changes (related to changing learning methods). The average scores for the four factors of process emphasis, understanding emphasis, strategy emphasis and learning method changes were significantly higher for students whose grades were in the top 25% than they were for students in the bottom 25%. Scores for learning content were significantly lower for students whose grades were in the top 25%. There was no significant difference between the two groups for failure tolerance. five of the factors found in our factor analysis (process emphasis, understanding emphasis, strategy emphasis, failure tolerance, and learning method changes) are cognitivist learning beliefs, and one (learning content) a non-cognitivist learning belief. We found a positive correlation between four cognitivist learning belief factors and grades and a negative correlation between the one non-cognitivist learning belief and grades.

We found a significant difference only in the case of students whose grades were in the top 25% for the following two subscale factor sets: process emphasis and understanding emphasis; process emphasis and learning method changes; understanding emphasis and strategy emphasis; and strategy emphasis and learning method changes. All these sets showed significant positive correlations. we found a significant difference only in the case of students whose grades were in the lower 25% for the following two subscale factor sets: failure tolerance and learning method changes (significant positive correlation); process emphasis and failure tolerance; process emphasis and learning content; and strategy emphasis and learning content (all significant negative correlations). From the results above, it appears that cognitivist learning beliefs, which emphasize understanding the

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meaning of studied content and learning methods, determine academic outcomes; it is possible that individuals with poor grades have a high orientation toward non-cognitivist learning beliefs, which emphasize quantity and environment.

In dentistry college education, the ability to interpret, assess, and retain information as well as integrate content learned from individual subjects and clinical reasoning gradually becomes more important from the lower to higher grades levels. Therefore, an inclination to value the process leading to the correct answer and the learning methods used to confirm one's state are believed to have increased. Moreover, to support dentistry college students, education in accordance with these learning beliefs will likely be useful.

CONCLUSION

Existing research highlights motivation, learning method used, [15] and perception of the effectiveness of learning strategies as determinants of learning belief [16]. Research also has shown that there is a reverse cause–effect process, in which learning beliefs determine learning strategies [13]. It appears that learning beliefs determined by objectives, learning strategy use, and perception of effectiveness then determine learning strategy usage. It would therefore be possible to posit a circular model for learning beliefs and learning strategies: ideas of learning change in response to perceptions of the effectiveness of certain learning strategies and again, by using learning strategies, learning beliefs become reinforced. Thus, it appears that in order to improve the academic outcomes of dentistry college students, cognitivist learning beliefs should be strengthened, and assessment of the effectiveness of used strategies is necessary. If learning guidance that takes this into account is provided, school support could be enhanced.

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