

# The Impact of Grit on University Student's Core Competency in Dental Hygiene Students

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**Background:** Recently, competency-based education has been reorganized in the dental hygiene curriculum. In education, non-cognitive factors are emphasized. Grit, the non-cognitive ability to persevere to achieve an individual's long-term goals, is emerging. This study aims to identify the degree of grit and core competencies in students and to investigate the relationship between them and the factors that affect these core competencies.

**Methods:** This study was conducted using 350 dental hygiene students who were randomly assigned a structured questionnaire to complete. The final analysis included 321 students. The survey contents evaluated grit, core competencies, and general characteristics. The difference in the degree of grit and core competencies in conjunction with the general characteristics of the subjects was analyzed using the t-test/Mann Whitney U-test and the ANOVA/Kruskal-Wallis H test. Multiple regression analysis was then conducted to determine the factors affecting the core competencies of the subjects.

**Results:** The difference of 'grit' according to general characteristics was statistically significant in 'major satisfaction', 'relationship', 'perceived academic achievement', 'grade point average (GPA)'. The difference in 'core competency' according to general characteristics was statistically significant in 'grade', 'department selection', 'major satisfaction', 'relationship', 'perceived academic achievement', 'GPA'. Among the sub-areas of 'grit', 'perseverance of effort' showed a high correlation with 'core competency' and was statistically significant. As a result of regression analysis, 'major satisfaction', 'perceived academic achievement' and 'grit' of dental hygiene students had a statistically significant influence on 'core competency'. Meanwhile, 'GPA' was not seen to be statistically significant in 'core competency'.

**Conclusion:** Grit, a non-cognitive factor, had a statistically significant effect on core competency, while the effects on GPA, a cognitive factor, were not statistically significant. Among the sub-factors of grit, 'perseverance of effort' had a statistically significant effect on 'problem-solving competency' and 'academic competency', which are 'core competency' sub factors.

**Key Words:** Competency based education, Dental hygiene education, Grit, Self-evaluating core competency assessment, University student core competency

## Introduction

Recently, competency-based education has been reorganized with non-cognitive factors being emphasized. An example of this is the National Competency Standards (NCS) in the field of dental hygiene education<sup>1-3)</sup>. Korea Collegiate Essential Skills Assessment (K-CESA) is a representative national university student core competency evaluation tool developed by the Korea Vocational Training Institute with support from the Ministry of Education,

Science and Technology. The tool is easy to conduct as it is in a web-based format, and in addition to self-evaluating, it is possible to measure the exact competency levels because it uses a performance type method. However, it takes more than 6 hours to complete the test, so the completion rate is less than 60%. It is also challenging to educate and manage the evaluator and secure objectivity in the case of subjective writing<sup>4)</sup>. The 'core competency assessment tool (COCOA)' was developed to make it easier for students to evaluate themselves and negate the above

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issues. COCOA can build a core competency-based education and management system, in which students can self-diagnose individual competencies, promote learning achievements, and improve how they learn. Furthermore, COCOA has the advantage of being able to compare and analyze the educational achievements of different universities.

Traditionally, university education has emphasized cognitive factors such as the acquisition of knowledge, skills, and academic achievement. However, the importance of non-cognitive factors in university education has begun to emerge<sup>5,6)</sup>. Grit, a psychological concept that is classified as a non-cognitive factor has attracted considerable interest recently as a factor predicting success.

Grit was first introduced in 2007 by Duckworth and his colleagues<sup>7)</sup> in the United States of America. Grit is defined by the persistence and continual effort of individuals to achieve long-term goals<sup>7)</sup>. In other words, it is the belief that through effort you can achieve your goals and through voluntary passion you can grow and develop yourself<sup>7)</sup>. The study of grit has been expanding recently and has been steadily increasing not only in Korea but also abroad. By April 2019, a total of 84 journals and 50 dissertations had been published.

In the United States of America, it was found that grit was a predictor of which cadets would complete a seven-week intensive training period called Best Barracks at the Military Academy<sup>8)</sup>. The National Spelling Bee, the largest English competition in the United States of America, also showed that those students with high grit were more likely to make it to a higher round<sup>8)</sup>. A study of the relationship between grit and academic achievement in 451 college students revealed that more the grit, higher the academic achievement<sup>9)</sup>. Grit was also seen to positively predict a high grade point average (GPA) when factors that could affect academic achievements, such as age and prior academic achievement, were controlled<sup>10)</sup>.

Research on grit has mostly focused on university students. Variables such as academic achievement, career preparation behavior, resilience, self-efficacy, self-esteem, mindset, and life satisfaction in the field of education and psychology have been studied previously<sup>11-15)</sup>. In Korea, grit was introduced for the first time in 2013. The study

conducted looked at the relationship between grit and GPA in high school as well as university students. It was found that grit had a significant effect on the GPA of both high school and university students<sup>16)</sup>. Grit was seen as closely related to a number of academic variables<sup>17)</sup>. In a study of 360 high school students, it was seen that both the direct and indirect effects of grit on academic achievement was statistically significant<sup>18)</sup>.

When the effect of grit on the ability to overcome trials during the third semester of 1,592 middle school students in 8 schools in the United States was investigated, results demonstrated that higher the grit, the more stable was the ability to overcome trials<sup>19)</sup>. Even with the influence of intelligence, talent, and other demographic variables known to affect individual achievement, grit still significantly predicts high achievement<sup>20)</sup>. Therefore, it can be seen that grit is closely related to achievement.

In the field of domestic nursing, studies on grit have been conducted since 2017. This research has been mainly focused on university students, 'adjustment to college life<sup>21)</sup>', and 'psychological well-being<sup>22)</sup>'. Studies have also examined the effects of academic stress, self-esteem, self-efficacy, academic achievement, major satisfaction, and positive psychological capital on grit by using grit as a dependent variable<sup>23-25)</sup>. There have been various studies conducted on nurses<sup>26)</sup>, Korean armed forces nursing academy cadets<sup>27)</sup>, and patients with brain neoplasms<sup>28)</sup>.

However, so far, no study on grit has been reported in the dental hygiene field either in Korea or abroad. There are also no studies that focus on grit and core competency. In the future, to develop competency-based education, it is necessary to research grit. It is essential to look at predictive variables that may affect core competencies common to dental students and students. Therefore, in this study, we investigated the effects and relationships between grit, core competency, and general characteristics on the academic achievement in a group of dental hygiene students. We also examined what factors influence core competency.

## Materials and Methods

### 1. Subjects and methods

This study was conducted using dental hygiene students. The data collection period was conducted from May 30, 2019 to June 7, 2019. The participants of this study agreed to participate voluntarily. They were informed as to the purpose of this study, and that samples would be extracted by convenience sampling.

The number of subjects required for this study was calculated using the G\*Power 3.1.9.4 software. The sample size that was required for multiple regression analysis was calculated as 184. This was based on a medium effect size of 0.15, significance level 0.05, power of 0.95, and a maximum of 12 independent variables. A total of 350 people were distributed the survey so as to account for a dropout rate. For the final analysis, 321 responses were used. We excluded 29 copies which were challenging to use due to insincere responses from the participant.

### 2. Questionnaire

This study used a self-reporting questionnaire that consisted of a number of questions formulated to measure university students core competency and grit levels. The questionnaire consisted of 48 questions, of which 10 focused on general characteristics, 12 on grit, and 26 on core competency.

#### 1) General characteristics

The general characteristics section included 8 questions on age, grade, gender, residence type, club activity, department selection, major satisfaction, and relationship status. The academic achievement section included 2 questions on students perceived academic achievement and their GPA.

#### 2) Grit

The grit section of the questionnaire used the grit scale, which was developed by Duckworth et al.<sup>7)</sup>, and then further adapted and reversed by Lee<sup>29)</sup> to ensure validity and reliability. Each item was measured using the Likert 5 point scale with 1 point meaning 'not at all', 2 points 'not

usually', 3 points 'normal', 4 points 'generally', and 5 points 'very much'. The higher the participant's total score was meant, the higher their passion and will was to achieve their long-term goals. In Lee<sup>29)</sup>, the reliability Cronbach'  $\alpha$  was 'consistency of interest' 0.70, 'perseverance of effort' 0.71 and a total of 0.79. In this study, the reliability Cronbach'  $\alpha$  was 'consistency of interest' 0.62, 'perseverance of effort' 0.66, and a total of 0.67.

#### 3) Core competency

The self-evaluating COCOA' tool developed by Park et al.<sup>30)</sup> was used in this study. The core competencies required for university students are seen as problem-solving, moral-ethical, global, and academic competency. The questionnaire consists of 41 questions that focus on 4 factors in the form of a self-reporting Likert 5-point scale so that students can easily select their core competency level. Problem-solving competency (15 questions) and academic competency (11 questions) were investigated in 26 of these questions. In Park et al.<sup>30)</sup>, the overall reliability of Cronbach'  $\alpha$  was 0.94, and in this study, it was 0.91. The reliability of Cronbach'  $\alpha$  was found to be 'problem-solving competency' 0.90 and 'academic competency' 0.89.

### 3. Data analysis

The participants answers on general characteristics, grit, and core competency were analyzed using frequency analysis and descriptive statistics. The difference in grit and core competency in conjunction with the participant's general characteristics were analyzed using the t-test or Mann Whitney U-test, ANOVA and Kruskal-Wallis H test. Post-analysis was done using the Scheffe multiple comparison test. The Pearson correlation coefficient was then conducted to understand the correlation between grit sub-factors and core competency sub-factors. Multiple regression analysis was conducted to determine the factors affecting core competency. Data was analyzed using PASW 12.0 for Windows (IBM Corp., Armonk, NY, USA).

## Results

### 1. Differences in grit and core competency based on general characteristics

The results from comparing the relationship between grit and core competency based on participants general characteristics are located in Table 1.

The 'residence type' was seen to be mainly 'home (67.6%)' while 'club activity' was mostly not active (72.9%). 'Job outlook' (69.4%) was the highest reason selected for the participant's selection of their dental hygiene department while 'aptitude interest (6.3%)' and 'departmental popularity (0.9%)' were relatively low. Perceived academic achievement' was seen to be the

**Table 1.** Differences in Grit and Core Competency based on General Characteristics (n=321)

Characteristic	Classification	n (%)	Grit		Core competency	
			Mean±SD	t/F (p)	Mean±SD	t/F (p)
Age (y)	19~20	194 (60.4)	2.85±0.41	5.075 (0.828)	3.41±0.45	10.321 (0.325)
	21~22	104 (32.4)	2.83±0.39		3.40±0.37	
	23~24	16 (5.0)	2.91±0.35		3.56±0.48	
	>24	7 (2.2)	2.83±0.36		3.40±0.31	
Grade	2nd	116 (36.1)	2.86±0.42	1.156 (0.316)	3.33±0.47 <sup>a</sup>	4.593 (0.011)
	3rd	153 (47.7)	2.81±0.39		3.43±0.40 <sup>ab</sup>	
	4th	52 (16.2)	3.90±0.35		3.54±0.34 <sup>b</sup>	
Gender	Male	9 (2.8)	2.99±0.33	1.443 (0.149)	3.49±0.35	0.653 (0.514)
	Female	312 (97.2)	2.84±0.40		3.41±0.43	
Residence type	Live apart from one's own family	84 (26.2)	2.85±0.44	0.314 (0.731)	3.44±0.43	1.370 (0.255)
	Home	217 (67.6)	2.85±0.38		3.39±0.41	
	Dormitory	20 (6.2)	2.78±0.35		3.54±0.49	
Club activity	Yes	87 (27.1)	2.86±0.44	0.228 (0.820)	3.43±0.51	0.363 (0.717)
	No	234 (72.9)	2.84±0.38		3.41±0.39	
Department selection	Admission score	23 (7.2)	2.76±0.33	2.978 (0.562)	3.26±0.34 <sup>a</sup>	18.896 (0.001)
	Acquaintance recommendation	52 (16.3)	2.82±0.38		3.41±0.42 <sup>a</sup>	
	Departmental popularity	3 (0.9)	2.86±0.25		3.55±0.35 <sup>ab</sup>	
	Job outlook	222 (69.4)	2.85±0.38		3.40±0.41 <sup>a</sup>	
	Aptitude interest	20 (6.3)	3.05±0.57		3.78±0.44 <sup>b</sup>	
Major satisfaction	Satisfaction	225 (70.1)	2.91±0.40	4.299 (<0.001)	3.51±0.39	7.016 (<0.001)
	Dissatisfaction	96 (29.9)	2.71±0.35		3.18±0.39	
Relationship	Good	156 (48.6)	2.93±0.41 <sup>a</sup>	13.694 (0.001)	3.54±0.38 <sup>a</sup>	34.683 (<0.001)
	Normal	159 (49.5)	2.78±0.36 <sup>a</sup>		3.30±0.43 <sup>ab</sup>	
	Bad	6 (1.9)	2.49±0.47 <sup>b</sup>		3.09±0.41 <sup>b</sup>	
Perceived academic achievement	Very bad	5 (1.6)	2.32±0.16 <sup>a</sup>	31.997 (<0.001)	2.90±0.25 <sup>a</sup>	53.082 (<0.001)
	Bad	52 (16.2)	2.70±0.35 <sup>ab</sup>		3.21±0.39 <sup>ab</sup>	
	Normal	181 (56.4)	2.82±0.37 <sup>b</sup>		3.38±0.37 <sup>bc</sup>	
	Excellent	73 (22.7)	3.04±0.40 <sup>b</sup>		3.66±0.43 <sup>c</sup>	
	Very excellent	10 (3.1)	2.95±0.50 <sup>b</sup>		3.50±0.54 <sup>bc</sup>	
GPA	>4.0	47 (14.6)	2.98±0.43 <sup>a</sup>	3.481 (0.008)	3.60±0.47 <sup>a</sup>	5.249 (<0.001)
	3.5~4.0	141 (43.9)	2.87±0.38 <sup>ab</sup>		3.42±0.38 <sup>ab</sup>	
	3.0~3.5	83 (25.9)	2.81±0.39 <sup>ab</sup>		3.39±0.38 <sup>b</sup>	
	2.5~3.0	36 (11.2)	2.72±0.35 <sup>ab</sup>		3.30±0.41 <sup>b</sup>	
	<2.5	14 (4.4)	2.67±0.40 <sup>b</sup>		3.10±0.68 <sup>c</sup>	

SD: standard deviation, GPA: grade point average.

<sup>a~c</sup>The same letter indicates no significant difference at  $\alpha=0.05$  by Scheffe multiple comparison test.

highest in 'normal (56.4%)' while the highest number of participants selected their 'GPA' as '3.0~4.0 (69.8%)'.

Looking at general characteristics the difference grit made was seen in 'major satisfaction ( $p < 0.001$ )', 'relationship ( $p < 0.001$ )', 'perceived academic achievement ( $p < 0.001$ )', and 'GPA ( $p = 0.008$ )'. 'Relationship' was seen to be significantly higher in 'good' and 'normal' groups than 'bad' ( $p = 0.001$ ). For 'perceived academic achievement', 'very bad' was statistically significantly higher in 'excellent', 'very excellent', and 'normal' groups ( $p < 0.001$ ). In 'GPA', the group with a GPA 'over 4.0' was seen to be significantly higher than the group with a GPA 'under 2.5' ( $p < 0.05$ ).

The difference in 'core competency' based on general characteristics appeared in 'grade ( $p = 0.011$ )', 'department selection ( $p = 0.001$ )', 'major satisfaction ( $p < 0.001$ )', 'relationship ( $p < 0.001$ )', 'perceived academic achievement ( $p < 0.001$ )' and 'GPA ( $p < 0.001$ )'. The 'core competency' of fourth grade was significantly higher than that of the second grade, while there was no significant difference between the fourth and third grades ( $p < 0.05$ ). In 'department selection', the group who answered 'aptitude interest' showed a significantly higher level of core competency than the group who answered 'acquaintance recommendation', 'job look' and 'admission score' ( $p < 0.05$ ). 'Relationship' was significantly higher in 'good' than 'bad' ( $p < 0.001$ ). The group that 'perceived academic achievement' as 'excellent' was seen to be significantly higher than the group that answered 'very bad'. There was no significant difference between 'very excellent' and 'normal' ( $p < 0.001$ ). GPA had the highest core competency in the '4.0 or higher' group and was statistically significant

in the 'less than 3.5' group ( $p < 0.001$ ).

The 'major satisfaction', 'relationship', 'perceived academic achievement' and 'GPA' all commonly showed statistically significant differences in grit and core competency. The higher satisfaction seen appeared to result in higher levels of grit and core competency. 'Major satisfaction' was seen to have higher levels of grit ( $p < 0.001$ ) and core competency ( $p < 0.001$ ). The higher the 'relationship' and GPA, the more significant was the difference in grit and core competency.

On the other hand, 'grade' and 'department selection' were different only in the core competency. There was no difference seen in 'age', 'gender', 'residence type', and 'club activity' in terms of both grit and core competency.

## 2. Degree and correlations between grit and core competency

The results of the correlation between dental hygiene students' scores of 'grit' and 'core competency' are located in Table 2.

The degree of 'grit (range 1~5)' was  $2.85 \pm 0.40$ , 'consistency of interests' was  $2.65 \pm 0.50$  and 'perseverance of effort' was  $3.05 \pm 0.52$ . The 'core competency (range 1~5)' was  $3.41 \pm 0.42$ , 'problem solving competency' was  $3.56 \pm 0.45$ , and 'academic competency' was  $3.21 \pm 0.57$ .

'Academic competency' in the 'core competency' section showed a significant correlation throughout grit'. On the other hand, 'problem-solving competency' showed a low correlation with 'consistency of interest' among two sub-factors of grit.

Among the sub-areas of 'grit', 'perseverance of effort' showed a high correlation with 'core competency' and

**Table 2.** Degree and Correlations between Grit and Core Competency (n=321)

Coefficient	Subscale	Mean±SD	Grit		Core competency	
			Consistency of interest	Perseverance of effort	Problem solving competency	Academic competency
Grit	Consistency of interests	2.65±0.50	1			
	Perseverance of effort	3.05±0.52	0.202***	1		
Core competency	Problem solving competency	3.56±0.45	0.071	0.419***	1	
	Academic competency	3.21±0.57	0.193***	0.542***	0.432***	1

SD: standard deviation.

\*\*\* $p < 0.001$ .

Total: grit ( $2.85 \pm 0.40$ ), core competency ( $3.41 \pm 0.42$ ).

was seen to be statistically significant.

### 3. Factor related to core competency

The results of multiple regression analysis to identify the factors affecting ‘core competency’ are located in Table 3. As a result of the Durbin-Watson test, which was 1.758, and therefore close to 2, it was seen as being suitable to use a multiple regression analysis model. The correlation between variables was confirmed to be  $R=0.566$ , and the tolerance and variance inflation factor (VIF) of all variables was more than 0.1 and less than 10, indicating that there was no problem of multi-collinearity.

As a result of the regression analysis, ‘major satisfaction ( $p<0.001$ )’, ‘perceived academic achievement ( $p=0.005$ )’ and ‘grit ( $p<0.001$ )’ of dental hygiene students was seen to have a statistically significant influence on ‘core competency’ (Adjusted  $R^2=31.1\%$ ). Meanwhile, ‘GPA’ was not statistically significant in ‘core competency’.

### 4. Factor related to problem solving competency

The results of the multiple regression analysis confirmed the factors affecting ‘problem-solving competency’ was among the sub-elements of ‘core competency’. The results of this are located in Table 4. The Durbin-Watson test was 1.808, which is close to 2; it was seen as being suitable to use a multiple regression analysis model. The correlation between variables was confirmed to be  $R=0.432$ , and the tolerance and VIF of all variables was 0.1 and less than 10. This indicates that there were no problems with multi-collinearity.

As a result of regression analysis, ‘major satisfaction ( $p=0.044$ )’ and ‘perseverance of effort ( $p<0.001$ )’ seen in dental hygiene students had a statistically significant effect on ‘problem-solving competency’ (Adjusted  $R^2=17.4\%$ ). Meanwhile, ‘perceived academic achievement’, ‘GPA’, and ‘consistency of interest’ were not statistically significant in ‘problem-solving competency’.

**Table 3.** Factor Related to Core Competency (n=321)

Characteristic	Unstandardized coefficient		Standardized coefficient	t	p-value	Multicollinearity	
	B	SE	$\beta$			Tolerance	VIF
(constant)	1.575	0.179		8.787	<0.001		
Major satisfaction	0.224	0.045	0.243	5.035	<0.001	0.922	1.085
Perceived academic achievement	0.095	0.033	0.170	2.850	0.005	0.608	1.645
GPA	0.027	0.047	0.034	0.586	0.558	0.641	1.560
Grit	0.375	0.053	0.350	7.062	<0.001	0.874	1.144
$R^2=0.320$ , Adjusted $R^2=0.311$ , $F=37.154$ , $p<0.001$ , Durbin-Watson=1.758							

VIF: variance inflation factor, GPA: grade point average.

**Table 4.** Factor Related to Problem Solving Competency (n=321)

Characteristic	Unstandardized coefficient		Standardized coefficient	t	p-value	Multicollinearity	
	B	SE	$\beta$			Tolerance	VIF
(constant)	2.378	0.208		11.449	<0.001		
Major satisfaction	0.104	0.052	0.107	2.023	0.044	0.921	1.086
Perceived academic achievement	0.004	0.039	0.006	0.098	0.922	0.594	1.684
GPA	0.001	0.054	0.002	0.024	0.981	0.641	1.560
Consistency of interests	-0.024	0.046	-0.027	-0.509	0.611	0.944	1.060
Perseverance of effort	0.346	0.048	0.399	7.197	<0.001	0.840	1.190
$R^2=0.187$ , Adjusted $R^2=0.174$ , $F=14.464$ , $p<0.001$ , Durbin-Watson=1.808							

VIF: variance inflation factor, GPA: grade point average.

### 5. Factor related to academic competency

The results of the multiple regression analysis to confirm the factors affecting ‘learning competency’ among the sub-elements of ‘core competency’ is located in Table 5. The Durbin–Watson test showed a value of 1.786, which is close to 2, it was seen as being suitable for a multiple regression analysis model. The correlation between the variables was confirmed to be  $R=0.675$ , and the tolerance and VIF of all variables was more than 0.1 and less than 10, indicating that there was no problem of multi-collinearity.

As a result of the regression analysis, ‘major satisfaction ( $p < 0.001$ )’, ‘perceived academic achievement ( $p < 0.001$ )’ and ‘perseverance of effort ( $p < 0.001$ )’ of dental hygiene students was seen to have a statistically significant influence on ‘academic competency’ (Adjusted  $R^2=17.4\%$ ). Meanwhile, ‘GPA’ and ‘consistency of interest’ were not statistically significant in ‘academic competency’.

## Discussion

In this study, we examined the degree of grit and core competency in a group of dental hygiene students and confirmed which factors affected core competency.

The mean score of grit in dental hygiene students who participated in this study was  $2.85 \pm 0.40$ . This was lower than the 3.31 points seen in a previous study, using the same tool, on the effect of grit and stress on college life adaptation in third and fourth grade nursing students<sup>21</sup>. It was also lower than the 3.12 points seen in a study on the effect that grit had on turnover intention in university

hospital nurses<sup>26</sup>. It is difficult to compare the results because there have been no prior studies conducted on dental hygiene students. However, the participants in these studies were 3rd grade, 4th grade, or clinical nurses, which may lower the results. I think these results differ because second-grade students who have not yet experienced clinical practice were included.

Among the sub-factors of grit, the consistency of interest ( $2.65 \pm 0.50$ ) was lower than the perseverance of effort ( $3.05 \pm 0.52$ ). This was similar to the results seen in the study of nursing students<sup>21</sup> and the results of the study on nurses<sup>26</sup>. In many previous studies, ‘consistency of interest’ was reported to be lower than ‘perseverance of effort’<sup>22,25,26</sup>. This is because the students who chose ‘aptitude interest’ and ‘departmental popularity’ in ‘department selection’ had high grit, but the reason for choosing that particular department was lower (Table 1). This seems to be due to students working hard rather than them having an interest in the dental hygiene department. It is necessary to improve the educational environment generally to maintain students interest in dental hygiene education. Also, the reliability of grit was lower than that of ‘perseverance of effort’ in the ‘consistency of interest’ sub-factor. This has been consistently reported in previous studies<sup>31-33</sup>. Unlike the Western culture where the grit scale was initially developed, Eastern culture is different in that it is more of a collectivist culture that adapts based on others<sup>31</sup>. Therefore, it is necessary to develop a grit scale suitable for Korean culture.

There was a difference seen in grit and core competency based on students general characteristics (Table 1). The

**Table 5.** Factor Related to Academic Competency (n=321)

Characteristic	Unstandardized coefficient		Standardized coefficient	t	p-value	Multicollinearity	
	B	SE				Tolerance	VIF
(constant)	0.438	0.217		2.018	0.044		
Major satisfaction	0.371	0.054	0.298	6.878	<0.001	0.921	1.086
Perceived academic achievement	0.145	0.041	0.192	3.558	<0.001	0.594	1.684
GPA	0.076	0.057	0.070	1.353	0.177	0.641	1.560
Consistency of interests	0.042	0.049	0.037	0.858	0.392	0.944	1.060
Perseverance of effort	0.431	0.050	0.390	8.593	<0.001	0.840	1.190

$R^2=0.455$ , Adjusted  $R^2=0.446$ ,  $F=52.616$ ,  $p < 0.001$ , Durbin–Watson=1.786

VIF: variance inflation factor, GPA: grade point average.

general characteristics that had a significant effect on grit and core competency were major satisfaction, relationship, perceived academic achievement, and GPA. In general, the higher the relationship scored, the better the perceived academic achievement, the higher the GPA, the higher the major, the higher the grit, and core competency levels were. On the other hand, grade and department selection were seen to have a significant effect on core competency. Core competency was seen to increase with higher grades, but not with grit. This is similar to the results of a previous study, which showed that there was a difference in core competency based on participants grades<sup>34)</sup>. I think that the difference seen in core competency as grades increase is influenced by education. However, because grit is a non-cognitive attribute that humans have, there is no difference based on grades. This shows that non-cognitive elements have been overlooked in traditional education, and in this context, the same is valid for department selection. Other previous studies have also reported that there was a difference in core competency between genders<sup>35)</sup>. This study did not compare the score of core competency according to gender because most of the participants were female students, due to higher numbers of females studying dental hygiene.

Grit and core competency were found to have a significant positive correlation (Table 2). These results can be understood in the same context as the psychological variables of university students, where core competency was seen to have a significant relationship<sup>35)</sup>. Grit had a statistically significant effect on core competency, and core competency was different by grit levels. In other words, efforts to improve both core competency and grit are needed. This suggests that appropriate education is required to enhance competence itself as well as competency-based education.

Major satisfaction, perceived academic achievement, and grit had a significant effect on core competency (Table 3). I perceive subjective academic achievement, major satisfaction, and grit as having more significant effects on core competency than objective academic achievement, such as a GPA. On the one hand, Table 1 shows that GPA has a significant effect on core competency. However, in Table 3, which shows the results of a regression analysis

done that controlled various variables, GPA was seen to not have a significant effect on core competency. Several previous studies have reported that academic achievement affects core competency<sup>30,36,37)</sup>. This is an unexpected result when most previous studies show that academic achievement has a statistically significant effect on core competency. However, the results of comparing subjective and objective academic achievement (like GPA) are not reported, so it is difficult to compare. According to some previous studies, that looked at a longitudinal analysis of the relationship between success after schooling, factors seen to determine success are not cognitive core competencies such as academic achievement or intelligence, but personality and characteristics (non-cognitive core competency) such as relationship and self-control<sup>38,39)</sup>. Also, considering that major satisfaction is just a subjective feeling about the major chosen, it was found that this is closely related to individual psychological characteristics<sup>40)</sup>. Therefore, non-cognitive factors have a closer influence on core competency rather than cognitive factors such as GPA.

It was confirmed in this study how the sub-factors of grit and the sub-elements of core competency affect each other (Table 4, 5). Major satisfaction, perseverance of effort, sub-factors of grit, were seen to have a significant effect on problem-solving competency, a sub-factor of core competency (Table 4). Major satisfaction, perceived academic achievement, and perseverance of effort had a significant effect on academic competency, which is a sub-factor of core competency (Table 5). In conclusion, the ‘consistency of interest’ which is one of the sub-factors of grit did not have a significant effect on ‘core competency’. Muenks et al.<sup>41)</sup> found that ‘perseverance of effort’ was more correlated with academic achievement than grit. Credé et al.<sup>42)</sup> also said that the correlation between ‘consistency of interests’ and ‘achievement’ is very weak, and that ‘consistency of interests’ weakens the correlation between ‘perseverance of effort’ and ‘achievement’. This is because students are trying to study for national examinations, graduation, and employment, not because of satisfaction of the department and aptitude interest. Also, ‘perceived academic achievement’ was not seen to have a significant effect on the problem-solving

competency among the sub-factors of core competency. Subjective academic achievement may be related to self-efficacy. You can have a high GPA, but you can believe that your GPA is low. On the other hand, your actual GPA may be low, but you think that your GPA is high. Problem-solving competence can be regarded as a cognitive factor, for example the ability to critical think. However, perceived academic achievement is thought to be more due to other characteristics, such as your subjective belief and attitude toward your academic competence.

Grit is a significant factor in predicting achievement and success in various fields in the long term. Therefore, cross-sectional studies have limitations. Also, considering that grit's reliability value is relatively low, and the predictive power of the consistency of interest is not significant, the operational definition and validity of the measurement tool seem incomplete. As a constructed concept, it is necessary to add an evaluation of grit.

It is necessary to compare grit with psychological attitude factors such as self-efficacy, self-control, self-esteem, resilience, and positive psychological capital that can affect achievement or competency.

The study on the effect of grit in dental hygiene students on their core competency levels should be preceded by the development of core competency in students attending university. This study is meaningful in that it examined the correlation between dental hygiene students' core competency levels, characteristics, and their level of grit through the use of a self-reporting core competency test.

To develop students' grit in the field of dental hygiene, further studies should be conducted to identify the factors affecting grit. Also, as no research has yet been done on the grit of dental hygienists yet, it is necessary to study this in the future.

## Notes

### Conflict of interest

No potential conflict of interest relevant to this article was reported.

### Ethical approval

This study was approved by the Namseoul University Bioethics Review Committee (IRB NSU-201903-006).

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