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Profile analysis of Korean high school students' core competencies and their correlations with academic achievement

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Abstract

This study identified the core competencies and the patterns of Korean high school students through Prototypical Profiles via Multidimensional Scaling (PAMS) and analyzed the correlation between the students' core competencies and academic achievement. The data of 274 students in one typical high school were used. The core competencies were measured by the Six Core Competencies Measurement Scale for High School Students in Korea (SCCMS) developed based on the 2015 Revised National Curriculum. As academic achievements, three subject (Korean, math, and English) scores from National Academic Achievement Test (NAAT) were collected. Of six competency levels, the students' 'community competency' level was the highest, but their 'aesthetic emotion competency' level was the lowest. The PAMS analysis revealed the presence of two prototypical profiles, 'cognition-oriented' type and 'affection-oriented' type. And the core competencies showed marginal correlation with academic achievement. Based on these findings, the need for 'tailored teaching and learning strategies' and 'appropriate assessment methods' for competency-based education was discussed.

Keywords: 2015 Revised National Curriculum, high school students' core competencies, profile analysis, academic achievement, correlation analysis

Introduction

With the advent of intelligent-information society, countries around the world are adopting competency-based education (CBE) to educate their men and women who could strengthen their national competitiveness (Namkung, Kim, Park, Jung, & Park, 2015; Namkung, Kim, Park, Choi, Park, & Chung, 2016; OECD, 2002, 2005; Trilling & Fadel, 2009; 2013, 2018, 2019). Since OECD (2002) invited the concept of competency into school education in the DeSeCo project, countries such as USA, Britain, Germany, and Taiwan have restructured their curricula based on competencies (Jonnaert, Masciotra, Barrette, Morel, & Mane, 2007; Lee, Jeon, Huh, Hong, & Kim, 2009; Yoon et al., 2007). In the United States, for example, the state of New Hampshire took initiative to implement the CBE in 2005, and as of 2017, all states — except for the state of Wyoming—are incorporating the CBE into their curricula (Yu, 2019).

In Korea, the Ministry of Education (MOE) in Korea announced the 2015 Revised National Curriculum (2015-RNC) to foster creative and interdisciplinary talents. The 2015-RNC highlighted six core competencies: Self-management (SM), Knowledge Information Processing (KI), Creative Thinking (CT), Aesthetic Emotion (AE), Communication (CO), and Community (CM) competencies (MOE, 2015). To effectively promote the competency-based curriculum, measuring students' core competencies and their relationship with other education-related variables with precision is imperative (e.g., academic achievement).

Research that measured competencies and explored their association with other education-related components mainly addressed life skills required of undergraduate students (Hwang, Kim, & Song, 2016; Lee & Kim, 2012). Others that designed to address the core competencies of secondary school students were loosely connected to the 2015-RNC because most of them were (a) commissioned before the implementation of the 2015-RNC, (b)used measurement scales unfit to be utilized in school contexts, and (c) lacked clear guidance as to how teachers should promote teaching and learning activities (Baek, Yoon, Shin, Son, & Kim, 2017; Jang, 2011; Kim, Park, Lee, & Oh, 2016; Namkung et al., 2016).

Of such limitations, the weak alignment of research with the 2015-RNC and the school contexts demands the need to devise better instruments to measure secondary students' core competencies. Several public research institutes have initiated projects (e.g., Namkung et al., 2015) to address this issue, and researchers have undertaken similar projects (e.g., Baek et al., 2017) on an individual level. Contrary to such investments, fewer attempts were made to offer teachers and students with feedback that can clarify the strengths and weaknesses in light of core competencies. To help teachers' give feedback in a formative way to their students, teachers must adjust their instructional approach to meet students' eye level and cultivate students' development (Morell, Collier, Black, & Wilson, 2017).

Rarely does existing research reveal the relationship between students' core competencies and academic achievement; most of the studies that do discuss such relationship were done at post-secondary level, reporting correlation between grade point average (GPA) in college and core competencies (Badcock, Pattison, & Harris, 2010; Baek, 2013; Hambur, Rowe, & Luc, 2002; Hwang et al., 2016; Lee & Kim, 2012; Song, 2016). Besides, few studies dealt with the relationship between competencies and academic achievement in the secondary school context (Kang, Kim, Kim, & You, 2013; Namkung et al., 2016).

With the nationwide implementation of the 2015-RNC, education policymakers and practitioners must measure secondary school students' core competencies and draw meaningful implications for the benefit of teachers and students. Only then can teachers and students diagnose their area of strengths and weaknesses and take the most needed measures accordingly. Hence, this study identified the level and profile of the core competencies by Prototypical Profiles via Multidimensional Scaling (PAMS). The correlation between academic achievement and core competencies was studied to understand the interplay of different types of feedback.

The study was driven by the following research questions:

1) What is the level of Korean high school students' six core competencies?
2) What are the prototypical profiles of students' six core competencies?
3) What is the correlation between students' six core competencies and their academic achievement?

Literature review

Competency in education

Since McClelland (1973) introduced the concept of competency, competency has primarily been discussed in job sectors until DeSeCo (Definition and Selection of Competencies) project of OECD (2002) furthered the concept to encompass students' abilities to live their life to the fullest. The project invited the concept of competency into school education and contributed to the emergence of competency-based education and competency-based curriculum (So, 2007). Upon completion of the project, countries around the world (Britain, Germany, Taiwan, etc.) have interpreted competencies from their own perspectives and restructured their curricula based on competencies (Jonnaert et al., 2007; Lee et al., 2009; Yoon et al., 2007). Besides, recently OECD (2018, 2019) has suggested three core (cognitive, health, social and emotional) foundations which are particularly important to prepare students for rapid economic, environmental and social changes, for jobs that have not yet been created, for technologies that have not yet been invented, and to solve social problems that have not yet been anticipated.

In the Republic of Korea, the 2007 Presidential Committee on Education Innovation proposed — through their education agenda called Vision and Strategy for Future Education — that policymakers and education stakeholders ought to restructure national curriculum based on core competencies. Korea Institute for Curriculum and Evaluation (KICE) took the steering wheel of the research effort to apply competencies into the curriculum (Kim et al., 2015; Lee et al., 2015; Park et al., 2008; Park & Rim, 2014)

Followings are six core competencies that the 2015-RNC delineated: Self-management (SM), Knowledge Information Processing (KI), Creative Thinking (CT), Aesthetic Emotion (AE), Communication (CO), and Community (CM) competencies (Ministration of Education 2017). Six core competencies in the 2015-RNC are an embodiment of knowledge, skill, and attitude required of students, enabling them to grow up to be responsible members of our society (Lee et al., 2015). The competencies offer ideals and directions for educational development, end goals, and accomplishments that education must point to, and the working principles to design and structure education contents (Lee et al., 2014).

Measuring competencies

In the United States, Common Core National Standards and Tests (CCNST) — commissioned by the National Governors Association (NGA) and the Council of Chief State School Officers (CCSSO) — established a set of assessment standards for secondary school students in forty-one states across the US to hone their competencies required in the workforce (Common Core State Initiatives, 2019).

Colleges, state Departments of Education, and National Education Association have formed Partnership for 21st Century Learning (P21) to administer competency standards to be used in public school in a national level. P21 has devised a floor plan for competency-based assessment in four competencies (Trilling & Fade, 2009).

The Assessment and Teaching of 21st-Century Skills (ATC21S) took this framework developed by P21 and developed detailed assessments for competencies. Founded by countries like the US, Australia, Finland, and Singapore, ATC21S grew to be multinational and multi-industry scale with sponsors like Microsoft, Intel, Cisco and flocked more than 250 researchers from around world (Erstad, 2009). ATC21S is primarily focused on developing assessments for competencies like collaborative problem-solving skill and communication & ICT literacy (Williams, Gannon, & Sawyer, 2013).

In Korea, several public research institutes embarked on projects to develop measures for student competencies. Since 2006, the Ministry of Education (MOE) and Korea Research Institute for Vocational Education & Training (KRIVET) collaborated to develop a measurement tool called Korea Collegiate Essential Skills Assessment (K-CESA) to diagnose undergraduate students' competencies and to guide the students' career pursuit (Korea Collegiate Essential Skills Assessment, 2018). K-CESA measures six domains that experts in colleges, research institutes, and industries value: communication proficiency, global sensitivity, interpersonal skills, integrative mind, an ability to use resource and information technology, and self-management.

As the concept of competency expanded, representative research measuring the competency of secondary school students was initiated the National Youth Policy Institute (NYPI). As a part of the International Association for the Evaluation of Educational Achievement (IEA) International Civic and Citizenship Education Study 2016, NYPI developed a measurement instrument comprised of youth competency index, a scientific measure of youth competency (Sung, Baek, & Jin, 2014). This was a meaningful step taken to formulate sound youth policy and to compare similar efforts throughout the world. In the research, competencies for adolescents had been identified through 242 questions divided into five respective competencies: lifelong learning, life management, career development, interpersonal, and social participation. The Korean Educational Development Institute (KEDI) is conducting longitudinal research measuring primary and secondary school students' competency. KEDI defines student competency as an ability to cultivate the skills needed to solve individual and social problems that students can face in their life. KEDI longitudinal research analyzes students' competencies and investigates relevant factors. To do so, KEDI developed a questionnaire consisting of 163 questions measuring students' competency levels and other factors pertaining to core competencies (Namkung et al., 2015).

To offer a measuring instrument more accessible to teachers, Baek et al. (2017) developed Six Core Competencies Measurement Scale for High School Students (SCCMS) based on the competency definitions in 2015-RNC. Baek et al. (2017) systematically

formulated the components (domains and sub-domains) of each core competency that reflects the teaching and learning environment in Korean secondary schools: SM as a clear self-identity, personal initiatives, and self-control; KI as a clear awareness about problem at hand, being able to explore solutions, and solving or evaluating measures taken; CT as being innovative, pertinent, and reasonable; AE as enjoying and being appreciative of various activities, actively engaging in creative and expressive activities, and thriving and pursuing quality life; CO as transmitting, constructing, and receiving messages; and CM as having respectful attitudes, openness, and participation with a sense of belonging. Each of the core competency was measured with Likert-type items (the total of 90 items), and the scale was verified through qualitative review and quantitative validation procedure of pilot test, factor analysis, and computation of reliability coefficient. The SCCMS is different from other instruments developed in public research institutes in ways that it can be administered in classrooms with ease and manifests the specified components of core to teachers and students.

Extracting representative competency profile using multidimensional scaling

KEDI, a government-funded research institute in Korea, has undertaken the research to extract students' competency profiles. Kim, Kim, Park, Park, Lee, and Chae (2014) revealed representative types and profiles of academic competencies of university students using prototypical profiles via multidimensional scales on subordinate compositions consisting of academic competencies. The two dominant patterns identified were 'higher-order thinking type' and 'ICT (information and communications technology) type.' For effective implementation of higher education strategies, policymakers and alike must be aware of these patterns and apply methods of competency measures, analysis, evaluation, and customized support accordingly.

Namkung et al. (2016) and Kil, Namkung, Park, Kim, Kim, & Son (2017) have extracted the representative profile using multidimensional scaling. 29,016 students from 255 primary or secondary schools had participated in the first year (2016) research of KEDI. KEDI used the multidimensional scaling to extract two representative profile — a weak creative competency with a strong social competency and a weak affection-related competency with a strong self-management and knowledge processing competency (Namkung et al., 2016). In the second-year (2017) competency research at KEDI, 23,286 students from 229 schools participated. This research discovered that student competency had increased over the year, and students' self-management was the highest, while their creative thinking was the lowest of all the six competencies measured. Besides, this second-year research extracted three representative profiles through latent profile analysis: one with high-level competency but requiring creative competency; another with average-level competency requiring a balanced development; and the last one with low-level competency demanding educational attention (Kil et al., 2017).

Core competencies and their relationship with academic achievement

The relationship between students' core competency and their academic achievement had not been explored sufficiently in the secondary education context. Most of the existing

research that explored the relationship between competency and academic achievement has been done in the higher education context (Lee, 2007; Song & Lee, 2016). In most cases, the correlation between the two is either weak or not statistically significant. Drawing from the research of Hambur et al. (2002), Badcock et al. (2010) says that students' GPA is a poor reference to measure undergraduate students' intelligence and other pertinent skills.

The research investigated K-CESA reports that academic achievement is minimally correlated with competency, or the correlation is not statistically significant. For instance, Lee and Kim (2012) found no statistically significant association between competency and GPA. In Baek's (2013) study, academic achievement was minimally correlated with communication competency (r = .281), integrative thinking competency (r = .333) resource and information technology competency (r = .306). Hwang et al. (2016) discovered that the students' self-management competency was positively correlated with their academic achievement.

Also, the correlation between secondary school students' core competencies and their academic achievement is largely limited. Kang et al. (2013) explored a competency measurement scale targeting the students in the first year (10th grade) of a high school in Daejeon and analyzed their levels of cognitive, affective and social competencies. They also looked at how behavior management skill and its effects on Korean language achievement; they found a low correlation between the competencies and Korean language achievement (r = .25 ~ .34). Lastly, a nationwide study Namkung et al. (2016) and Kil et al. (2017) conducted at KEDI revealed that academic achievement affects students' competencies, controlling for family, school, and geographic differences.

Methods

Data

To meet the purpose of this study, the data of core competencies and academic achievements were collected. First, 327 students in their sophomore year of one typical high school in Korea were measured, using Six Core Competencies Measurement Scale for High School Students (SCCMS) developed by Baek et al. (2017). Second, academic achievements were collected from those students in the same school mentioned above using National Academic Achievement Test (NAAT). In order to analyze the correlations between core competencies and academic achievements, the NAAT data were matched with the core competencies data using students' ID number. After eliminating unmatched cases because of missing ID or non-participation in both tests, as well as insincere responses, the responses of 274 students were used for analysis.

Measurement

The SCCMS developed by Baek et al. (2017) was used to measure core competencies of students. The SCCMS was composed of 5-likert type items, where the maximum score was 5.0; 15 items for each core competency and 90 items for total scale. The construct validity of the SCCMS was verified through confirmatory factor analysis (model fit of TLI

= .912 ~ .992, CFI = .956 ~ .996, RMSEA = .024 ~ .066, and standardized domain-item factor loadings were in an acceptable range: .520 ~ .890). Cronbach's coefficient *alpha* verified its reliability (α = .862 ~ .925). Table 1 shows the example items of SCCMS (Baek et al., 2017).

Table 1. SCCMS example items

Competencies	Example Items	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
SM	I diligently prepare for my classes and club activities all the time.	①	②	③	④	⑤
KI	I can organize collected information systematically.	①	②	③	④	⑤
CT	I offer useful ideas in group projects	①	②	③	④	⑤
AE	I can construct messages through a metaphor or a figure of speech.	①	②	③	④	⑤
CO	I can organize message to deliver concisely and clearly.	①	②	③	④	⑤
CM	I try not to develop stereotypes or biases.	①	②	③	④	⑤

For academic achievement, the scores of NAAT conducted on June 1st, 2017 were used. As a mock test for Korea's College Scholastic Ability Test (CSAT), NAAT was developed and administered by Busan Office of Education. In this study, the NAAT scores in Korean language (*Mean* = 79.62, *SD* = 17.91), Math (*Mean* = 65.15, *SD* = 21.37), and English (*Mean* = 77.12, *SD* = 19.18), where each maximum score was 100.

Data analysis

To identify the major profile of students' six core competencies and its relationship with academic achievement, PAMS and correlation analysis had been conducted. PAMS is a method used to explore major profile patterns in a given population (Davison, Gasser, & Ding, 1996; Davison Kim, & Ding, 2001). PAMS reparametrizes a linear latent variable model to interpret variables as a profile pattern.

PAMS analysis can be divided largely into two steps (Davison et al., 1996). First, PAMS explores a dominant profile pattern called the prototypical profile in data. In PAMS, prototypical profiles are posited; each observed profile is represented as a linear combination of the prototypical profiles. To identify the profiles, PAMS applies multidimensional scaling (MDS), which standardizes the mean of prototypical profiles to zero. Therefore, positive values of dimension scale represent that scores are higher than a mean of the profile, whereas negative values show that scores are lower than the standardized mean.

Second, PAMs estimates person parameter using a degree of correspondence between the observed individual profile and the prototypical profile. The relationship between the prototypical profile and correspondence weights (similarity to the prototypical profile) can be represented as below (Davison et al., 2001).

$$m_{pt} = c_p + \sum_k w_{pk} X_{tk} + e_{pt}$$

Where m_{pt} : observed score of subject p on variable t
c_p : level parameter of subject p's profile
w_{pk} : correspondence weight between the actual profile of subject p and the prototypical profile k
X_{tk} : score of variable t in the prototypical profile k
e_{pt} : measurement error and systematic deviations from the model

These parameters can analyze the relationship between profiles and other variables of interest. Owing to this merit, PAMS has been applied in the field of education research examining important patterns or trends of student characteristics (Altun & Mazman, 2015; Ding, Davison, & Petersen, 2005; Park & Yang, 2007; Park, Chung, & Shin, 2013).

In this study, prototypical profiles of students' six core competencies were extracted through the PAMS model. Also, Pearson's correlation between student's correspondence weight and academic achievement was examined.

Results

High school students' levels of six core competencies

The means of the 274 participants' six core competencies fell in the range of 3.65 and 3.96, while their standard deviations ranged from .51 to .59. Of six competencies, CM had the highest mean values, whereas AE had the lowest (see Table 2).

Table 2. Descriptive statistics of six core competencies

Domain	*M*	*SD*	MIN	MAX
Self-Management (SM)	3.74	0.56	1.80	5.00
Knowledge-Information Processing (KI)	3.84	0.51	2.27	5.00
Creative Thinking (CT)	3.70	0.57	2.00	5.00
Aesthetic Emotion (AE)	3.65	0.59	2.00	5.00
Communication (CO)	3.87	0.57	2.00	5.00
Community (CM)	3.96	0.54	2.47	5.00
Overall	3.79	0.46	2.57	5.00

Having compared the levels of core competencies by gender, students' CT and AE differed significantly. When the core competency levels were compared by major, the KI of students who majored in humanities & social studies (HS) differed significantly from those in science & technology (ST) (see Table 3).

Table 3. *t*-test for core competency differences

	Gender					Major			
		N	*Mean*	*SD*	*t*		*N*	*Mean*	*SD*	*T*
SM	M	132	3.79	.60	1.64	HS	93	3.69	.59	-.99
	F	142	3.68	.52		ST	181	3.76	.54	
KI	M	132	3.86	.54	.84	HS	93	3.73	.56	-2.41*
	F	142	3.81	.49		ST	181	3.89	.48	
CT	M	132	3.79	.60	2.55*	HS	93	3.61	.62	-1.75
	F	142	3.61	.53		ST	181	3.74	.54	
AE	M	132	3.54	.63	-3.09**	HS	93	3.74	.56	1.72
	F	142	3.75	.53		ST	181	3.61	.60	
CO	M	132	3.80	.56	-1.81	HS	93	3.86	.64	-.26
	F	142	3.93	.58		ST	181	3.88	.54	
CM	M	132	3.93	.56	-.78	HS	93	3.95	.57	-.14
	F	142	3.98	.52		ST	181	3.96	.52	
Overall	M	132	3.79	.49	-.17	HS	93	3.76	.49	-.73
	F	142	3.80	.43		ST	181	3.81	.44	

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

As shown in Table 4, the correlation fell in the range of .486 and .786, and the correlations with the overall score fell in the range of .771 and .863, indicating high correlations.

Table 4. The correlation of the core competencies ($N = 274$)

	SM	KI	CT	AE	CO	CM
KI	.720***					
CT	.665***	.786***				
AE	.486***	.497***	.542***			
CO	.602***	.673***	.636***	.649***		
CM	.609***	.565***	.555***	.622***	.717***	
Total	.820***	.849***	.842***	.771***	.863***	.819***

*** $p < .001$

Profile analysis of six core competencies

PAMS was conducted to explore prototypical profiles of six core competencies. The first step of the analysis was to extract prototypical profiles via multidimensional scaling. Evidenced by fit statistics of Young's S-Stress and Kruskal's Stress, two prototypical profiles — rather than one — were drawn (see Table 5). S-Stress and Stress indices were close to zero (.005 and .004 respectively), and the explanatory power of the model () was as high as 99.99%, indicating an excellent mode.

Table 5. Model fit of multidimensional scaling

	One dimension	Two dimensions
S-stress	.08425	.00499
Stress	.13211	.00397
	.94487	.99988

Overall, the two prototypical profiles had relatively high CT together with low CM but showed visible differences (see Figure 1).

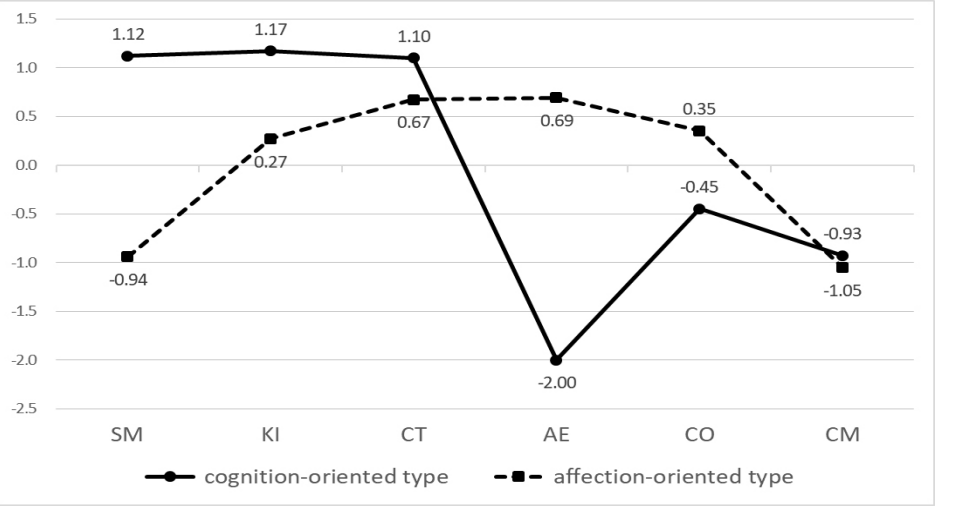

Figure 1. Prototypical profiles of six core competencies

One prototypical profile generated relatively high SM and KI but with low AE and CO. Students identifiable with this type had high thinking or management ability for self-management or information processing but lacked aesthetic sensibility and open attitude toward community. Regardless of the core competency levels, the first profile showed relatively strong cognition-oriented (SM and KI) but with weak affection-oriented (AE and CO) characteristics. Reflecting these dominant features, it was named 'cognition-oriented type.'

The other, on the other hand, turned out to have relatively high AE and CO, but low

SM and KI. Because it showed relatively strong affection-oriented but weak cognition-oriented competencies, it was named 'affection-oriented type'. Because the parameters of prototypical profiles indicate relative distance within each profile, one should not view the profiles as absolute measures.

For the second step of PAMS, each student's parameters of correspondence weight and elevation were examined (see Table 6). The correspondence weight indicates the similarity to each prototypical profile, and the elevation parameter indicates the overall level of competencies. Those parameters have an average of zero, and non-zero values represent the standard deviation above or below the average (Culpepper & Davenport, 2009). Besides, an explanatory power showed that, on average, 50% of individual profiles could be accounted for by a linear combination of the two prototypical profiles.

Table 6. Descriptive statistics of student parameters estimated by PAMS analysis

	N	Min.	Max.	Mean	SD
Correspondence weight to cognition-oriented type	274	-0.78	1.41	0.00	0.28
Correspondence weight to affection-oriented type	274	-1.56	1.37	0.00	0.36
Elevation parameter	274	-2.21	2.17	0.00	0.83
Explanatory power (R^2)	274	0.00	0.97	0.50	0.27

Based on the correspondence weights, students were categorized into two groups: one group whose student correspondence weight to cognition-oriented type was bigger than that of affection-oriented type versus the other whose student correspondence weight to affection-oriented type bigger than that of cognition-oriented type. Of 274 students, 120 students could be categorized into a group whose characteristics resembled cognition-oriented and 154 students into the other group whose feature resembled affection-oriented type — the result differed by gender (x^2= 6.166, p < .05) and major (x^2= 6.260, p < .05) (see Table 7).

Table 7. Cross table of dominant type, gender, and major

Dominant type	Gender		Major	
	Male	Female	Humanities & Social Studies	Science & Technology
Higher similarity to cognition-oriented type	68 (51.5%)	52 (36.6%)	31 (33.3%)	89 (49.2%)
Higher similarity to affection-oriented type	64 (48.5%)	90 (63.4%)	62 (66.7%)	92 (50.8%)
Total	132 (100%)	142 (100%)	93 (100%)	181 (100%)
	6.166*		6.260*	

* p < .05

The results of PAMS provide useful information about individual students. The following two figures demonstrate students' individual profiles compared to prototypical profiles. Student #96's profile was representative of a cognition-oriented type as shown in

[Figure 2]. The student's correspondence weight to the cognition-oriented type was 1.41, while his or her weight to the affection-oriented type was .45. The prototypical profiles explained 82% of the student's profile, and his or her elevation parameter was .40 placing the student slightly above average.

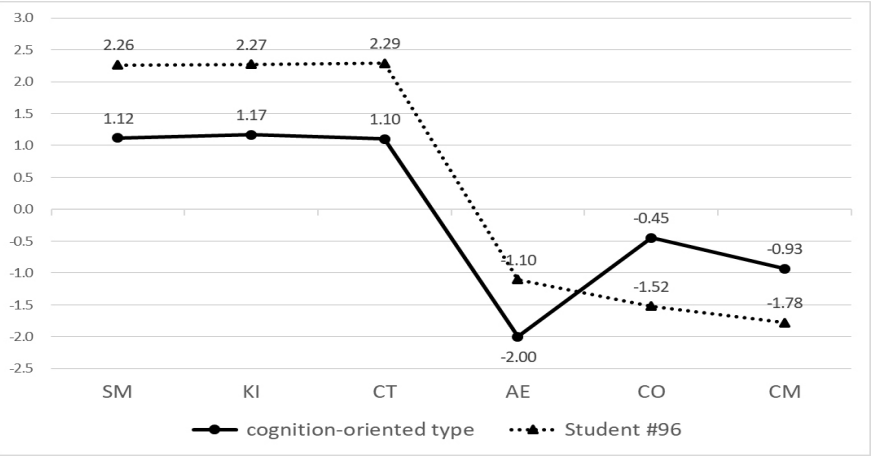

Figure 2. Representative case of cognition-oriented type

The profile of student #45 was representative of an affection-oriented type as shown in [Figure 3]. The student's correspondence weight to the affection-oriented type was 1.37, while his or her weight to the cognition-oriented type was .65. The prototypical profiles explained 94% of the student's profile, and his or her elevation parameter was -.42 placing the student slightly below average.

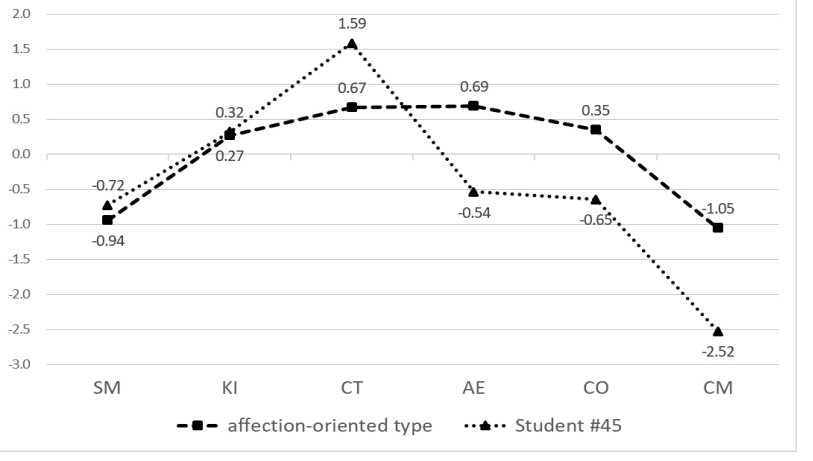

Figure 3. Representative case of affection-oriented type

Correlation analysis of core competencies and academic achievement

As shown in Table 8, the correlation between six competencies and academic achievement ranged from .136 to .388 — the correlation of AE with math, AE with English, CM with English were not statistically significant. The result showed that academic achievement had a marginal influence on the students' core competency levels.

Table 8. Correlation of core competencies and academic achievement

	Korean	Math	English	Overall
SM	.229***	.328***	.248***	.300***
KI	.379***	.377***	.359***	.411***
CT	.323***	.388***	.271***	.345***
AE	.136*	.033	.036	.072
CO	.291***	.250***	.254***	.292***
CM	.146*	.225***	.114	.182**
Overall	.301***	.308***	.255***	.319***

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 9 shows the correlation between correspondence weight to two prototypical types and the students' academic achievement. The correspondence weights to prototypical profiles, the descriptive statistics demonstrated in Table 6, were compared to academic achievement (see Table 9). The result revealed that the weight to the cognition-oriented type had a statistically significant correlation with academic achievement, and the correlation was particularly high with mathematics. This indicates that the more similar a student's profile is to the cognition-oriented type, the higher his or her academic achievement level is — especially in math. The weight to the affection-oriented type, however, had a statistically significant correlation only with the Korean language, and the correlation coefficient was rather low (below .2). These results imply that Korean high schools had been focused more on cognition-oriented competencies than affection-oriented competencies.

Table 9. Correlation of student parameters and academic achievement

	correspondence weight to cognition-oriented type	correspondence weight to affection-oriented type
Korean	.221***	.161**
Math	.315***	-.048
English	.289***	.077
Overall	.307***	.063

** $p < .01$, *** $p < .001$

Discussion and conclusion

This study identified the levels and profiles of six core competencies of Korean high school students whose education is further reinforced by the competency-based curriculum (CBE), 2015-RNC. The data of six core competencies and academic achievements from 274 high school students were used. The core competencies were measured using SCCMS developed by Baek et al. (2017), while academic achievements were collected using NAAT developed by Busan Office of Education. As a result, two types of prototypical profiles were extracted, and their correlations with academic achievement were analyzed.

The main results of this research are as follows. First, high school sophomore students' six core competency levels ranged between 3.65 and 3.96 (M = 3.79), where the maximum score was 5.0. Male students' CT was higher than that of female students (t = 2.55, p < .00), while female students' AE was higher than that of male students (t = -3.09, p < .00). When analyzed by majors — Science & Technology (ST) and Humanities & Social Science (HS) — KI of the students majoring in ST was higher than that of students who majored in HS (t = -2.41, p < .00). Also, the correlation of six core competencies fell in the range of .486 and .786. These findings may offer an insight that educators encouraged to prescribe a tailored educational treatment to students whose competency strengths differ.

Second, in an attempt to identify the patterns of six core competencies via PAMS analysis, two prototypes were extracted: 'cognition-oriented type' and 'affection-oriented type'. Cognition-oriented type demonstrated strength in SM and KI but showed weak affective competencies like AE and CO. On the contrary, affection-oriented type showed strength in AE and CO but had relative weakness in cognitive ability like SM and KI. Because the focus of this research was placed on identifying latent groups and student characteristics with precision to offer customized educational prescriptions, the findings affirmed the presence of different patterns in a micro-level analysis. Therefore, student profile analysis must be actively applied in school levels to devise educational strategies befitting CBE.

Third, the correlation between core competencies and academic achievement was not visibly high — the correlation between AE and CM was virtually non-existent. This result aligns with the results of existing research reporting that core competencies and academic achievement are minimally correlated at best (Baek, 2013; Hwang et al., 2016; Kang, Park, Kim, You, & Kim, 2012; Lee & Kim, 2012; Namkung et al., 2016). When the correlation between each prototype's correspondence weight and academic achievement was analyzed, the weight to the cognition-oriented type had statistically significant correlation, whereas the weight of the affection-oriented type did not. These results suggest that tests for measuring academic achievement such as NAAT are primarily focused on cognitive achievement rather than affective qualities. The implementation of 2015-RNC, however, demanded the range of academic achievement be widened to incorporate cognitive abilities together with affective abilities. Therefore, new test items to comprehensively measure students' various abilities need to be developed to capture core competencies like AE and CM with precision. Considering that assessment practices at schools are considerably influenced by CSAT, NAAT in the least has indirect implications on the assessment practices at schools.

To sum up, the findings of this study capitalizes the need for tailored teaching and learning strategies that befit students' profiles of competencies and advanced assessment practices to evaluate the competencies as a target of education. First, this study clarified the

need for devising tailored teaching and learning strategies by extracting two different prototypical profiles of core competencies. In fact, recent studies on CBE have consistently highlighted the importance of personalized and self-paced learning in realizing the goal of CBE, which is to assure that all students are equipped with core competencies. Some even went on to coin the term 'personalized competency-based education (PCBE) (Marzano, Norford, Morgan, Finn Ⅲ, Mestaz, & Selleck, 2017; Yu, 2019).

Furthermore, this study also proved with empirical evidence that academic achievement may accelerate cognition-oriented competencies but unlikely to do the same for affection-oriented competencies. Hence, considering that the focus of education has been heavily paid on cultivating cognitive abilities, more endeavors and strategies to cultivate all six core competencies with balance are needed. Ultimately, in order to successfully implement CBE, the assessment must incorporate both cognition- and affection-oriented abilities in teaching and learning environment. The significance of developing and diversifying assessment practices in a way that successfully measures core competencies and provide formative feedback to teachers and students has been emphasized in recent studies of CBE (Yu, 2019).

This study, however, bears certain limitations in that the data used have been collected from one high school, thus only partially representing all high school students across the nation. Hence, a caution advised when applying the research outcome to other groups of students. One must note that the participants were from a typical Korea high school setting, thus empirically capitalizing on the field study to tailor teaching and learning strategies.

Further studies incorporating samples representative of Korean middle and high students are recommended to implement CBE in Korean public schools. In doing so, the level of core competencies and their patterns may be better explained by student variables (gender and major), school variables, or demographic variables. Lastly, effective teaching and learning strategies for each competency pattern must be delved deeper.

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