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Development and Validation of the Future Creative Confluence Competency (F3C) Test for College Students in South Korea

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The purpose of this study was to develop and validate a test to measure future creative confluence competency (F3C), which is the capability of future talents. Creative competency and confluence competency were derived as the constructs of the F3C, and measurement items were developed to measure each construct. Seventeen experts were engaged in verifying contents validity of the test. In addition, the data collected from 653 college students were analysed to confirm reliability and validity of the test. The F3C test consists of four sub-constructs of creative ability, creative personality, integrated thinking ability, and new knowledge and value creation ability with a total of 27 items.

Key words: *Future creative confluence competency test, creative competency, confluence competency, validation.*

1. Introduction

With Artificial Intelligence (AI) centered science technology expected to change future society, countries around the world are revising their educational curricula to promote talented people who can adapt to future society. The core of each country's curriculum revolves around schools developing these individuals' ability to solve problems, creative thinking and collaboration, rather than teaching individual knowledge or skills that AI can replace. The 2015 revised curriculum in Korea presents six core competencies (self-management, knowledge information processing, creative thinking, aesthetic emotion, communication and community competency) to be fostered through education. In order to

develop such core competencies, schools should activate various student participation classes suitable for the characteristics of the subjects.

The teaching-learning method for fostering creative confluence talents that can adapt to future society should be a way to support each student to find what they want to do and should be operated in a way that schools and teachers can help and develop their abilities. In addition, efforts at the university level should be made so that the direction of human resource development education can connect elementary schools to higher education. To foster creative confluence talents suitable for future society by systematically preparing them in the developmental stage through education, it is necessary to establish the characteristics of future talents that Korea should pursue and to form a basic model of what skills should be developed from elementary education through to higher education. As young learners and adult learners, namely novice and expert, demonstrated expression of creative ideas and creativity development ought to be considered (Cropley, 2001).

Accordingly, the Educational Model for Fostering Future Creative Confluence Talents proposed by Lee (2017) outlines the characteristics of future talents who can cope with the rapidly changing future environment as "finding the new idea, integrating and converging various knowledge to create new knowledge of new value, monitoring oneself, designing and driving the future vision, the creative confluence competency to demonstrate creative leadership" (Puccio et al., 2014). Lee (2017) established creative confluence talents as the future talents shaped by our education and devised a systematic educational model that connected elementary education to higher education with the aim to foster them.

The ultimate goal to be nurtured in this educational model is the competency that future creative talents must have (future creative confluence competency, hereby F3C), and its constructs are creative competency and convergent competency. The former includes creative ability and creative personality, whereas the latter includes integrated thinking ability and new knowledge and value creation ability. In addition, while fostering competency in the cognitive aspect, it was suggested that affective and behavioural characteristics such as self-concept, creative leadership and self-directed learning ability, should be nurtured as the personal characteristics of future talents (Lee et al., 2020). In previous research explaining self-concept as multidimensional in adaptation (Fuentes et al., 2011; Martínez-Antón et al., 2007; Mruk, 2006), positive self-concept suggested a high correlation between social adaptation and integration. In addition, Puccio et al., (2014) emphasised that a leader who adapts to new changes and tries to innovate through challenge is a creative leader; this is a characteristic of talents required in future society. Therefore, it is noted that a leader with creative leadership can stimulate someone's imagination, recognise their opinions and create creative changes by presenting new goals and directions for the organisation.

In this way, in accordance with the demand for a plan for fostering future talents through

school education, significant research has been conducted: on the core competency required for future talents; on the derivation of core competency (Cho & Lee, 2014; Jeong et al., 2018; Kim & Lee, 2017; Park et al., 2014); on the development of core competency measurement test (Kang et al., 2014; Kim et al., 2008; Lee et al., 2011); on the relationship between variables related to core competency, creative competency and confluence competency (Akram & Yalda, 2014; Kim & Lee, 2016; Ko & Lee, 2020; Lee et al., 2014); and on teaching and education methods for competency building (Lee & Kim, 2017; Lee & Park, 2014; Lee et al., 2015; Sung et al., 2009).

However, it is now necessary to develop a test to identify and measure the concept and constructs of creative confluence competency required in future society. Therefore, in this study, F3C is defined as a strategy to foster future talents as creative confluence talents, and a measurement test is developed based on this. First, F3C is defined as a psychological resource that includes future talents' characteristics by integrating creative capability and confluence capability that can actively respond to various situations in the rapidly changing future society. Creative competency means to create new ideas and recreate culture with flexible and original thinking, and to integrate open and sensitive personalities. Moreover, it implies coping with various problematic situations by recreating new knowledge and values across diverse areas of knowledge with: a positive perception of oneself; respecting others; leading community cooperation; and having the insight to monitor and manage oneself. These are the abilities, attitudes and characteristics of talents harmoniously implicit in future talents characteristics (Lee et al., 2020, p. 112–113). Based on this concept definition, constructs are derived to develop and validate tests that can measure F3C.

2. Method

2.1 The content validity of experts

The purpose of this study was to develop a measurement test by deriving the constructs of F3C. Its concept was defined and the content validity of experts was confirmed for the constructs and the appropriateness of 28 items. A total of 17 participants — four males and 13 females between 20 and 40 years of age and holding at least a university degree — who were experts in the fields of lifelong education, pedagogy and educational psychology confirmed content validity. The content validity results are presented in Table 1. The content validity ratio (CVR) of the experts ranged from 0.647 to 1. The whole items were validated by meeting the criterion of Lawshe (1975).

Table 1: Content Validity for F3C Test

Item Number	*M*	*SD*	*CVR*
1	4.882	0.332	1.000
2	4.765	0.437	1.000
3	4.765	0.437	1.000
4	4.647	0.606	0.882
5	4.647	0.702	0.765
6	4.529	0.800	0.647
7	4.706	0.588	0.882
8	4.706	0.686	0.765
9	4.824	0.393	1.000
10	4.706	0.588	0.882
11	4.588	0.712	0.765
12	4.588	0.712	0.765
13	4.529	0.875	0.765
14	4.471	0.800	0.647
15	4.706	0.470	1.000
16	4.647	0.786	0.647
17	4.647	0.862	0.765
18	4.706	0.588	0.882
19	4.824	0.393	1.000
20	4.765	0.437	1.000
21	4.647	0.702	0.765
22	4.765	0.437	1.000
23	4.706	0.470	1.000
24	4.765	0.562	0.882
25	4.706	0.588	0.882
26	4.588	0.507	1.000
27	4.765	0.437	1.000
28	4.824	0.393	1.000

2.2 Research participants

In this study, content validity was confirmed by 17 experts, and the concept, constructs and items were determined by reflecting the results; then, a survey was conducted to validate the measurement test. A total of 697 students from S University in Seoul were collected between September and November 2019 using the Web Survey tool. Among the collected data, the final 653 were used for analysis, excluding unfaithful data. Table 2 represents the research participants' demographics.

Table 2: Participants' Demographics

Variables	Item	n (%)
Gender	Male	311 (47.6)
	Female	342 (52.4)
Age	under the age of 25	496 (76.0)
	over 25 years of age	157 (24.0)
Major	Humanities and Social Sciences	243 (37.2)
	Nature	93 (14.2)
	Engineering ·IT	317 (48.5)
Grade	1st	116 (17.8)
	2nd	143 (21.9)
	3rd	220 (33.7)
	4th	174 (26.6)

2.3 Research procedure

By analysing previous studies, this study is based on the future confluence education model that connects elementary education to higher education and assumes that the competency of talents should be creative confluence competency. The concept of F3C for fostering future creative confluence talents was operationally defined and constructs were derived. Then, the content validity of experts was verified after developing an educational model for fostering future creativity confluence competency.

In addition, after developing items that are able to measure creative competency and confluence competency, which are the constructs of F3C, the experts' content validation was confirmed. Data collected from 653 university students were analysed to verify the structure of the test and validate it.

2.4 Data analysis

The following statistical techniques were used in data analysis. First, data collected from 17 experts were analysed for mean, standard deviation and content validity ratio (CVR) to verify content validity of the test. Second, data collected from 653 college students were analysed for construct validity, convergent validity, discriminant validity and cross validity using confirmatory factor analysis. Descriptive statistics and correlations of the data were also analysed.

3. Results

3.1 F3C conceptual structure model and definitions of its constructs

3.1.1 Conceptual structure model of F3C

In this study, the concept of F3C was operationally defined and its constructs were derived. After verifying the content validity of the experts, a measurement test was developed. F3C is defined in this study as an integration of creative competency and confluence competency that can actively respond to various situations in a rapidly changing future society, and it is a psychological resource that includes future talents.

Creative competency consists of creative ability that creates new and diverse ideas and devises unique products and creative personality that means affective characteristic by which one considers everything with curiosity and sensitivity. In addition, confluence competency includes an integrated thinking ability that encompasses knowledge in various areas as well as the ability to recreate knowledge and values to cope with new and diverse problem situations. At the same time, positive self-concept is the overall perception of oneself as an individual's affective and behavioural characteristics, creative leadership respects others and leads community cooperation, and self-directed learning ability gives an insight into monitoring and managing oneself. They refer to a talented person's abilities and attitudes, which are harmoniously embedded in the characteristics of future talents. The conceptual structure model of F3C is shown in Figure 1.

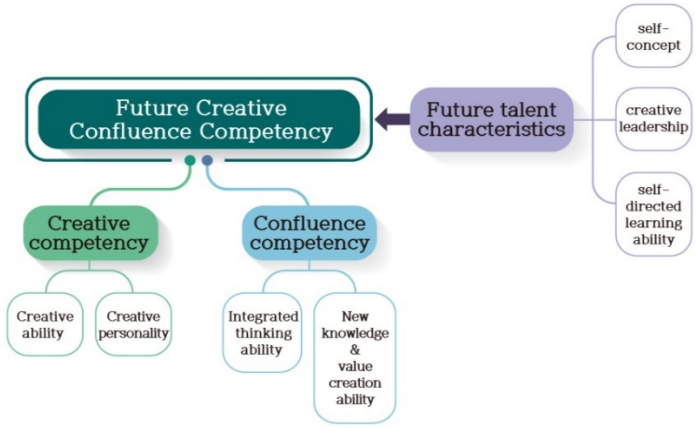

Figure 1: The Conceptual Structure Model of F3C

3.1.2 Definitions of constructs of F3C

The definitions of constructs of F3C are shown in Table 3 below.

Table 3: Definitions of Constructs of F3C

Construct	Definition	Sub-construct	Definition
Creative competency	Focuses on creativity and integrates creative thinking ability and creative personality. The ability to generate new, diverse, and unique ideas that are different from others, to consider everything with curiosity and sensitivity, to commit to a task, and to link creative ability to the community's interests and values to the final achievement.	Creative ability	Cognitive ability to create new and diverse ideas, devise unique products that are different from others and devise creative alternatives.
		Creative personality	Affective characteristic by which one considers everything with curiosity and sensitivity, has task commitment, and supports that creative ability can be linked to final achievements connected to the interests and values of the community.
Confluence competency	Ability to create knowledge or value by integrating knowledge and skills in various fields based on expertise in majors and understanding of other disciplines.	Integrated thinking ability	Ability to understand, analyse, infer, synthesise and link information, knowledge and skills in majors and various fields.
		New knowledge & value creation ability	Ability to reconstruct or create new knowledge or value through an interdisciplinary approach.
Future talent characteristics	Overall individual characteristics required for adaptation to future society and for performing an important role.	Self-concept	Self-image, one's perception of oneself in the areas of cognition, affection, society and body.

	Self-concept of self-awareness, image and self-perception of oneself; self-management and respect for others; creative leadership that leads to community cooperation; and self-directed learning ability to monitor and manage one's own learning.	Creative leadership	Leadership that adapts to society by actively self-managing, respecting others, and encouraging the use of diverse resources through community cooperation to create creative confluence products.
		Self-directed learning ability	Ability to self-monitor and manage oneself in cognitive, affective and behavioural areas and to strategically pursue learning objectives.

3.2 Correlation, descriptive statistics and validation

3.2.1 Correlation values and descriptive statistics of measurement variables

The measurement test of F3C in this study consists of four sub-constructs: creative ability, creative personality, integrated thinking ability, and new knowledge & value creation ability. The total number of items in this measurement test was 28, with nine for creative ability, nine for creative personality, five for integrated thinking ability and five for new knowledge & value creation ability. As a result of convergent validity verification of this measurement test using confirmatory factor analysis, the factor load of item number 4 of creative personality ("I do not get bored or give up easily, even if it is a routine or a simple, repetitive task") was too low as $\lambda = 0.27$; excluding this, a total of 27 items were tested for validity.

Table 4 shows the correlation values and descriptive statistics between the measurement variables. The correlations between the 27 observed variables were all significant at the levels of $p = 0.05$ and 0.01. The mean of the measurement variable has a value between the minimum of 3.15 and the maximum of 3.80, and standard deviation (SD) has a value between the minimum of 0.780 and the maximum of 1.099. Both skewness and kurtosis are within the range of $\pm|2|$, forming a normal distribution.

Table 4: Correlation between Variables and Descriptive Statistics

	CA1	CA2	CA3	CA4	CA5	CA6	CA7	CA8	CA9	CP1	CP2	CP3	CP5	CP6	CP7	CP8	CP9	CT1	CT2	CT3	CT4	CT5	NN1	NN2	NN3	NN4	NN5
CA1	1																										
CA2	.505**	1																									
CA3	.429**	.377**	1																								
CA4	.560**	.437**	.353**	1																							
CA5	.550**	.433**	.402**	.594**	1																						
CA6	.485**	.334**	.399**	.392**	.418**	1																					
CA7	.602**	.439**	.428**	.550**	.544**	.499**	1																				
CA8	.589**	.468**	.412**	.497**	.496**	.484**	.578**	1																			
CA9	.497**	.410**	.571**	.400**	.453**	.505**	.509**	.597**	1																		
CP1	.331**	.312**	.385**	.335**	.328**	.305**	.314**	.397**	.497**	1																	
CP2	.106**	.090*	.184**	.138**	.159**	.211**	.194**	.128**	.225**	.357**	1																
CP3	.183**	.163**	.272**	.236**	.251**	.232**	.225**	.222**	.305**	.334**	.379**	1															
CP5	.177**	.131**	.272**	.227**	.290**	.233**	.267**	.206**	.281**	.227**	.245**	.358**	1														
CP6	.325**	.286**	.438**	.259**	.269**	.337**	.319**	.370**	.455**	.483**	.254**	.300**	.303**	1													
CP7	.213**	.189**	.278**	.309**	.303**	.270**	.320**	.288**	.330**	.295**	.267**	.389**	.454**	.313**	1												
CP8	.134**	.111**	.183**	.134**	.155**	.198**	.197**	.159**	.207**	.227**	.534**	.267**	.240**	.186**	.287**	1											
CP9	.266**	.288**	.257**	.313**	.294**	.295**	.284**	.255**	.287**	.307**	.208**	.170**	.229**	.276**	.295**	.255**	1										
CT1	.242**	.194**	.270**	.287**	.317**	.294**	.311**	.253**	.340**	.261**	.288**	.336**	.417**	.267**	.452**	.254**	.293**	1									
CT2	.318**	.204**	.257**	.295**	.276**	.293**	.317**	.325**	.319**	.252**	.237**	.312**	.330**	.218**	.346**	.254**	.278**	.443**	1								
CT3	.273**	.233**	.324**	.328**	.355**	.285**	.316**	.307**	.335**	.253**	.263**	.404**	.422**	.222**	.437**	.286**	.270**	.506**	.494**	1							
CT4	.263**	.282**	.313**	.319**	.340**	.312**	.332**	.325**	.420**	.301**	.270**	.441**	.423**	.309**	.453**	.241**	.248**	.430**	.445**	.515**	1						
CT5	.273**	.258**	.337**	.250**	.310**	.292**	.321**	.334**	.360**	.303**	.259**	.502**	.433**	.291**	.382**	.217**	.217**	.423**	.409**	.467**	.553**	1					
NN1	.301**	.213**	.269**	.249**	.246**	.340**	.364**	.352**	.375**	.264**	.158**	.285**	.273**	.278**	.330**	.174**	.193**	.283**	.324**	.320**	.351**	.348**	1				
NN2	.231**	.205**	.223**	.209**	.202**	.252**	.241**	.253**	.300**	.194**	.135**	.130**	.213**	.197**	.214**	.088*	.246**	.221**	.162**	.219**	.254**	.187**	.336**	1			
NN3	.256**	.205**	.274**	.205**	.229**	.248**	.246**	.302**	.382**	.317**	.227**	.216**	.269**	.301**	.252**	.118**	.131**	.282**	.372**	.297**	.329**	.262**	.351**	.272**	1		
NN4	.458**	.379**	.387**	.388**	.471**	.392**	.454**	.436**	.447**	.327**	.216**	.279**	.311**	.362**	.344**	.188**	.324**	.346**	.376**	.383**	.385**	.377**	.336**	.315**	.356**	1	
NN5	.419**	.307**	.368**	.377**	.378**	.389**	.386**	.436**	.482**	.343**	.222**	.249**	.234**	.372**	.292**	.208**	.296**	.283**	.343**	.336**	.384**	.320**	.376**	.240**	.485**	.466**	1
M	3.27	3.34	3.53	3.36	3.44	3.24	3.30	3.15	3.30	3.50	3.80	3.70	3.45	3.28	3.42	3.59	3.65	3.58	3.44	3.35	3.51	3.60	3.24	3.53	3.16	3.40	3.32
SD	.940	.933	.881	.952	.875	.948	.901	.985	.964	.965	.882	.829	.790	.938	.844	.943	.916	.780	.839	.841	.806	.809	.887	.835	1.099	.805	.886
skewess	-.205	-.195	-.294	-.352	-.428	-.078	-.227	-.118	-.184	-.263	-.568	-.573	-.278	-.115	-.240	-.307	-.455	-.400	-.237	-.169	-.395	-.423	-.133	-.354	-.064	-.259	-.248
kurtosis	-.621	-.660	-.481	-.426	-.239	-.655	-.384	-.734	-.733	-.572	-.024	.341	-.138	-.591	-.272	-.570	-.285	.046	-278.	-.110	-.010	.038	-.474	-.217	-.881	-.110	-.381

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

Note: CA- creative ability, CP- creative personality, CT- integrated thinking ability, NN- new knowledge & value creation ability

3.2.2 Convergent validity

Convergent validity, which indicates whether a latent variable is consistently measured, can be verified by factor load (0.50 to 0.95) and significance (C.R. = 1.965 or higher), by average variance extracted (AVE) (0.5 or higher), and by concept reliability (0.7 or higher) (Woo, 2014). The following Table 5 and Figure 2 show the results of convergent validity through one-dimensional confirmatory factor analysis. The model to which the maximum likelihood (ML) was applied was suitable as $\chi^2 = 914.224$ ($df = 316$, $p < 0.001$), $TLI = 0.903$, $CFI = 0.913$, $RMSEA = 0.054$. In the case of some items (CP2, CP8, CP9, NN2), factor loading was a little less than 0.5, and the AVE value of creative personality and new knowledge and value creation ability was also lower than 0.5. However, when the observation variable was removed — as it could hinder content validity — additional variables were not deleted. Construct reliability and significance exceeded 0.7 and 1.965, respectively, and no overall problem was detected with regard to convergent validity.

Table 5: Factor Loading and AVE, Reliability

Path		Nonstandardisation coefficient	S.E.	C.R.	*p*	Standardisation coefficient	AVE	Cronbach α
CCA←	Creative Ability	1.020	0.054	18.765	0.000	0.759		
CA2 ←	Creative Ability	0.801	0.054	14.773	0.000	0.600		
CA3 ←	Creative Ability	0.766	0.051	14.956	0.000	0.608		
CA4 ←	Creative Ability	0.927	0.055	16.804	0.000	0.681		
CA5 ←	Creative Ability	0.877	0.051	17.322	0.000	0.702	0.519	0.906
CA6 ←	Creative Ability	0.869	0.055	15.800	0.000	0.641		
CA7 ←	Creative Ability	0.975	0.052	18.709	0.000	0.757		
CA8 ←	Creative Ability	1.063	0.057	18.667	0.000	0.755		
CA9 ←	Creative Ability	1.000				0.726		
CP1 ←	Creative Personality	1.221	0.135	9.037	0.000	0.520		
CP2 ←	Creative Personality	0.975	0.116	8.368	0.000	0.454		
CP3 ←	Creative Personality	1.214	0.125	9.747	0.000	0.602		
CP5 ←	Creative Personality	1.163	0.119	9.767	0.000	0.605	0.330	0.794
CP6 ←	Creative Personality	1.165	0.130	8.944	0.000	0.510		
CP7 ←	Creative Personality	1.346	0.133	10.120	0.000	0.655		
CP8 ←	Creative Personality	0.943	0.120	7.850	0.000	0.411		
CP9 ←	Creative Personality	1.000				0.449		
CT1 ←	Integrated Thinking Ability	0.916	0.061	14.942	0.000	0.655		
CT2 ←	Integrated Thinking Ability	0.956	0.066	14.526	0.000	0.635		
CT3 ←	Integrated Thinking Ability	1.078	0.067	16.150	0.000	0.715	0.572	0.869
CT4 ←	Integrated Thinking Ability	1.054	0.064	16.438	0.000	0.729		
CT5 ←	Integrated Thinking Ability	1.000				0.689		
NN1 ←	New Knowledge & Value Creation Ability	0.829	0.065	12.756	0.000	0.568		
NN2 ←	New Knowledge & Value Creation Ability	0.596	0.060	9.922	0.000	0.434		
NN3 ←	New Knowledge & Value Creation Ability	1.019	0.080	12.665	0.000	0.563	0.401	0.765
NN4 ←	New Knowledge & Value Creation Ability	0.926	0.060	15.315	0.000	0.699		
NN5 ←	New Knowledge & Value Creation Ability	1.000				0.685		

Note: CA- creative ability, CP- creative personality, CT- integrated thinking ability, NN- new knowledge & value creation ability

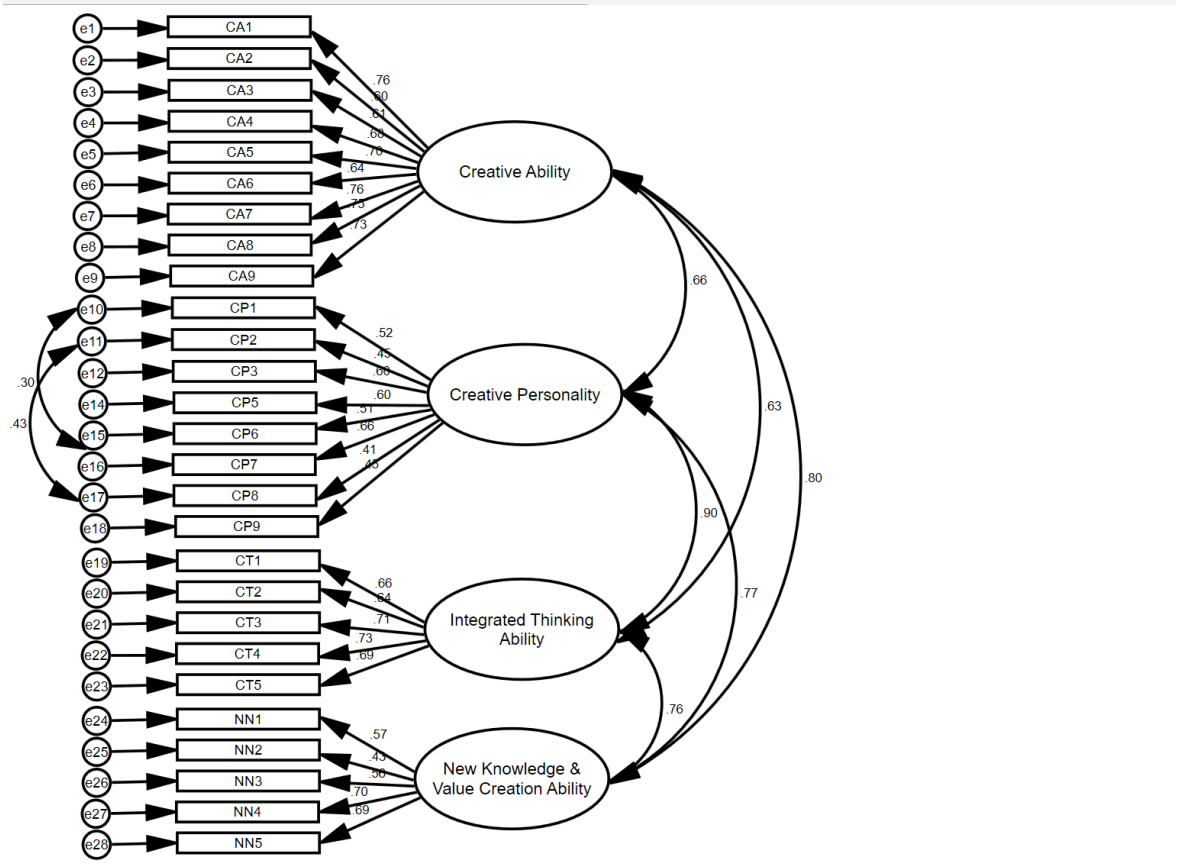

Figure 2: One-dimensional Confirmatory Factor Analysis (Standardized Coefficient)

3.2.3 Discriminant validity

Discriminant validity is the degree to which the difference between different latent variables can be verified by determining whether Ø±2×S.E. contains 1 and by the χ^2 difference between the unconstrained and constrained models (Woo, 2014). Table 6 shows the correlation and reliability intervals between the sub-variables of this measurement test. Ø±2×S.E. does not include 1, thus ensuring discriminant validity. Between the unconstrained model (χ^2 =914.224, df = 316) and the constrained model (χ^2 =1173.652, df = 317), the correlation between creative personality and integrated thinking ability is $\Delta\chi^2$ = 259.428 (Δdf = 1), which had the highest value and marked a statistically significant difference between the two models ($p < 0.001$). This result also shows that discriminant validity is secured.

Table 6: Correlation Reliability Intervals between Latent Variables

			Correlation (Ø) between latent variables	Ø±2×S.E.
Creative Ability	↔	Creative Personality	0.664	0.664 ± 2×0.023 = 0.618~0.710
Creative Personality	↔	Integrated Thinking Ability	0.900	0.900 ± 2×0.023 = 0.854~0.946
Integrated Thinking Ability	↔	New Knowledge & Value Creation Ability	0.764	0.764 ± 2×0.024 = 0.716~0.812
Creative Ability	↔	Integrated Thinking Ability	0.627	0.627 ± 2×0.024 = 0.579~0.675
Creative Personality	↔	New Knowledge & Value Creation Ability	0.769	0.769 ± 2×0.023 = 0.723~0.815
Creative Ability	↔	New Knowledge & Value Creation Ability	0.804	0.804 ± 2×0.030 = 0.744~0.864

3.2.4 Cross validity

Measurement equivalence was conducted to verify whether the measurement test for F3C developed in this study was identified as yielding the same results for male students (n = 311) and female students (n = 342). As shown in Table 7, $\Delta\chi^2$ between the unconstrained model (without any restrictions between the two groups) and the measurement weights model (with the same factor load between the two groups) is 24.522 (Δdf = 23), which is not statistically significant ($p < 0.05$), and the cross validity of this test was secured. This result shows that male and female college students do not perceive the future confluence competency measurement test differently.

Table 7: Measurement Equivalence Verification

	χ^2	*df*	*CFI*	*TLI*	*RMSEA*	$\Delta\chi^2$	sig.
Unconstrained	1536.800	634	0.866	0.851	0.047		
Measurement weights	1561.322	657	0.865	0.856	0.046	$\Delta\chi^2(23)=24.522$	Not sig.
Structural covariances	1568.100	666	0.866	0.859	0.046	$\Delta\chi^2(9)=6.778$	Not sig.
Measurement residuals	1624.677	695	0.862	0.860	0.045	$\Delta\chi^2(29)=56.577$	Not sig.

4. Conclusions

In this study, the concept of F3C was defined and its sub-constructs were derived; the F3C test was developed through validity verification. First of all, this study defined the concept of F3C as the competency to cope with and adapt by converging knowledge in a direction that produces creative and new values in various and changing situations of future society. In addition, it considered that future talents should not only have creative competency and confluence competency but also form a positive self-concept about themselves as a characteristic of future talents as well as design and lead self-directed vision and demonstrate creative leadership as a member of the community. Therefore, reflecting this point of view, it included creative competency and confluence competency as constructs, and it recommended to also consider the characteristics of future talents.

The F3C test consists of two constructs of creative competency and confluence competency: creative competency has two sub-constructs of creative ability and creative personality, and confluence competency also has two sub-constructs of integrated thinking ability and new knowledge and value creation ability. The F3C test with four sub-constructs of 27 items was developed through reliability and validation verification. Although the F3C test developed in this study has four sub-constructs of creative ability, creative personality, integrated thinking ability, and new knowledge & value creation ability, it is suggested that self-concept, creative leadership and self-directed learning ability should be also considered as the competencies of future talents, based on Lee's (2017) Educational Model for Fostering Future Creative Confluence Talents.

In conclusion, this study suggests what competencies and characteristics of future talents ought to be nurtured through education, reflecting the needs of future society, and how they can be measured. Therefore, it is expected that a curriculum connecting elementary education to higher education can be constructed by reflecting the concept and constructs of F3C, as suggested in this study.

References

Akram, S., & Yalda, D. (2014). The relationship between self-regulation and creativity and process of resolving problem. *International Journal of Basic Sciences & Applied Research, 3*, 19–25.

Cho, B. G., & Lee, K. H. (2014). Development of core competence for developing a convergence class model in social area. *Global Creative Leader*, *4*(2), 57–72.

Cropley, A. J. (2001). *Creativity in education & leaning*. Kogan Page Limited.

Fuentes, M. C., Fernando, J., Gracia, E., & Lila, M. (2011). Autoconcepto y ajuste psicosocial en la adolescencia [Self-concept and psychosocial adjustment in adolescence]. *Psicothema, 23*(1), 7–12.

Jeong, H. I., Cho, D. Y., Choi, J. S., Lee, J. M., Chang, E. H., & Kang, H. J. (2018). Study on the required and priority competencies for future talent at life stages in the 4th Industrial Revolution. *Journal of Lifelong Education*, *24*(4), 61–92.

Kang, Y. H., Park, S. H., Lim, H. N., Jung, D. C., Hwang, J. W., & Seol, G. I (2014). KEDI. Student Competency Index Survey. Korea Educational Development Institute Research Report, RR 2015–31.

Kim, C. Y., & Lee, K. H (2017). *Asia-pacific Journal of Multimedia Services Convergent with Art, Humanities, and Sociology*, *7*(7), 89–97 http://dx.doi.org/10.14257/ ajmahs.2017.07.46

Kim, G. H., Kim, J. Y., Jang, G. Y., So, G. H., Kim, J. H., & Kang, Y. B. (2008). *A study on the development and promotion plan of youth life core competency 1*. General Report. Korea Institute of Curriculum and Evaluation.

Kim, S. Y., & Lee, K. H (2016). An effect of confluence instruction model on creative personality and career key competencies of elementary school students. *The Journal of the Korean Society for Gifted and Talented*, *15*(3), 173–193.

Ko, J. Y., & Lee, K. H (2020). Relations between core competency and creative personality of university students for competency-based career education. *Global Creative Leader: Education & Learning*, *10*(1), 219–243. http://dx.doi.org/10.34226/ gcl.2020.10.1.219

Lawshe, C. H. (1975). A quantitative approach to content validity. *Personnel Psychology*, *28*(4), 563-575.

Lee, K. H., & Park, S. H. (2014). The comparison of university students' creativity and creative leadership to promote the creativity education in university. *The Journal of the Korean Society for Gifted and Talented*, *13*(3), 59–83. https://doi.org/ 10.17839/jksgt.2014.13.3.59

Lee, K. H. (2017). *Korea future education report*. Kwangmoonkag**.**

Lee, K. H., Jun, J. S., Tae, J. M., Yang, H. J., Park, J. G., Lee, H. J., Kim, C. Y., & Park, J. M. (2020). *Creative confluence education*. Jungminsa.

Lee, K. H., Kim, E. K., Koh, J. Y., & Park, C. S. (2011). Development of a learning competence test for college students: Focusing on cognition, learning motivation and learning behavior. *Korean Journal of Educational Psychology*, *25*(4), 791–809. URL http://www.dbpia.co.kr/journal/articleDetail?nodeId=NODE06763866

Lee, K. H., & Kim, C. Y. (2017). The effect of online creativity class on promotion of creative personality and self-concept. *Journal of Education & Culture (JOEC)*, *23*(1), 33–64. https://doi.org/10.24159/joec.2017.23.1.33

Lee, K. H., Lew, K. H., & Kim, E, K. (2014). Analysis of university students' learning competencies according to school year and academic discipline. *Youth Facilities and Environment*, *12*(3), 27–36

Lee, K. H., Shin, O. S., & Kim, C. Y. (2015). A study of strategies for creativity convergence education based on creative competency through research on creativity and creative leadership of university students. *The Korean Journal of Educational Psychology*, *29*(4), 653–676. http://www.dbpia.co.kr/journal/article Detail?nodeId=NODE06764036

Martínez-Antón, M., Buelga, S., & Cava, M. J. (2007). La satisfacción con la vida en la adolescencia y su relación con la autoestima y el ajuste escolar [Adolescent life satisfaction and its relationship with adolescent self-esteem and school adjustment]. *Anuario de Psicología, 38*(2), 293–303.

Mruk, C. J. (2006). *Self-esteem research, theory and practice: Toward a positive psychology of self-esteem*. Springer.

Park, K. M., Choi, Y. H., Hong, J. H., Lee, K. N., Moon, S. H., Tae, J. M., Lee, K. P., Min, B. K., & Noh, K. S. (2014). A Validity study on the Key Competencies Factors of STEAM. *The Korean Journal of Technology Education (KJTE)*, *4*(3), 214–234.

Puccio, G. J., Mance, M. M., & Murdock, M. C. (2014). *Creative leadership: Skills that drive change* (2nd edition). SAGE Publications.

Sung, B. C., Boo, J. Y., Han, K. I., & Lee, K. H. (2009). Perception of education community about teacher's competency. *Journal of Fisheries and Marine Sciences Education*, *21*(1), 78–95. http://www.dbpia.co.kr/journal/articleDetail? nodeId=NODE01198049

Appendix

■ Future Creative Confluence Competency (F3C) Test

Future Creative Confluence Competency is (1) creative competency (creative ability, creative personality), (2) confluence competency (integrated thinking ability, new knowledge & value creation ability), (3) future talents characteristics (self-concept, creative leadership, self-directed learning ability). Please read each of the questions given below, determine the degree that best matches you, and check (√) one of 1 to 5 questions.

* Do not check all ③ or any questions without thinking, and please respond to all of them.

① Strongly disagree ② Disagree ③ Normal, ④ Agree, ⑤ Strongly agree

Item	answer				
1. I am good at creating products with my own unique ideas that are different from others.	①	②	③	④	⑤
2. I can constantly create stories on various topics.	①	②	③	④	⑤
3. I tend to look at things or phenomena from various perspectives.	①	②	③	④	⑤
4. When I talk to my colleagues or have a meeting, I come up with a lot of ideas so I can present them in detail.	①	②	③	④	⑤
5. When I face with a problem, I can offer alternative to a new idea compared to others.	①	②	③	④	⑤
6. I can make many different objects with different uses, even if given the same material.	①	②	③	④	⑤
7. My new and unique ideas, presented through my understanding various fields, are often evaluated as necessary and valuable.	①	②	③	④	⑤
8. I usually have many thoughts, so I tend to express various ideas or create products.	①	②	③	④	⑤
9. I see or experience things and do not just dismiss them, and I think from various angles and connect with various ideas.	①	②	③	④	⑤

10. I constantly ask questions and want to know about many things around me.	①	②	③	④	⑤
11. I am immersed in a topic or problem and continue until the assignment is completed.	①	②	③	④	⑤
12. I can easily understand new facts or theories that I encounter by comparing and applying the knowledge I already know.	①	②	③	④	⑤
13. I am well aware of the essential differences of similar phenomena.	①	②	③	④	⑤
14. I ask questions without overlooking what others take for granted.	①	②	③	④	⑤
15. I grasp the point well, even if it is a complex problem.	①	②	③	④	⑤
16. Once you have set your mind on something, you must stick with it to the end, no matter what the difficulties may be.	①	②	③	④	⑤
17. I can adapt to new circumstances or new beginnings interesting and easily.	①	②	③	④	⑤
18. I understand the information and conditions given and can apply them appropriately to problems or situations through logical and systematic analysis.	①	②	③	④	⑤
19. I can think and realize how I can integrate and converge the knowledge of my major into other areas.	①	②	③	④	⑤
20. I can analyze complex problems that require advanced thinking skills and organize and solve them systematically.	①	②	③	④	⑤
21. I can understand and evaluate knowledge and phenomena in various fields by forming links.	①	②	③	④	⑤
22. I am good at thinking of reconstructing newly learned knowledge by integrating it with already acquired knowledge or information.	①	②	③	④	⑤
23. Even materials that are already useless can be made useful by renewing the method.	①	②	③	④	⑤
24. By understanding and accepting other cultures, one can think about ways to change traditional or existing cultures.	①	②	③	④	⑤
25. I like looking for successful cases with good interdisciplinary connections.	①	②	③	④	⑤
26. In order to adapt to the situation or solve a problem in new circumstances, innovative ideas/values can be created by breaking away from existing fixed ideas/values.	①	②	③	④	⑤

27. I enjoy creating new knowledge and effectively applying it by converging knowledge from various fields to solve real problems. ① ② ③ ④ ⑤

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