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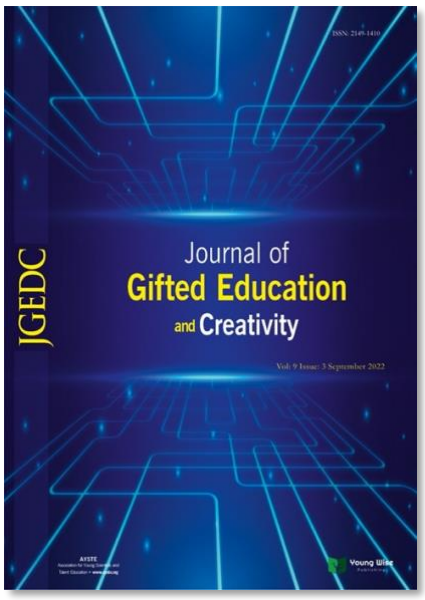

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Research Article

Teachers in identification of gifted students: adaptation of an observation form[1]

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Abstract

The first stage in identification of gifted students is the nomination step. Any mistake that teachers might make in nomination process might result in failure to identify gifted students or deprivation of relevant support that their skills require. Due to the quite detailed and long-term nature of teacher observations of children in recent years, it has been emphasized that teacher observation and resulting nomination process are very important in developing teacher observation scales and identifying gifted students. The goal of this study is to assist teachers in identification and nomination of 5-9 year-old gifted students. Another goal of the study is to test validity and reliability of Teacher's Observation of Potential in Students Form, which is considered to be effective in selecting gifted students. The study was planned and patterned according to relational and methodological research type. Study data were collected from 179 teachers and 1252 5-9 year-old students in government preschools and primary schools affiliated with Directorate of National Education in Kırklareli City Centre, Lüleburgaz and Babaeski districts. Analysis results indicate that Observation Forms are valid, reliable and compatible with Social Skills Assessment Scale, Marmara Primary School Readiness Scale and Denver II Developmental Screening Test. It has been concluded that all the students nominated by means of Teacher's Observation of Potential in Students Form passed the entrance test to Science, Art and Education Centre. Study results indicate that Teacher's Observation of Potential in Students Form might be effectively used by teachers to nominate gifted students. As Teacher's Observation of Potential in Students Form is capable of meeting the psychometric conditions, it might also be added that the form is valid and reliable.

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Introduction

Many scientists argue that human intelligence is an innate mental skill used to perceive and remember knowledge. However; several scientists thinking the other way have claimed that human intelligence is a mental skill that adapts to the environment (Gardner and Seana, 2006; Kaplan and Saccuzzo, 2005). Giftedness has historically been observed in various forms ranging from IQ tests to identification of multiple skill types. Ideas of giftedness and intelligence tests that occurred with Renaissance Age developed from early 20th century until today. Current definitions of giftedness place more importance to the combination of cognitive skills and non-intellectual personality traits (Coleman, Micko & Cross,

[1] This research has been made up of the doctora thesis (2020) titled as "Teachers in Identification of Gifted Students"

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2015; Linn, 2015). Reis and Renzulli (2000) define gifted and talented children as a wide-range group that have sufficiently developed skills in one or more fields and require changes in school setting for their education.

Today, it iş widely accepted that children must perform cognitive skills in the first 10 % (or better) of their chronological peer groups in order to be recognized as gifted (Aiken, 2012). Intelligence tests used for diagnosis of gifted students might cause disadvantage for students coming from families of lower socio-economic status. Students' intelligence test performance are related to richness of their life experience and learning opportunities. Therefore, children who have an inadequate environment for life long learning are likely to display poorer performance in intelligence tests. In diagnosis process of gifted students, their socio-economic and cultural differences might be taken into account and performance of children from lower socio-economic status might be assessed in multiple ways (Sak, 2014). Güçyeter (2016), who have studied identification processes in Turkey suggests that that there is not an identification process intended for disadvantaged groups such as children from lower socio-economic status, gifted girls etc., adding that identification tools must be developed to identify disadvantaged groups.

Turkish Grand National Assembly (TGNA), established a parliamentary investigation committee on 5 April, 2012 in order to identify gifted children, reveal problems related to their education and create employment opportunities in fields that will contribute to the development of our nation. The report issued by this committee emphasized that gifted students must be identified and supported at early ages as required by the principle of early education. The report also emphasized the need to use "various measurement tools, observation forms, intelligence tests, skill tests, creativity, motivation, leadership etc. which are designed according to national norms for different skill fields"(TGNA, 2012, p. 332). Additionally, 2013-2017 Strategy and Implementation Plan issued by the Ministry of National Education gave place to the concept of special talent, revealing that identifying individuals with special (superior) skills with various identification methods and providing appropriate education for their talents must be involved in sustainable government policies (Güçyeter, 2016). Before teachers fill in nomination forms, it is very important to inform them on which criteria they must assess their students (Akar and Uluman, 2013).

Researchers suggest using a more flexible and multi-dimensional approach to identify gifted students (Al-Hroub, 2010; Fetzer, 2000; Renzulli, 1990). In this approach, individually administered intelligence tests, academic achievement, creativity tests and dynamic assessments are used. Therefore, identification programs for gifted students have begun to follow a multi-dimensional approach that does not only depend on IQ scores but also other tools including systematic observations, check lists, rating scales, motivation and creativity, intellectual features (Al Hroub, 2013; Pfeiffer and Larosewich, 2008). Schroth, and Helfer (2008) carried out a study on school staff's belief in identification of gifted students and concluded that teachers' nomination methods were the second most effective identification method after performance evaluation and before standard tests (Al-Hroub, 2010 -2013- 2014).

Nomination is the first step in identification of gifted students. Any mistake that teachers might make in nomination process might result in failure to identify gifted students or deprivation of relevant support according to their skills (Akar and Akar, 2011). The first phase of identification process carried out in Science, Art and Education Centres is the teachers nominating their own students. Here, the most significant aspect is which criteria teachers resort to in the first step of identification because a criterion overlooked or neglected might cause a gifted student be eliminated before participating in identification process (Özberk and Özberk, 2016). Due to the quite detailed and long-term nature of teacher observations of children in recent years, it has been emphasized that teacher observation and resulting nomination process are very important in developing teacher observation scales and identifying gifted students. Results of studies carried out with gifted students and their teachers indicate that well structured forms filled by teachers might contribute to the process considerably (Karadağ, 2016). Teachers must be informed and become conscious about which criteria to follow in identifying students (Erişen, Birben, Yalın and Ocak, 2015). While suggesting and assessing gifted students, teachers must fill developmental and screening forms based on careful and systematic observations rather than resorting to their general views. Thus, it becomes easier to identify multi-dimensional hidden strengths which cannot be measured with ordinary intelligence tests and all student are involved in evaluation process (Yılmaz, 2015).

Aim of Study

The goal of this study is to introduce a valid and reliable observation form which will guide teachers in identification of gifted students.

Method

Research Model

The method of the study, carried out for identification of 5-9 year-old gifted students by their teachers in classroom setting, is relational screening. This study was also planned and patterned according to methodological research type.

Participants

The study was carried out with preschool teachers and class teachers employed in government preschools, kindergartens and primary schools in 2018-2019 academic period in Kırklareli province centre and Lüleburgaz and Babaeski districts. Research group includes 179 teachers and 1252 students selected among 5-9 year-old students with disproportionate cluster sampling method.

Data Collection Tools

General Data Form: General data form involves questions posed to teachers about their gender, professional experience, educational status, branch, level of their class, type of school, the number of students in their class, presence of inclusive education student and education of gifted students.

Social Skills Assessment Scale (SSAS) : Social Skills Assessment Scale (Akçamete and Avcıoğlu, 2004) was used in order to test criteria validity of TOPS and ICOF measurement tools which were used in this study. It was developed by Akçamete and Avcıoğlu (2004). The scale is a measurement tool that has 69 items assessing social skills that 7-12 year-old children with 5-Likert type scoring method between "always does" (5) and "never does" (1) and has no reverse item. Findings on validity and reliability of the scale reveal that Social Skills Assessment Scale is a valid and reliable scale that might be used to measure social skill levels of 7-12 year-old children (Akçamete and Avcıoğlu, 2004).

Marmara Primary School Readiness Scale (MPSRS) : Marmara Primary School Readiness Scale (Unutkan Ö.P. 2003) was used in order to test criteria validity of TOPS and ICOF measurement tools which were used in this study. MPSRS was developed by Unutkan (2003) in order to assess school readiness level of 5-6 year-old (60-78 months) of children who pass from preschool education to primary school. The developmental form was designed to collect data on each developmental field based on observations of teachers and parents on the child. Practice form of the scale provides data on basic academic skills by working individually with the child.

Denver Developmental Screening Test (DDST): Denver Developmental Screening Test was used in order to identify how far developmental ages of students selected with TOPS and ICOF were ahead of their chronological ages; in other words to prove the efficiency of TOPS form in selecting gifted students. DDST has four sections with 116 items which are designed to screen the following developmental fields: a) Personal-Social Field: communicating with people, meeting their personal needs, problem-solving skills, b) Linguistic Development Field: hearing, comprehension and linguistic skills, c) Fine Motor Skills: Hand-eye coordination, using small objects and d) Gross Motor Skills: Sitting, jumping and coordinated action of gross muscles in general terms.

Teacher's Observations of Potential in Students (TOPS) Form: TOPS measurement tool is a scale that helps teachers to identify potential in small children aged between 5 and 9. There are two different types of TOPS form: one is designed to observe the whole class, the other to observe a single student. Each TOPS form has instructions on its cover. The file provides examples of behaviours that gifted students might display and space is left beside to take notes of anecdotes. Back of each form is used to keep record and teachers seek for patterns that the child displays during observations (Coleman and Coltrane, 2010).

TOPS Whole Class Observation Form (WCOF) : TOPS WCOF is a form printed on blue cardboard and designed to observe all the students in the class. The front of the observation form includes items that describe the goal,

instructions and following steps. The back of WCOF provides 103 items that exemplify behaviours that are likely to be displayed by 5-9 year-old candidate gifted students in 9 fields (Coleman and Coltrane, 2010).

TOPS Individual Classroom Observation Form (ICOF): It is a form printed on yellow cardboard and designed to observe each selected student individually. Front cover of ICOF includes items that explain the goal, instructions and the following steps. The back of the observation form provides 103 items that exemplify behaviours that are likely to be displayed by 5-9 year-old candidate gifted students in 9 fields (Coleman and Coltrane, 2010).

TOPS Teacher's Assessment Form: It us a form used to assess whether 103 sample behaviours in 9 groups work in practice stage according to the results of teacher practice and observations (Coleman and Coltrane, 2010).

TOPS Child Profiles: It is the part of TOPS that includes Demographic Data of the students observed (identified) with WCOF and data related to their achievement in reading, writing, maths-science, socio-emotional development (Student Achievement Survey). In cases where TOPS measurement tool cannot be used in Child Profiles tool, there is also TOPS Form Disabilities Form for the options that students consider to be a barrier to identification of their potential (Coleman, 2016).

TOPS Form Teacher Closing Survey: It is a 10-iten survey that reflects the views of teachers on using TOPS Form at the end of the study (Sample Items: Using the TOPS Form had a revolutionary effect on my point of view to the students. TOPS Form helped me to notice students whom I would miss otherwise. etc). (Coleman, 2016).

Data Collection

For the goal of this study, relevant permission was received via e-mail to use TOPS (Teacher's Observations of Potential in Students), which was developed in the United States by Cooleman (2016) in order to identify and support gifted students. Permission to use SSAS (7-12 age) (Akçamete and Avcıoğlu, 2004) for the study was received by the author from Avcıoğlu. The author attended a seminary and received the certificate to use MPSRS (60-78 months which was developed by Polat (2003). DDST was also used with permission for the study. After completing the translation of TOPS Observation Form, permission was received from Trakya University Social and Human Sciences Research Ethics Board. After receiving the permission of ethics board, the author received permission from Kırklareli Governorship Directorate of National Education to carry out the study in the schools in 2018-2019 fall semester. Study data were collected in two stages. In the first stage, teachers were introduced and taught how to use WCOF. Then, this form was given to voluntary teachers, who were asked to observe and record all their students for four weeks according to the instructions. After four weeks, WCOF was taken from teachers who stated that they had no student meeting the form criteria and these teachers filled "General Data Form", "Teacher Item Assessment Form", "Teacher Closing Survey" and "TOPS Child Profiles Obstacles Section". In the second stage, teachers who stated that they wanted to do individual observation were given ICOF and asked to observe for four weeks each student whom they identified as gifted in Whole Class Observation form. Students who were identified with this form after four weeks were asked to fill in various forms; SSAS (7-12 years) was administered to primary school students who attended the first, second, third and fourth grades, MPSRS (60-78 months) and DDST to preschool and kindergarten students. On the other hand, teachers were asked to fill in "General Data Form", "Teacher Item Assessment Form", "Teacher Closing Survey" and "TOPS Child Profile" form. At the end of the study, list of students who passed SAECED test were received from schools and compared in order to identify the efficiency of ICOF.

Data Analysis

SPSS-22 and Mplus pack programs were used for the analysis in the study. Item analysis was carried out with SPSS and confirmatory factor analysis was carried out with Mplus in order to confirm the validity and reliability of TOPS measurement tool. Skew and kurtosis values were studied in order to check the suitability of study data to normal distribution. T test was used for two-group comparison of normally distributed quantitative data. Pearson Correlation Coefficient was used in order to identify the correlation between WCOF sub-dimensions and ICOF sub-dimensions and the correlation between SSAS sub-dimensions and MPSRS sub-dimensions. Significance level of all statistical analysis were identified according to $p<0.05$ (Statstutor, 2020).

Findings

Findings on Scope Validity:

Strict CVI value was calculated 0,97 and Relax CVI value 1.00 for all items of TOPS Whole Class Observation Form while Strict value was calculated 0.97 and Relax CVI 1.00 for all items of TOPS Individual Class Observation form. These values Show that the forms meet scope validity.

Findings on Structure Validity:

Structure validity was tested with CFA (Confirmatory Factor Analysis). CFA model was built for the structure given in TOPS Whole Class Observation Form (Figure 1). When fit index are taken as criteria, the model yielded significant results with current data ($\chi 2(23)=$ 191, 399, CFI=0.96, RMSEA=0.07 (90% CI 0.067 - 0.087), WRMR (Weighted Root Mean Square Residual) = 1.66).

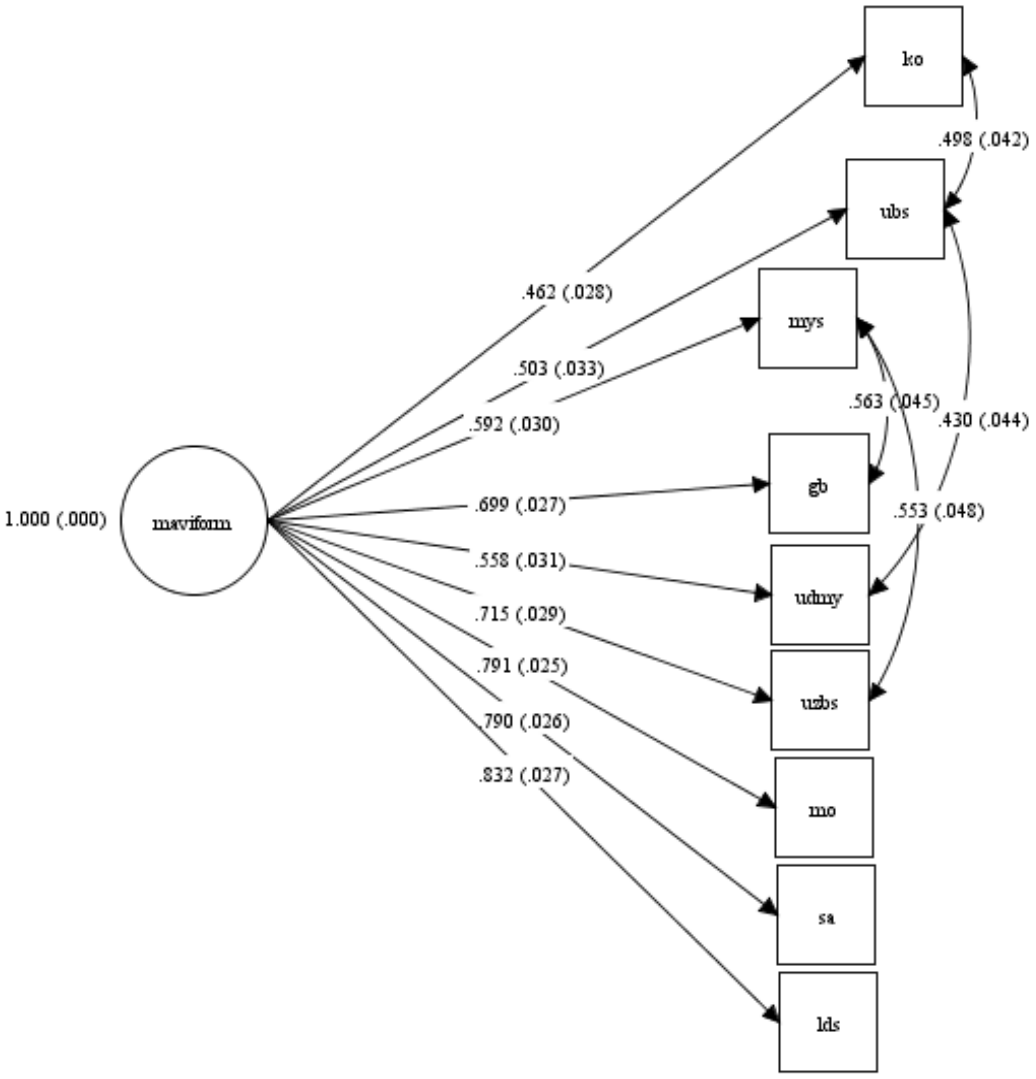

Figure 1. CFA model for TOPS Whole Class Observation Form

The model also yielded significant results with current data for TOPS Individual Class Observation Form ($\chi 2(22)=$ 144,216, CFI=0.97, RMSEA=0.09 (90% CI 0.077 - 0.106), WRMR (Weighted Root Mean Square Residual) = 1.32) (Figure 2).

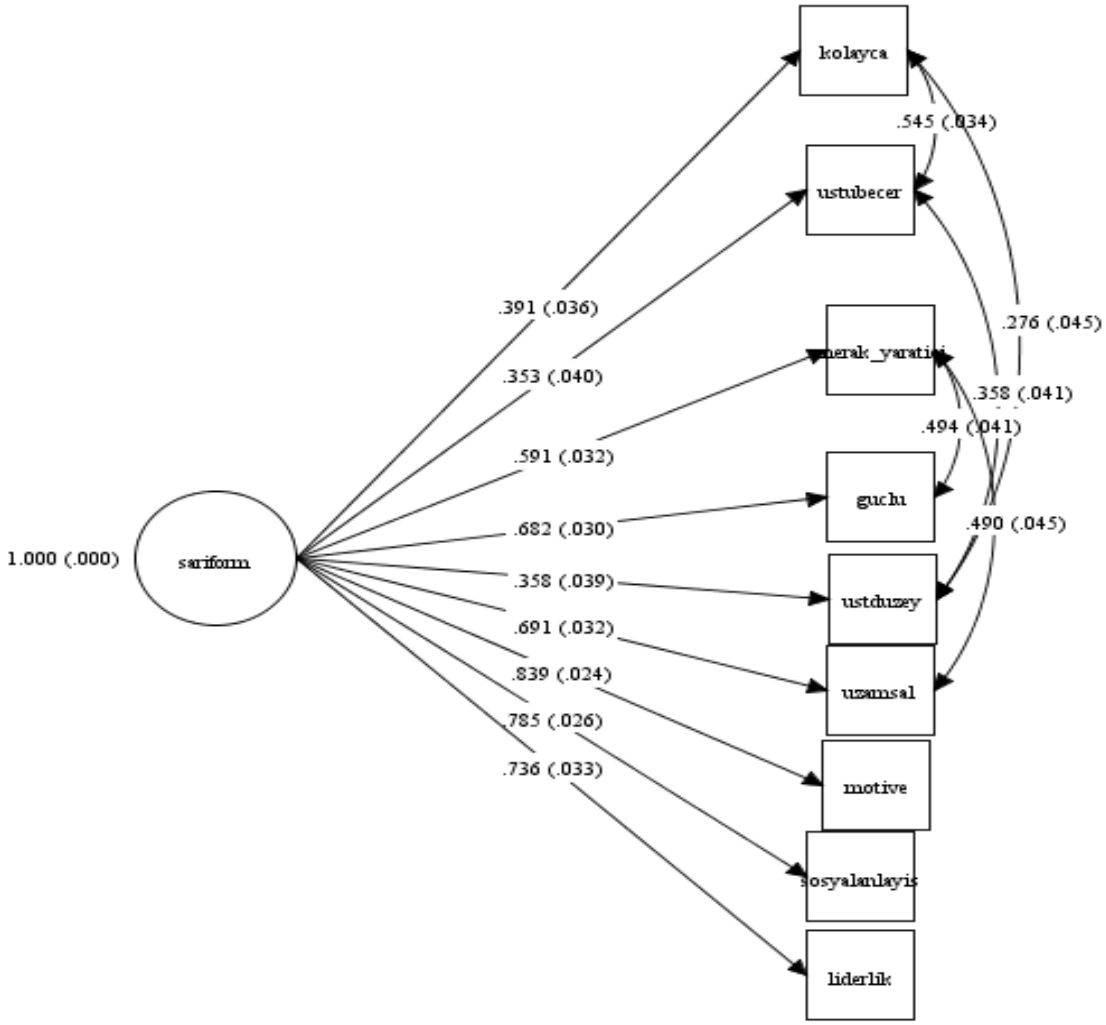

Figure 2. CFA model for TOPS Individual Class Observation Form

It is understood that sub-dimensions of TOPS Whole Class and Individual Class Observation Form are significantly correlated with each other and both forms overlap each other and meet structure validity.

It is understood that the correlation between sub-dimensions of TOPS Whole Class Observation Form ranges between.108 and .484. These results indicate that there is a moderate correlation between sub-dimensions of TOPS Whole Class Observation Form in this study. The correlation between sub-dimensions of TOPS Individual Class Observation Form ranges between .133 and .524. These results indicate that there is a moderate correlation between sub-dimensions of TOPS Individual Class Observation Form in this study. Consequently, it is understood that sub-dimensions of TOPS Whole Class and Individual Class Observation Form are significantly correlated with each other and both forms overlap each other and meet structure validity (Table 1).

Table 1. Pearson Correlation Coefficient Results Regarding the Scores of the Students Determined by the ICOF Sub-Fields of the Students Determined by the Teachers with WCOF

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 Learn Easily (**Individual**)	r	-																	
	p	-																	
	n	-																	
2Superior Exhibitions (**Individual**)	r	,476**																	
	p	,000																	
	n	666																	
3 Exhibitions Of Curious and Creativity	r	,152**	,137**																
(**Individual**)	p	,000	,000																
	n	666	666																
4 Have Strong Interests (**Individual**)	r	,203**	,194**	,569**															
	p	,000	,000	,000															
	n	666	666	666															
5 Exhibitions of High-Level Logic and	r	,282**	,328**	,075	,074														
Problem Solving Behavior (**Individual**)	p	,000	,000	,053	,056														
	n	666	666	666	666														
6 Spatial Skills Exhibitions (**Individual**)	r	,133**	,132**	,553**	,501**	,163**													
	p	,001	,001	,000	,000	,000													
	n	666	666	666	666	666													
7 It Is Motived (**Individual**)	r	,310**	,240**	,449**	,417**	,253**	,430**												
	p	,000	,000	,000	,000	,000	,000												
	n	666	666	666	666	666	666												
8 Social Understanding Exhibitions	r	,231**	,206**	,340**	,372**	,281**	,353**	,520**											
(**Individual**)	p	,000	,000	,000	,000	,000	,000	,000											
	n	666	666	666	666	666	666	666											
9 Leadership Behavior Exhibitions	r	,213**	,227**	,287**	,317**	,255**	,327**	,444**	,524**										
(**Individual**)	p	,000	,000	,000	,000	,000	,000	,000	,000										
	n	665	665	665	665	665	665	665	665										
10 Learn Easily (**Whole**)	r	**,773****	,377**	,128**	,158**	,139**	,103**	,256**	,209**	,208**									
	p	,000	,000	,001	,000	,000	,008	,000	,000	,000									
	n	666	666	666	666	666	666	666	666	665									
11 Superior Exhibitions (**Whole**)	r	,389**	**,702****	,093*	,138**	,233**	,074	,161**	,197**	,184**	,411**								
	p	,000	,000	,017	,000	,000	,056	,000	,000	,000	,000								
	n	666	666	666	666	666	666	666	666	665	1252								
12 Exhibitions Of Curious and Creativity	r	,058	,059	**,749****	,442**	,015	,452**	,323**	,252**	,237**	,125**	,198**							
(**Whole**)	p	,136	,125	,000	,000	,703	,000	,000	,000	,000	,000	,000							
	n	666	666	666	666	666	666	666	666	665	1252	1252							
13 Have Strong Interests (**Whole**)	r	,093*	,073	,443**	**,763****	-,009	,392**	,302**	,290**	,251**	,121**	,235**	,523**						
	p	,017	,061	,000	,000	,824	,000	,000	,000	,000	,000	,000	,000						
	n	666	666	666	666	666	666	666	666	665	1252	1252	1252						
14 Exhibitions of High-Level Logic and	r	,236**	,275**	,054	,068	**,745****	,097*	,231**	,283**	,241**	,246**	,400**	,174**	,182**					
Problem Solving Behavior (**Whole**)	p	,000	,000	,166	,080	,000	,012	,000	,000	,000	,000	,000	,000	,000					
	n	666	666	666	666	666	666	666	666	665	1252	1252	1252	1252					
15 Spatial Skills Exhibitions (**Whole**)	r	,100**	,092*	,473**	,437**	,086*	**,769****	,387**	,353**	,353**	,108**	,212**	,512**	,469**	,227**				
	p	,009	,018	,000	,000	,026	,000	,000	,000	,000	,000	,000	,000	,000	,000				
	n	666	666	666	666	666	666	666	666	665	1252	1252	1252	1252	1252				
16 It Is Motived (**Whole**)	r	,180**	,128**	,362**	,311**	,110**	,324**	**,755****	,387**	,366**	,308**	,207**	,360**	,344**	,272**	,366**			
	p	,000	,001	,000	,000	,005	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000			
	n	666	666	666	666	666	666	666	666	665	1252	1252	1252	1252	1252	1252			
17 Social Understanding Exhibitions	r	,088*	,121**	,227**	,265**	,162**	,214**	,357**	**,761****	,381**	,197**	,276**	,296**	,355**	,303**	,326**	,424**		
(**Whole**)	p	,023	,002	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000		
	n	666	666	666	666	666	666	666	666	665	1252	1252	1252	1252	1252	1252	1252		
18 Leadership Behavior Exhibitions	r	,151**	,182**	,244**	,241**	,213**	,282**	,393**	,449**	**,750****	,275**	,295**	,309**	,315**	,347**	,353**	,434**	,484**	-
(**Whole**)	p	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	-
	n	666	666	666	666	666	666	666	666	665	1252	1252	1252	1252	1252	1252	1252	1252	-

*p<.05; **p<.01

It was found that both sub-fields of TOPS measurement tools were significant and consistent with each other. This shows that both forms of the scale complete and overlap each other (Table 2).

Table 2. Standard Deviation, Mean and T-Test Results of Students' Skill Gap Scores Determined by Teachers According to WCOF Sub-Fields and ICOF Sub-Fields

	Whole* Individual**	**N**	***x***	**ss**	**t**	**sd**	**p**
Learn Easily	Whole	586	,55	,497	-4,084	1211,049	**,000*** **
	Individual	666	,66	,472			
Superior Exhibitions	Whole	586	,36	,481	-8,451	1235,492	**,000*** **
	Individual	666	,59	,491			
Exhibitions Of Curious and	Whole	586	,42	,495	-4,589	1231,192	**,000*** **
Creativity	Individual	666	,55	,497			
Have Strong Interests	Whole	586	,34	,475	-5,245	1242,489	**,000*** **
	Individual	666	,48	,500			
Exhibitions of High-Level Logic and	Whole	586	,35	,479	-7,299	1239,118	**,000*** **
Problem Solving Behavior	Individual	666	,56	,496			
Spatial Skills Exhibitions	Whole	586	,35	,479	-1,883	1237,013	,060
	Individual	666	,40	,491			
It Is Motived	Whole	586	,35	,479	-3,016	1239,360	**,003*** **
	Individual	666	,44	,496			
Social Understanding Exhibitions	Whole	586	,31	,466	-3,947	1244,071	**,000*** **
	Individual	666	,42	,494			
Leadership Behavior Exhibitions	Whole	586	,31	,463	-3,021	1243,060	**,003*** **
	Individual	666	,39	,488			

* TOPS Whole Class Observation Form; ** TOPS Individual Class Observation Form; ***p< 0.01

Findings on Criterion Validity:

Considering the correlation between sub-dimension of TOPS ICOF and MİHÖ scale, it is understood that both scales are consistent with each other and have an acceptable level of criterion validity (Table 3).

Table 3. Pearson Correlation Coefficient Results of Pearson Correlation Coefficients of Students' MPSRS Sub-Dimensional Scores Determined by Teachers with ICOF

		1	2	3	4	5	6	7	8	9	10	11	12	13
1 M Mental development and language development	r	-												
	p	-												
	n	-												
2 M Socio-emotional development	r	**,645****												
	p	,000												
	n	48												
3 M Physical development	r	**,415****	**,477****											
	p	,003	,001											
	n	48	48											
4 M Self care skills	r	**,401****	**,456****	**,891****										
	p	,005	,001	,000										
	n	48	48	48										
5 Learn Easily	r	,062	-,110	,131	,111									
	p	,675	,456	,375	,451									
	n	48	48	48	48									
6 Superior Exhibitions	r	,222	**,301***	**,379****	**,301***	,305*								
	p	,129	,038	,008	,037	,035								
	n	48	48	48	48	48								
7 Exhibitions Of Curious and Creativity	r	,222	**,347***	**,325***	,220	,220	,413**							
	p	,130	,016	,024	,132	,133	,004							
	n	48	48	48	48	48	48							
8 Have Strong Interests	r	**,301***	,273	,257	,236	-,066	,642**	,483**						
	p	,038	,060	,078	,107	,658	,000	,001						
	n	48	48	48	48	48	48	48						
9 Exhibitions of High-Level Logic and Problem Solving Behavior	r	,117	**,285***	**,315***	,191	,070	,588**	,456**	,527**					
	p	,429	,050	,029	,193	,635	,000	,001	,000					
	n	48	48	48	48	48	48	48	48					
10 Spatial Skills Exhibitions	r	,069	,201	**,354***	,232	,185	,671**	,549**	,600**	,597**				
	p	,640	,170	,014	,113	,208	,000	,000	,000	,000				
	n	48	48	48	48	48	48	48	48	48				
11 It Is Motived	r	,200	**,384****	**,398****	,284	,210	,645**	,539**	,391**	,521**	,379**			
	p	,172	,007	,005	,051	,152	,000	,000	,006	,000	,008			
	n	48	48	48	48	48	48	48	48	48	48			
12 Social Understanding Exhibitions	r	,186	**,338***	,277	,185	,117	,469**	,525**	,482**	,743**	,438**	,651**		
	p	,206	,019	,056	,209	,430	,001	,000	,001	,000	,002	,000		
	n	48	48	48	48	48	48	48	48	48	48	48		
13 Leadership Behavior Exhibitions	r	,096	,198	**,299***	,205	,304*	,487**	,573**	,400**	,719**	,576**	,539**	,768**	-
	p	,516	,177	,039	,163	,036	,000	,000	,005	,000	,000	,000	,000	-
	n	48	48	48	48	48	48	48	48	48	48	48	48	-

*p<.05; **p<.01

It was found that there is a consistency between several sub-dimensions of TOPS Individual Class Observation Form and Social Skills Assessment Scale which was used in order to identify the criterion validity of TOPS Individual Class Observation Form, which shows that criterion validity is at an acceptable level (Table 4).

Table 4. Pearson Correlation Coefficient Results of Pearson Correlation Coefficients of Students' SSAS Sub-Dimensional Scores Determined by Teachers with ICOF

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1 Basic Social Skills	r	-																			
	p	-																			
	n	-																			
2 Basic Speaking Skills	r	**,387****																			
	p	,000																			
	n	410																			
3 Advanced Speaking Skills	r	**,246****	**,413****																		
	p	,000	,000																		
	n	410	410																		
4 Interaction Starting Skills	r	**,246****	**,273****	**,509****																	
	p	,000	,000	,000																	
	n	410	410	410																	
5 Interaction Sustaining Skills	r	**,260****	**,434****	**,357****	**,468****																
	p	,000	,000	,000	,000																
	n	410	410	410	410																
6 Group Work Skills	r	**,497****	**,230****	**,224****	**,205****	**,252****															
	p	,000	,000	,000	,000	,000															
	n	410	410	410	410	410															
7 Emotional Skills	r	**,146****	**,175****	**,248****	**,468****	**,426****	,027														
	p	,003	,000	,000	,000	,000	,587														
	n	410	410	410	410	410	410														
8 Self-control Skills	r	**,170****	**,243****	**,396****	**,310****	**,270****	**,137****	**,303****													
	p	,001	,000	,000	,000	,000	,005	,000													
	n	410	410	410	410	410	410	410													
9 Accepting Results	r	,027	,061	**-,143****	-,071	-,015	,060	**-,142****	-,029												
	p	,582	,215	,004	,151	,764	,225	,004	,555												
	n	410	410	410	410	410	410	410	410												
10 Giving Instructions	r	**,340****	**,467****	**,197****	**,371****	**,349****	**,320****	,079	,096	**,182****											
	p	,000	,000	,000	,000	,000	,000	,112	,052	,000											
	n	410	410	410	410	410	410	410	410	410											
11 Cognitive Skills	r	-,029	,013	,035	**,197****	**,251****	-,080	**,380****	**,139****	**-,115***	,038										
	p	,560	,787	,482	,000	,000	,106	,000	,005	,020	,443										
	n	410	410	410	410	410	410	410	410	410	410										
12 Learn Easily	r	,006	-,008	-,041	,035	,054	-,043	,062	,027	**-,178****	-,036	**,116***									
	p	,909	,865	,405	,482	,272	,390	,207	,587	,000	,472	,019									
	n	410	410	410	410	410	410	410	410	410	410	410									
13 Superior Exhibitions	r	,006	-,005	,024	,006	-,036	-,034	-,021	,028	-,070	-,068	,049	,476**								
	p	,911	,913	,625	,905	,463	,495	,677	,574	,156	,167	,321	,000								
	n	410	410	410	410	410	410	410	410	410	410	410	666								
14 Exhibitions Of Curious and Creativity	r	,040	-,060	,059	,056	-,055	-,093	**,118***	,005	**-,207****	-,060	**,148****	,152**	,137**							
	p	,422	,227	,234	,256	,267	,060	,017	,916	,000	,224	,003	,000	,000							
	n	410	410	410	410	410	410	410	410	410	410	410	666	666							
15 Have Strong Interests	r	,069	**-,100***	,031	-,007	-,034	-,071	,050	-,017	**-,245****	-,052	,083	,203**	,194**	,569**						
	p	,161	,044	,529	,890	,489	,150	,309	,727	,000	,292	,092	,000	,000	,000						
	n	410	410	410	410	410	410	410	410	410	410	410	666	666	666						
16 Exhibitions of High-Level Logic and Problem Solving Behavior	r	-,003	,023	-,023	,089	,062	-,081	,083	-,002	**-,114***	-,056	**,154****	,282**	,328**	,075	,074					
	p	,947	,641	,648	,071	,209	,101	,092	,961	,021	,259	,002	,000	,000	,053	,056					
	n	410	410	410	410	410	410	410	410	410	410	410	666	666	666	666					
17 Spatial Skills Exhibitions	r	,018	**-,126***	-,008	,040	-,030	-,083	**,127***	,005	**-,231****	**-,170****	**,118***	,133**	,132**	,553**	,501**	,163**				
	p	,719	,011	,869	,420	,540	,092	,010	,923	,000	,001	,017	,001	,001	,000	,000	,000				
	n	410	410	410	410	410	410	410	410	410	410	410	666	666	666	666	666				
18 It Is Motived	r	,018	-,032	**,099***	,085	,000	-,072	**,128****	**,133****	**-,270****	-,082	**,168****	,310**	,240**	,449**	,417**	,253**	,430**			
	p	,720	,518	,044	,087	,995	,146	,009	,007	,000	,096	,001	,000	,000	,000	,000	,000	,000			
	n	410	410	410	410	410	410	410	410	410	410	410	666	666	666	666	666	666			
19 Social Understanding Exhibitions	r	,084	,050	,039	,056	,032	,007	**,113***	,054	**-,147****	,004	**,198****	,231**	,206**	,340**	,372**	,281**	,353**	,520**		
	p	,090	,308	,425	,256	,515	,889	,022	,278	,003	,941	,000	,000	,000	,000	,000	,000	,000	,000		
	n	410	410	410	410	410	410	410	410	410	410	410	666	666	666	666	666	666	666		
20 Leadership Behavior Exhibitions	r	,073	**-,042**	,078	,000	-,011	,001	**,180****	,058	**-,181****	-,069	**,164****	,213**	,227**	,287**	,317**	,255**	,327**	,444**	,524**	-
	p	,139	,398	,115	,993	,821	,992	,000	,239	,000	,164	,001	,000	,000	,000	,000	,000	,000	,000	,000	-

	n	409	409	409	409	409	409	409	409	409	409	409	665	665	665	665	665	665	665	665	-

*p<.05; **p<.01

Findings on Inner Consistency

Analysis in this study includes calculation of Cronbach alpha coefficient of TOPS measurement tool both for WCOF and ICOF. Inner consistency coefficient Cronbach Alpha was found (α=0.798). Inner consistency coefficient Cronbach alpha was found (α=0.792) for nine sub-dimensions of ICOF. Thus, analysis for both WCOF and ICOF indicate that the measurement tool is reliable (Ayre and Scally, 2014; Yeşilyurt and Çapraz, 2018).

When teachers who are involved in the study do not use TOPS form, they fill in TOPS Form Obstacles Survey about obstacles that prevent them from identifying students' potential. When general distribution of their responses to the survey are analysed, it is remarkable that most of the teachers (86.2 %) state that current measurement tools are insufficient in identifying gifted students (Table 5).

Table 5. The Distribution of the Responses to the TOPS Child Profiles Obstacles Section Regarding the Options that Students See as Barriers in Identifying Their Potential in Case Teachers Do Not Use the TOPS Form

TOPS Child Profiles Obstacles Section	Yes		No	
	n*	%	n*	%
Behavior *(child's socio-emotional behaviors, mobility - asking a lot of questions - talking - disturbing her friends, etc).*	300	44,1	381	55,9
Demographic elements *(poverty, race, marital status of parents, status, occupation, socio-economic status, etc.)*	77	11,3	604	88,7
Current measurement tools *(limitation or inadequacy of available detection and diagnosis tools for gifted students)*	**587**	**86,2**	**94**	**13,8**
Low expectation *(-if any- previous teachers had low expectations for the child)*	376	55,2	305	44,8
Lack of parental support *(lack of socio-economic and emotional support of the family)*	512	75,2	169	24,8
Success so far *(academic success/failure to date)*	451	66,2	230	33,8
Verbal language *(child's mother tongue being different, not being understood due to dialectal or linguistic differences)*	72	10,6	609	89,4

**Total number of teachers participating in the study (n= 681)*

Findings on the Efficiency of Teacher's Observation of Potential in Students (TOPS) Form that Teachers Use to Identify Gifted Students:

It is remarkable that developmental age of five year-old students who are considered to be gifted by their teachers who use ICOF are two years ahead of their calendar age according to the DDST. This show that TOPS is a suitable measurement tool for identifying gifted students.

According to the findings on Table 6; TOPS Form works well in this field both because all primary school students selected by teachers with TOPS passes the "Science, Art and Education Centre Entrance Test" and preschool children selected with TOPS displayed a remarkable performance in DDST (Table 6).

Table 6. Frequency Information on the Success Status of the Students Selected as High Potential by the Teachers using ICOF in the 2018/2019 Academic Year in the SAECET Exam

Province/ county	School Code	Teacher Code	Number of students in the class *	Number of students selected with WCOF	Number of students selected with ICOF	Students Successful in the SAECED Exam		
						Number	Student Class	Student Code
Kirklareli City Centre	A1	M.A.	25	6	6	1	2	E.M.İ
	A1	M.K.	29	13	6	1	2	E.D.D
	A1	H.B.	35	7	7	1	3	M.E.P
	A1	Z.G.	32	18	5	1	3	B.S.S.
	A2	F.M.	27	5	1	1	3	B.E.G
	A2	M.C.	28	6	3	3	2	E.A.Z-Y.G.C.-E.A.P
	A2	İ.B.	27	16	10	2	1	C.D.-E.Ç
	A2	N.T.	29	10	10	1	1	E.D.G.
	A3	S.G.	22	10	4	1	3	M.P.S
	A3	B.Ç.C.	24	7	1	1	3	E.R.
	A3	S.A.	26	10	8	2	1	N.K.A-Z.S.P.
	A3	E.K.	24	12	1	1	2	S.T.A.
	A4	B.G.	21	13	2	1	3	B.Ö.
Babaeski District	A5	Y.İ.	24	5	3	2	2	B.Y.B.-Z.S.
	A5	H.O.	26	12	5	2	2	A.G.-A.E.
	A5	A.B.	25	12	7	3	3	A.O.-K.Ö.-Ü.D.Y
	A5	M.S.A.	23	9	4	1	3	E.T.S.
Lüleburgaz District	A6	G.Ö.	30	30	4	4	1	E.Ç.-A.A.A.-A.B.-Ç.T.C.
	A6	Y.A.	33	18	16	1	2	T.D.G.
	A6	F.O.	36	30	6	1	3	Ö.B.
	A6	Ö.F.	38	9	4	1	3	E.E.P.
	A6	F.D.	35	17	3	1	3	A.E.F.
	A7	Ş.K.	30	5	5	2	1	D.E.-M.E.İ.
	A7	A.D.	31	8	5	2	2	Ç.E.G.- R.T.M.
	A7	R.D.	26	14	14	1	3	K.Ö.
	A7	K.B.	23	18	11	1	3	D.B.T.
	A8	H.K.	23	16	15	1	2	Ş.K.
	A8	S.Ş.	22	14	14	1	3	M.A.K.
Total			**774***	**350**	**180**	**41**		

Conclusion

This study was carried out for identification of 5-9 year-old candidate gifted students by teachers. Another goal of the study is to check validity and reliability of TOPS form, which is considered to be effective in selecting gifted students. To ensure that TOPS measurement tool meets scope validity, it must meet linguistic validity to the target culture first of all. After finding scope validity rate (SVR), mean value of SVR was taken to identify scope validity index (SVI) (Yeşilyurt and Çapraz, 2018). After calculating SVR values, Strict CVI value was found 0,97 and Relax CVI value 1.00 for all items of TOPS Whole Class Observation Form while Strict value was found 0.97 and Relax CVI 1.00 for all items of TOPS Individual Class Observation form. In other words, these values show that it has scope validity. Structure validity of

TOPS measurement tool was tested with CFA (Confirmatory Factor Analysis) technique. When fit index are taken as criteria, the model yields significant results with current data ($\chi 2(23) = 91, 399$, CFI=0.96, RMSEA=0.07 (90% CI 0.067 - 0.087), WRMR (Weighted Root Mean Square Residual) = 1.66). The correlation between sub-dimensions of TOPS Whole Class Observation Form ranges between.108 and .484. Büyüköztürk (2010) defines correlation between .70 and .1 as strong correlation while correlation between .30 and .70 as moderate correlation. Taking these views into account, we might say that there is a moderate correlation between sub-dimensions of WCOF in this study. On the other hand, the correlation between sub-dimensions of TOPS Individual Class Observation Form ranges between ,133 and ,524, which shows that there is a moderate correlation between sub-dimensions of ICOF in this study. Correlation between sub-dimensions of WCOF and ICOF was checked in order to identify inner-test consistency between WCOF and ICOF. An analysis of the correlation between sub-dimensions of the two measurement tools shows that their correlation ranges between 702 and .773. Büyüköztürk (2010) defines correlation between .70 and .1 as strong correlation while correlation between .30 and .70 as moderate correlation. Taking these views into account, we might say that there is a strong correlation between sub-dimensions of WCOF and ICOF.

It is accepted that the measurement tool has criterion validity if scores of students identified within the whole class is significantly higher than scores of individually identified children (Ercan, and Kan, 2004). In other words, it was found that sub-skill differences of both forms (WCOF and ICOF) of TOPS measurement tool were significant and sub-fields of both form were consistent with each other. It was concluded that sub-fields of both forms of Turkish version overlapped each other and had acceptable criterion validity.

When the correlation between sub-dimensions of TOPS Individual Class Observation Form and sub-dimensions of SSAS was analysed in order to identify the criterion validity of the form, it was found that the correlation level ranged between .000 and .231. According to Statstutor (2020), coefficients between ,00 and 19 obtained with significant findings in correlation analysis indicate a very poor correlation while values between ,20 and ,39 indicate a poor correlation, values between ,40 and ,59 moderate correlation, values between ,60 and ,79 strong correlation and values ,80 and 1,0 indicate a very strong correlation. According to these results, several sub-dimensions of ICOF and sub-dimensions of SSAS used for identifying the criterion validity of ICOF are consistent and criterion validity is at an acceptable level. Considering the correlation between sub-dimensions of TOPS Individual Class Observation Form and MPSRS sub-dimensions, it was found that their correlation ranged between .285 and .398. According to these results, there is a consistency between sub-dimensions of TOPS Individual Class Observation Form and sub-dimensions of MPSRS and criterion validity was acceptable. Ecological Validity might be defined as the extent to which test performance reflects and predicts real life behaviours (Salkind, 2010). ; the fact that all primary school students selected by teachers with TOPS passed the "Science, Art and Education Centre Entrance Test" and preschool children selected with TOPS displayed a remarkable performance in DDST shows that this measurement tool has ecological validity. Inner consistency coefficients were re-calculated in order to identify the reliability of all measurement tools used in this study. Reliability of TOPS measurement tool was tested with inner consistency coefficient. Inner consistency coefficient, used in studies to estimate reliability coefficient, includes reliability estimation by working the measurement tool once (Şencan, 2005). Thus, inner consistency coefficients (Cronbach's Alpha) of sub-dimensions of SSAS were found; Basic Social Skills (α=0,980); Basic Speaking Skills (α=0,948); Advanced Speaking Skills (α=0,931); Interaction Starting Skills (α=0,913); Interaction Sustaining Skills (α=0,896); Group Work Skills (α=0,999); Emotional Skills (α =0,783); Self-control Skills (α=0,937); Coping with Aggressive Behaviours (α=0,393); Accepting Results (α=0,826); Giving Instructions (α =0,873) and Cognitive Skills (α=0,826), respectively. On the other hand, inner consistency coefficients of MPSRS sub-dimensions were found; Mental Development and Linguistic Development (α=0,956); Socio-emotional Development (α=0,903); Physical Development (α=0,849); Self-care Skills (α=0,966), respectively. Consequently, the study results indicate that inner consistency coefficients of both measurement tools, which were used to test criterion validity, were suitable for the purpose of t this research. Inner consistency coefficient Cronbach's alpha was found (α=0.798) for nine sub-dimensions of TOPS Whole Class Observation Form. Inner consistency coefficient Cronbach's alpha was found (α=0.792) for nine sub-dimensions of TOPS Individual Class Observation Form. According to the

analysis results in this study, it is possible to say that both WCOF and ICOF are reliable measurement tools (Ayre and Scally, 2014; Yeşilyurt and Çapraz, 2018).

Consequently, these observation forms which were adapted to Turkish are considered to encourage development of other tools such as scale, form in Turkey, where there is a lack of tools to identify gifted students. Valid and reliable forms used for identifying gifted students are expected to contribute to the fields. Moreover; as psychometric features of TOPS are quite adequate in meeting relevant criteria, we might say that the TOPS form can be used in researches and analyse gifted students in the context of many variables and contribute to the fields.

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Research Article

Environmental sensitivity of gifted children: a picture analysis based research [1]

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Abstract

Picture analyses are a highly valid method used to understand students' emotions. There are many research findings indicating that gifted and talented students are highly sensitive to environmental problems. However, there is a need for more multidimensional and deeper analyses. In this study, picture analyses on environmental problems were conducted in order to understand the students' relationships with the environment and their feelings about these relationships. This research, which was conducted with case study, one of the qualitative research methods, was applied in the city of Malatya, which is at the middle level according to the development index in Turkey. A total of 24 primary school fourth grade students, 12 boys and 12 girls, who are gifted and intelligent, were studied. These students were also receiving support education in the science and arts centres in their region. As a data collection tool, the drawings of gifted students on environmental problems were used. These drawings were analysed by four teachers who are experts in their fields. Semi-structured interview forms were used to support the analyses of these drawings about environmental problems. The interviews were subjected to content analysis. According to the findings of the research, it was determined that there were feelings of desire for a clean and green environment, love and protection for living creatures in the natural environment, deep sadness for a degraded environment, constant discomfort in the face of visual, auditory and sound pollution, anger and anger against the inadequacy of the measures taken against environmental pollution, and high anxiety about the deterioration of the natural environment.

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Introduction

Today, painting gains more importance as a powerful tool in recognizing the child and obtaining information about his personality structure.(Halmatov,2020). In painting, the technique of recognizing the individual with his pictures has a high operability and validity, since the cost of the equipment to be used is low or the way to obtain this equipment is easy. Pictures to be used in diagnosing personality and intelligence are accepted as a very effective method that gives clues about the individual's mental processes (Leontyev, 2000). Gudinaf asked for a human drawing with the "Draw a Human" test he developed in 1926, and he conducted rich clinical experiments to transform this test into a personality and intelligence diagnostic test with the necessary scales. Later, he published a book called “Psychological Test” with pictures

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and obtained data about the personality structures of the participants who were subjected to the test. These tests have been used in studies on personality and intelligence for many years. In 1948 (La Figura Humana) by Karen Mochover, a story was invented with a random picture drawing test, in which a human being was painted and another human being painted, and information about the psychic processes and the personality structure of the participant was obtained. In 1948, another researcher, John Buck, developed the first personality test through drawing with the "Draw House, Tree and Human" test in 1948, and its use is still very common today. The "Family Draw Test" was used for the first time in 1958, but the name of the scientist who developed it is unknown. The scientists, who were between Hunse Volfe and Reznikov as the creator of the test, tried to detect the emergence of domestic violence through children's pictures with this test.

It is seen that environmental education research and environmental awareness-raising research has increased in recent years and these studies are also inclusive of all students. Özdemir (2011) researched the effect of the natural education programme which is carried out based on the natural experience and concluded that there is an increase in environmental awareness of students at the end of the education programme. In the research which was conducted by Uzun (2007), it is stated that despite the presence of positive thoughts of secondary education students against the environment, their behavior towards the environment is still negative. It is stated that gifted students are more sensitive to global issues (Piechowski, 1997) and problems considering the environment (Clark, 1992; Cullingford, 1996). Özsoy (2012) observed that primary education students have expressed their environmental awareness via the pictures that they have drawn and emphasized the fact that the students' perception of the subject needed to be determined before determining their environmental awareness. Çal (2019) assesses, that the gifted students' visual awareness is more potent than their peers in his research on the gifted students' visual awareness of the environment. In the study examining the environmental perceptions of gifted students and their peers of Karakaya, Ünal, Çimen, and Yılmaz (2018), it has been determined that students perceive their environment holistically and their perceptions of environmental problems are multifaceted.

Children's awareness of their environment, perceiving the negativities experienced and expressing them with pictures other than words and writing is a more effective, simpler, and more sincere language than using the words they have learned before (Isabel and Shirley, 2003). This language reflects children's emotional, psychological and social nature and their affections, concerns, dreams, happiness, and many other moods (Schirrmacher, 2002, 74). The symbols used by children in these pictures provide important clues in understanding the process between their prior knowledge and their current knowledge. When these clues are interpreted correctly, the opportunity to get to know the child and his/her experiences better can be achieved (Yurtal & Artut, 2008). Furthermore, it is stated that while analyzing the thoughts that the students reflect on the pictures, it is necessary to have them explain the pictures they draw, considering the fact that the analysis of pictures with drawings alone may be insufficient (Ersoy and Türkkan, 2009; Ersoy and Türkkan, 2010).

Gifted Students & Environmental Sensitivity

Overexcitability domains, theorized by Dabrowsky (1972), enable us to understand the different behaviors and attitudes of gifted people compared to normal ones. Environment is one of the most important issues that concern humanity today and in the future. The sensitivity of gifted children to this issue has been examined in many studies. Saricam & Sahin, (2015)' study is a Structural Equation Modeling study was conducted for the variables that affect environmental awareness and attitude in highly gifted children. Highly gifted students' environmental awareness, environmental attitude, curiosity and exploration scores were higher than non-gifted. It has been found that gifted students have a very high level of environmental awareness (Tanık Önal, 2020). However, it can be said that all studies are quantitative and insufficient in terms of describing the environmental sensitivities of gifted children. This situation makes it necessary to conduct qualitative research in this field. A certain group of gifted students are forced to express their thoughts and feelings openly. It is seen that they use metaphors in relation to this. For example, the opinions and evaluations of gifted students about the Science and Art Centers they are enrolled in are taken with metaphors. Kunt & Tortop (2013)' study, the use of metaphor in understanding gifted students was suggested. Metaphors are a tool that provides an indirect

explanation about a concept. In this research, it was investigated to have information about the ideas, opinions and feelings of the students through the analysis of their pictures.

Importance of the Research

This research is significant in terms of understanding the environmental sensitivities of gifted students by bringing together the concepts that gifted students perceive about environmental problems through pictures and the events related to these concepts, seeing holistically, reflecting on what they see and think on the pictures creatively.

Purpose of the Research

In this research, it is aimed to determine the gifted students' environmental sensitivity with painting analysis. Following this purpose, the research questions below were sought.

- How is it that gifted students at the primary school level describe their sensitivity to environmental problems through painting?
- How do gifted primary school students describe their suggestions for environmental problems through pictures?
- What are the views of gifted students at the primary school level on environmental problems?

Method

Research Model

This research was conducted with a case study, one of the qualitative research methods and techniques. Creswell (1998) defines qualitative research as a process of making sense of social life and human problems by questioning them with unique methods. The research is a descriptive study. Descriptive studies aim to explain the interaction between situations, considering the relationship of current events with previous events and conditions (Kaptan,1998). The pictures considering environmental sensitivities drawn by the 4th-grade gifted students who participated in the research were interpreted by four art teachers who were trained in picture analysis. In qualitative studies, in cases where more than one researcher works together in data analysis, a desired level of reliability is achieved in cases where the rapport between the researchers' evaluations is 70% or more (Yıldırım & Şimşek, 1999). Specific to this research, it was observed that the consensus in the common opinions of the experts participating in the research was 95%.

Study Group

Opinions were collected from 4th-grade students, 12 girls and 12 boys, attending Science and Art Centers in Malatya in the 2020-2021 academic year. The class level, gender and age codes of the participants are presented

Table 1. Structures of Participants and Codes

Participant No	Grade	Gender	Age	Code
1	4	M	10	P1-M-10
2	4	M	10	P2-M-10
3	4	M	10	P3-M-10
4	4	M	10	P4-M-10
5	4	M	10	P5-M-10
6	4	M	9	P6-M-9
7	4	M	9	P7-M-9
8	4	M	9	P8-M-9
9	4	M	9	P9-M-9
10	4	M	9	P10-M-9
11	4	M	9	P11-M-9
12	4	M	9	P12-M-9
13	4	F	9	P13-F-10
14	4	F	9	P14-F-10
15	4	F	10	P15-F-10
16	4	F	10	P16-F-10

17	4	F	10	P17-F-10
18	4	F	10	P18-F-10
19	4	F	9	P19-F-9
20	4	F	9	P20-F-9
21	4	F	9	P21-F-9
22	4	F	9	P22-F-9
23	4	F	9	P23-F-9
24	4	F	9	P24-F-9

Procedure

The students participating in the study were asked to draw pictures about environmental problems and explain these pictures for 2 hours with each student in their classes during the class hours deemed appropriate by the class teachers. It was done by four art teachers and a classroom teacher in examining, interpreting, and categorizing the pictures of environmental problems taken from the students. In this study, which was conducted with a total of 24 students, the collected opinions and visuals were recorded.

Data Collection and Analysis

Children's Picture Analysis

As children tell the pictures they draw, they tell their own stories. These pictures bear the traces of important events in their personal inner worlds. Picture analyzes are accepted as a source of information in recognizing and making sense of the inner and outer world of children. Children use a unique visual language to reflect the events they experience and the way they perceive these events, according to their own thoughts and views. (Venger, 2011). The choice of painting subject, their attitude while painting, and the information they give about the painting contain important clues (Halmatov, 2016). Painting, which is one of the ways of expressing children's emotions, begins to be made with a unique look after the age of seven (Savaş, 2015). Painting can be thought of as a window that reflects children's feelings and thoughts (Malchiodi, 2013). The subject and figure choices in the paintings are used to determine the social, cultural, and psychological priorities of the child (Yavuzer, 1992). In this study, the pictures that will be used to determine the environmental sensitivity of the children were made by the students and their opinions were taken. These interviews were recorded and subjected to content analysis together with the pictures. The analyzed pictures were grouped into sub-themes and presented in tables.

Semi-structured Interview Form

In this study, the opinions of the participants were collected through a "semi-structured interview form". Semi-structured interviews provide both fixed-choice answering and to go in-depth in the relevant field (Büyüköztürk 2014). In the research, the pictures made by gifted primary school 4th-grade students to determine their environmental sensitivity were explained to the students under three headings, and data were obtained. These data The obtained data were firstly converted into codes, which is the smallest meaningful unit, and then by the induction method.

Results

Analysis of the pictures drawn by gifted 4th-grade students regarding environmental sensitivities

The concepts and figures used by gifted primary school students to describe their sensitivity to environmental problems through pictures are presented in Table 1.

Theme 1. Perception of Environmental Problems

Table 1. Figures and Concepts Used to Describe Environmental Problems

Theme 1. Perception of Environmental Problems		
Sub-theme 1. Sources of Environmental Problems	**f**	**%**
People	19	79,1
Factories	7	29,1
Cars	2	8,3
Cars	1	2,4
Disrupted environment	19	79,1
Clean Environment	18	75,0
Garbage and waste	14	58,3
Axe-Saw	9	37,5
Plastics	6	25,0
Roads	3	12,5
Sub-theme 2. Consequences of Environmental Problems	**f**	**%**
Polluted air and smoke	10	41,6
Desertification	5	20.8
Climate change	5	20,8
Sub-theme 3. Clean Environment Indicators	**f**	**%**
Sea, lake, river	7	29,1
Grass	10	41,6
Forest	10	41,6
House	9	37,5
Flower	8	33,3
Birds	3	12,5
Trees	19	79,1
Clouds	7	29,1
Sun	12	50,0
Sub-theme 4. Solutions for Environmental Problems	**f**	**%**
Recycling	7	29,1

Looking at Table 1, it can be said that gifted students can be grouped under four sub-themes under the theme of perceptions of environmental problems. These are Sources Of Environmental Problems, Consequences Of Environmental Problems, Clean Environment Indicators, And Solutions For Environmental Problems. 79% of gifted students used human, tree, and degraded environment figures and concepts. In the paintings of these students for environmental awareness, the relationship between humans, trees, and the degraded environment was established in the paintings of 19 students. It was stated that they consider cutting trees as a priority in environmental degradation and they stated that the felled trees disrupt the balance of nature. The statements of people that they destroy the green areas and damage the environment by cutting the trees were also reflected in the students' opinions. Looking at the concepts and figures they used in their paintings in general, 18 students painted a clean environment, 14 students drew garbage, 12 students painted the sun, 10 students painted the forest, 10 students painted grass, 10 students painted dirty air and smoke, 9 students painted axes and saws, 9 students painted houses. 8 students reflected flowers, 7 students recycling, 7 students factory, 7 students cloud, 7 students stream, lake, and sea. There were 5 students each who used concepts in pictures about climate change and desertification. 2 students and 1 student used cars to describe their environmental perceptions in their pictures.

The rate of gifted students describing the clean environment in their pictures is 75%. It was determined that this rate reflected the students' desire to see a clean environment in their descriptions. Garbage and other wastes are expressed as

58%. It has been seen that garbage and other wastes are among the most used figures and concepts to describe environmental pollution.

Forest, grass, and polluted air depictions were reflected in the pictures at a rate of 41%. Figures and concepts were used in pictures with an ax, saw, and house figures in 37%, recycling, factory, cloud, lake, and stream depictions, and 29.1%. A group of students expressed in their pictures that pollution is caused by plastics at the rate of 25%. In order to describe climate change, gifted students divided the planet into two and depicted desertification and green space in 28% of the pictures. Birds are depicted as beings damaged by environmental pollution. The students who showed the roads as places dug on the earth to pollute the environment in case of environmental pollution used these figures and concepts at a rate of 12.5%, the students who described the exhausts of the cars caused environmental pollution at 8.3%, the students who described the sound pollution used these figures and concepts at a rate of 2.4%. In the pictures of gifted students, the statements that the garbage is not thrown into the trash are expressed with speech bubbles. The reflection of the comparison of the clean environment and the dirty environment in the pictures may be due to the efforts of the children to reveal the image difference between the clean environment and the dirty environment. Students, who expressed more than one environmental problem by using more than one visual in sections on the same page, reflected the visual realities according to their age. Visual reality is defined as the tendency to reflect the events and phenomena in their pictures, which is common in children's drawings (San, 1979, 40). In this study, gifted students tried to reveal nature as a whole by trying to reflect on the events as a whole in order to express visual reality. In some paintings, the effects of global climate change and desertification are depicted in the parts divided into two. The fact that these gifted students express global climate changes and desertification is an indication that these students are aware of the global dimensions of environmental problems, and the fact that they reflect light and sound pollution in their paintings is an indication that they perceive their environmental sensitivity in different dimensions. Students stated that excessive consumption will bring production and this situation causes environmental problems, they are aware of the fact that erosion is an environmental problem, and the rapid increase in plastics destroys living things and pollutes nature.

Theme 2. Solution Suggestions for the Environmental Problems Perceived by Gifted Children

The sub-headings of how gifted students describe their suggestions for environmental problems, which they reflect in their drawings, are presented below.

Table 2. Suggestions for Solutions for Environmental Problems of Gifted Students

Sub-themes	**f**	**%**
Protection and growth of trees	10	41,6
Separating waste to keep the soil clean	10	41,6
Installing filters on chimneys for air cleaning, reducing solid fuels	10	41,6
Less production and shopping to protect the environment	10	41,6
Taking measures for global climate change and drought	6	25,0
Providing training to increase the number of people who protect the environment	6	25,0
Cleaning polluted water to prevent water contamination	5	20,8
Protection of living species by keeping the ecosystem clean	4	16,6
Punishment of people who pollute the environment	4	16,6
Taking measures for sound, visual and environmental pollution	3	12,5
Less use of chemical drugs	2	8,3

When we look at Table 2, 10 students divided the picture papers into sections by 41% to ensure the trees to be protected and grown, to evaluate the wastes to keep the soil clean, to install filters on the factory chimneys to clean the air and to reduce solid fuels, to make less production and shopping for the protection of the environment. Suggestions for training to increase the number of people who protect the global climate change, drought and environment are reflected in the pictures of 6 students at a rate of 25%. 20.8% of 5 students described the establishment of a dirty water cleaning system in order to prevent water pollution. Ensuring the protection of living things by keeping the ecosystem clean and punishing people who pollute the environment were depicted by 16.6% of 4 students in their paintings, while

sound, visual and environmental pollution were included in the works of 12.5% of 3 students, and less use of chemical drugs by 8.3% by 2 students. has received.

In this research, it is seen that the 4th-grade gifted students describe the environmental event that they are most affected by, the cutting of trees, the pollution of the soil, and the pollution of the air. It is understood from the interviews that the reason why the water pollution is mentioned by fewer students is that the water coming to the house is clean and they see the pollution of the water flowing in a nearby area less. In this case, it can be concluded that the students produce more ideas about environmental pollution that they can observe in their close environment and reflect on the pictures. Suggestions that stand out in the views on reducing environmental problems; sorting and recycling waste, reducing production and consumption, segregating for water cleaning, installing filters in chimneys for air cleaning and reducing solid fuels, penalizing people who cause environmental pollution, reducing sound, light, and visual pollution, fewer chemicals for products grown in the environment drug use was determined in the interviews. These suggestions are generally memorized information about cutting trees, collecting garbage, and cleaning the air in 4th-grade primary school students (Pınar & Yakışan, 2016), but in this study, it is seen that gifted students' solution suggestions emerge in more detail in line with their advanced awareness. Theme 3. Opinions of gifted primary school students on environmental problems.

Theme 3. Opinions of Gifted Primary School Students on Environmental Problems

The views of gifted primary school students on environmental problems are presented in table 3 with subheadings.

Table 3. Opinions of Gifted Primary School Students on Environmental Problems

Sub-themes	**f**	**%**
I want to live in a clean and green environment	15	62,5
The lack of protection of the trees makes me upset	12	50,0
I do not want to live in a polluted environment	11	45,8
I am worried that the planet will deteriorate more and more	10	41,6
I think too much production and shopping pollutes the environment.	9	37,5
I want those who create air pollution to be punished	8	33,3
Global climate change and desertification worry me	6	25,0
I want environmentally conscious people to be more	5	20,8
Light, sound, and visual pollution is too much and tiring in cities	3	12,5

According to the opinions of the students forming the sub-headings presented in Table 3, the desire of gifted primary school students attending the 4th grade to see a clean and green environment was expressed by 15 students with 62.5%.

"I want to live in a clean and green environment, but I don't know how to achieve it. Some people pollute the environment so much, that I can't protect it alone". (P15-F-10)

"When I go to our village, it relaxes me because it is green, it is a very calm and peaceful place." (P9-M-9)

The unhappiness about not protecting the trees was expressed by 12 students at the rate of 50%.

"Why do they cut down trees? They are both beautiful and very useful".(P5-M-10)

"I am very sad when a tree is cut down because I know that it is a creature that cleans our air and decorates our environment". (P11-M-9)

"We must protect forests, otherwise, air pollution will increase, we cannot breathe, we will get sick".(P21-F-9)

Eleven students stated that they do not want to live in a polluted environment with a rate of 45.8%.

"I don't want to live in a polluted environment". (P20-F-9)

"Environmental pollution harms the health of all living things. It spoils mine". (P14-F-10)

Ten students who expressed their concerns about the increasing pollution of the planet constitute 41.6% of the students participating in the research

"Our planet is getting more and more polluted. Concrete and garbage everywhere. Greenery is decreasing. Forests are being destroyed". (P13-F-10)

"I am worried that there will be more environmental pollution in the future. Because environmental pollution increases more with the increase of people".(P4-M-10)

Nine students stated in their opinions that too much production and shopping cause environmental pollution at a rate of 37.5%.

"They pollute the environment while making many products. Especially plastics This issue worries me". (P6-F-10)

"Too much shopping causes pollution because the more we buy, the more garbage we throw out. For example, I had a lot of toys, when they broke, I threw them away. Every child does this and the garbage is increasing more and more. I am sorry for that"(P14-F-10)

Eight students who are disturbed by air pollution constitute 33.3% of the total students.

"Those who pollute the air are destroying our clean air, I think they should be punished. I am angry with them".(P24-F-9)

"Gas from factories and cars pollutes the air, I am disturbed by this".(P2-M-10).

Feeling anxiety about global climate change is 25% of the opinions of 6 students.

"Our planet is getting warmer, the rains are decreasing and our environment is becoming a desert, we use a lot of electrical things in our house, so I think it would be better if we use electrical items less (P3-M-10)

"My father told me that climates change and I researched it. There are many floods and storms, the land flows into the seas and the ice melts, living things die. This issue worries me a lot". (P8-M-9)

A total of 5 students, with 20.8%, expressed their opinions, who wanted to increase the number of environmentally sensitive people. The comparison of sensitive people and insensitive people was also depicted in the students' drawings.

"Sensitive people protect their environment, but insensitive people do not. I get very angry with them. We need sensitive people very much". (P4-F-10)

"People need to see what they're doing. Most of them don't even realize they're polluting because the scavengers are sweeping before we wake up but throwing them in big dumps. Big dumps pollute". P5-F-10)

The feeling of constant discomfort in the face of light, visual and sound pollution constitutes 12.5% of the total of 3 students.

"There are posters and light boards in every corner around us. Our eyes are getting tired". (P12-M-9)

"Night lights on the beaches are killing turtles".(P13-F-10)

"The noises coming from the cars are excessively disturbing, I'm getting excessively tired". (P7-M-9)

Pictures of Gifted Students on Environmental Problems

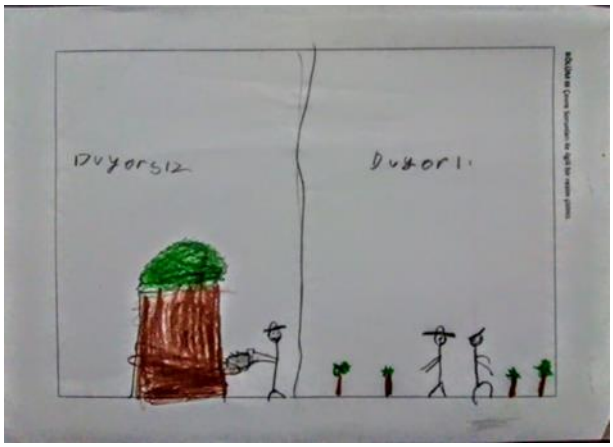
Examples of the pictures made by gifted 4th-grade students for the environment within the scope of this research are presented below.

Picture 1. Deterioration of The Ecosystem on a Global Extent (*P11-M-9)*

Picture 2. *Polluted Environment* (P7-M-9)

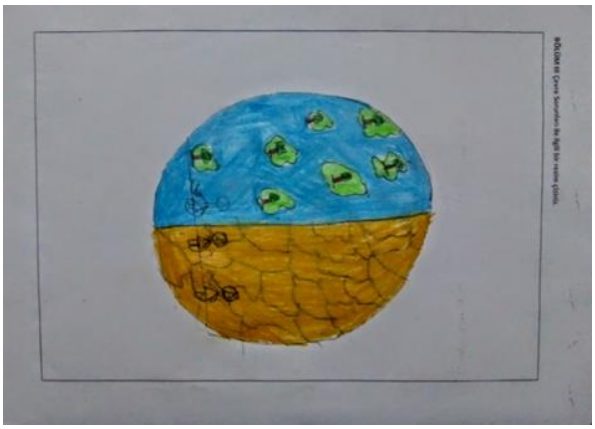
Picture 3. *Polluted Environment And Clean Environment (P17-F-10)*

Picture 4. *Clean Environment and Ruined Environment (P8-M-9)*



Picture 5. Sensitive and Insensitive People (P7-M-9)

Picture 6. Noise, Light, and Visual Pollution (P11-M-9)



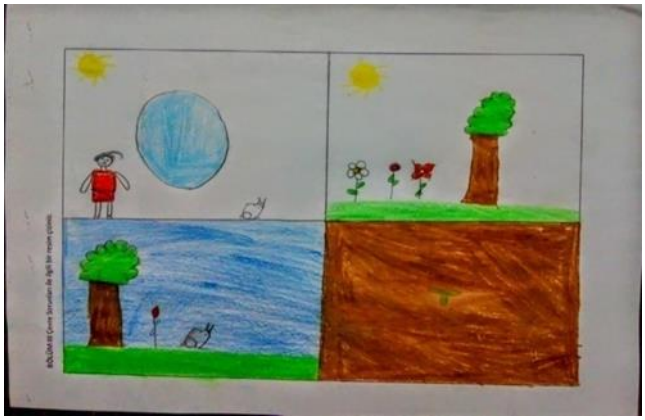
Picture 7. Global Climate Change and Desertification(P2-M-10)

Picture 8. An Environment Without Water and A Green (P15-F-10)

Picture 9. Over- consuming, Light, Air, Soil Pollution (P16-F-10)

Picture 10. Landslide and Erosion (P20-F-9)

Picture 11. Cutting of Trees and Air Pollution (P10-M-9)



Picture 12. Spoiling of the Ecosystem, Decreasing of the Species (P13-F-10)

Picture 13. Cutting of Trees and Water Waste (P10-M-9)

Picture 14. Environmental Pollution and The Last Tree (P24-F-9)

Picture 15. Causes of Water and Air Pollution (P8-M-9)

Picture 16. Water and Air Pollution (P19-F-9)

Picture 17. Air Pollution and Cutting of the Trees (P12-M-9)

Conclusion and Discussion

In order for an individual to be aware of what is going on around him/her, he/she must be aware of the effect of everything he/she uses in her life on him/her environment. For this reason, it is of great importance for students to grow up with a sustainable environmental understanding (Tanriverdi, 2009) and to be sensitive individuals. According to Bowker (2007), Lindeman-Matthies (2002), and Wilson (1996), children learn about the environment better through activities that require active participation. Erten (2004), (Bakar, 2002) on the other hand, mentions that people who are interested in plants and animals in childhood or who have experiences intertwined with nature are more sensitive to environmental problems in their youth and adulthood. It was determined that 7 students, 3 girls, and 4 boys, who participated in the study, had a village life. These students, who benefited from environmental education at the school and science and art center, stated that they actively participated in tree planting activities, observed the apricot spraying activities in the village, observed that the natural areas around them were destroyed by the construction of buildings and mines, by trying to separate daily wastes (plastic, batteries, glass, oil) into recycling bins in their interviews.

In the researches on specific subjects in picture analysis, individuals are asked to paint and tell pictures about a particular subject. These pictures, which are used as findings in the research, give the painter clues about the functioning of that person's soul. In addition, the pictures that they randomly draw without being tied to a specific subject are good visual presentation tools to describe the moods of children (Furt, 1988). Gifted primary students described their views on environmental problems by reflecting on the environment in which they lived and its characteristics, the meanings, and emotions they created in this environment in their paintings. Hague (2001); Ring, (2006); Senemoğlu (2004) found that gifted students tend to design (Kopytin,2018) and rearrange their environment with strong creativity (Yavuzer, 1993). According to the visual narratives obtained from the pictures drawn by the students, it was seen that they used the skills of aesthetics in their perspective, architectural view, restructuring, creative thinking, searching for solutions to the problems in their environment, and presenting these solutions. This situation, which can be considered as a sign of high sensitivity toward protecting their environment (Uçar, 2015), is included in the descriptions of the gifted students who participated in this study. According to the data obtained from the interviews with the students, the cutting of trees and the garbage in nature disturb the visual perceptions of the students. Similar to their peers, they see treeless areas and garbage as a primary problem of environmental pollution. Their descriptions that they are uncomfortable with this situation arise from the effort to express these discomforts (Loyentyev, 2000). Their descriptions that they are uncomfortable with this situation stem from the effort to express these discomforts. Unlike their peers, these students stated that environmental pollution occurs as a result of production for excessive consumption, sound, visual and light pollution harm living things, chemical drugs cause environmental pollution, global climate change, and desertification

destroys living species. While describing the environmental problems of gifted primary school students, they established a relationship between humans, trees, and the degraded environment.

These students stated that environmental problems are caused by humans (Ayvaz, 1998) and that these problems can be solved by humans. Environmental sensitivities for children in this period develop primarily based on the experiences they observe in their immediate environment (Çobanoğlu, Er, Demirtaş, Özan and Bayrak (2006) Littledyke 2004). It has been observed that no matter how much the grade levels of the students increase in primary and secondary school, their perspectives on environmental problems do not change except for some stereotypes. According to these students, environmental pollution is stated as air, soil, and water pollution, garbage, and other wastes. However, global climate change and desertification, radioactive and chemical wastes, sound, light, and visual pollution, pollution caused by excessive production and consumption, and erosion are environmental problems that students in this age group should be aware of (Pınar and Yakışan, 2017). In the interviews with gifted primary school students, 18 of the 24 students described the sensitivities about the immediate environment in the pictures, while 6 students described the problems of the distant environment on a global scale. The fact that gifted students have higher environmental sensitivity than their peers (Uğulu, 2013) is similar to the results of this research. By dividing the drawing paper into two, the students also reflected on the conversations of the figures who protect the environment and those who do not. In environmental pollution, it is seen that environmental problems are depicted in their paintings with sub-themes such as the dumping of wastes into the soil and the sea, not into the garbage, the damages of floods and excessive precipitation, the pollution of the air by factory chimneys, global climate change and accordingly the spread of desertification, and the deterioration of the ecosystem. In some of the pictures, it was seen that the children expressed more than one environmental problem. These are included in the expressions such as pollution, global climate change, environmental awareness, soil, air pollution, water, visual, sound, and light pollution. The fact that excessive shopping consumption, increasing production, and raw material needs are also considered as environmental problems shows that these students have strong perceptions about their environment. In this study, the perception of the sun is reflected in the pictures both in a clean environment and in a polluted environment. The reason for this is that they think that the sun is a source of life for living things, but when they cut trees, it will cause climate change and desertification. In this case, it can be thought that gifted students look at events from multiple perspectives.

Suggestions of gifted primary school students about environmental problems; trees were not cut down, soil, air, and water were not polluted. It can be said that the reason why the water pollution is described by fewer students compared to the descriptions made on the subjects they observe with the perception of the immediate environment is because the students think that the water coming to the house is clean. According to Dienno and Hilton (2005), a person who knows and is aware of his environment can only be sensitive to his environment. In this case, it can be thought that the students produced more ideas about environmental pollution that they could observe and reflected on in the pictures. Allerby (2000), in his research with children and young people, determined that clean world perception drawings are more common in younger children. The clean environment perception of gifted primary school students is also reflected in their paintings.

Shepardson (2005) asked students to describe the environment and collected the data with drawn pictures. As a result of the research, most of the students stated that they see the environment as a source of food, water, and oxygen for living things. It has been observed that the environment descriptions in the pictures drawn by the gifted students participating in this study reflect the reality that the environment has an ecosystem and that living things need clean air, soil, and water in this ecosystem. It can be thought that gifted students approach environmental problems more realistically and can see events in a wider range. It is thought that being a citizen who grows up in a country, is sensitive to the environment, is aware of environmental problems and produces solutions, can raise future generations in this direction (Özdemir, 2011).

The fact that gifted primary school students participating in the research reflected the people living in the polluted environment as unhappy and the people living in the clean environment as happy is similar to the study of Özsoy and Ahi (2004) with primary school students, while people in clean environment drawings smile, people in dirty

environment drawings are reflected as sad. It is understood from the interviews and analysis of the pictures in this research that the sensitivity of the students towards environmental problems is also in emotional dimensions. It was determined that the students felt high anxiety about their desire to live in a natural environment, a sense of love and protection towards the living things around them, a feeling of deep sadness against a degraded environment, a sense of constant discomfort in the face of visual, auditory and sound pollution, the inadequacy of the measures taken against environmental pollution and the feeling of anger and anger against insensitive people and the deterioration of the natural environment.

Recommendations

Recommendations for Practitioners

Today, due to the global increase in environmental problems, more research is needed to determine the environmental sensitivity of these students, who are the adults of the future. The results to be obtained from such research aimed at determining students' perceptions of the environment and their views on environmental problems can help them raise sensitive individuals as the adults of the future. Tools such as picture analysis can be used more widely to determine the psycho-emotional characteristics of gifted students.

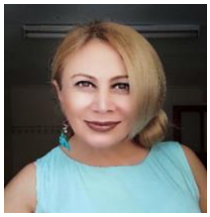
Recommendations for Researchers

Due to the qualitative nature of this research, it may be recommended to use different data collection tools in future research.

Limitations

This research is limited to 12 female and 12 male students who are determined to be gifted in the 4th grade attending Science and Art Centers in Malatya province of Turkey in the 2020-2021 academic year.

Biodata of Author



Doctorate **Şengül Korkut** was a primary school teacher at the Turkish Ministry of National Education for 30 years. Besides, she worked as the primary school teacher of the gifted students for 15 years. Korkut got her master's degree in Malatya Inönü University and her doctorate in Bolu Abant Izzet Baysal University in Turkiye. Currently, she continues her doctoral studies at Friedrich-Alexander-University of Erlangen-Nürnberg as a visiting researcher under the supervision of Prof.Dr. Albert Ziegler. In addition to her academic researches on social studies education, she provided special training for the basic education of the gifted students and designed differentiated curriculum for the gifted students and applied them in the classes. She also currently conducts studies on the self-regulated skills of the students. Korkut's research areas, educational psychology, special education, basic education, gifted and talented education of students, classroom management education, social studies education, nature education, ecological literacy education.

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Research Article

Combined effect of curiosity, creativity, and motivation on academic performance of senior high school students

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Abstract

Academic performance has consistently become the primary measure of students progress in school. As a yardstick, it is evident, based on the interaction of students' psychological abilities, such as curiosity, creativity and motivation, which seem to be disregarded. The current study, therefore, investigated the combined effect of curiosity, creativity, motivation, and academic performance in core mathematics and integrated science. Two research hypotheses guided the study. The study adopted a correlational design. A sample of 652 was used through the purposive, simple random, stratified-proportionate, and systematic sampling techniques. Adapted curiosity, creativity, motivation scales, expert-developed core mathematics, and integrated tests were used to collect the data. The data were analysed inferentially with multivariate regression. The study revealed that students' curious behaviours, creative abilities, and motivation are related and complement one another as students pursue their academic goals. At the same time, core mathematics predicted better in integrated science than its inverse. Therefore, schools should allow students to investigate issues in their environment, engage in personalised activities and provide them with stimulating consequences after academic processes. These would help harness their curious abilities, promote creativity and invoke motivation in them.

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Introduction

Education is an invaluable component of every nation. In judging the worth of education, the onus lies in the academic performance of students. Academic performance is an essential criterion used to assess students' success in their studies, making it vital to understand the factors responsible for determining, predicting, mediating, and causing variance in academic achievement (Ahmad & Bruinsma, 2006). Likewise, in Ghana, students' academic performance has become the yardstick for measuring the success or failure of learning processes (Ampofo, 2020; Ampofo & Benedict, 2015; Kwapong, 2021; Seddoh, 2013). Among the factors that play significant roles in the observation or realisation of academic performance of students are curiosity, creativity, and motivation. Litman (2008) defined curiosity as the motivation to search for information concerning a specific learning area. Curiosity is psychological energy that leads learners to engage in explorative behaviours that might result in rewards or prevent information gaps in their memory system. Curiosity is an integral part of a student's success, even if such students are from poor socioeconomic

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backgrounds. For example, a survey among 6,200 learners in the United States found that curiosity was a key factor that made students of low socioeconomic status excel at school (Burgess, Shah, Hough, & Hynynen, 2016). Thus, curiosity has significant pedagogic value in teaching and learning (Nurishlah, Budiman, & Yulindrasari, 2020; Singh & Manjaly, 2022).

Creativity appears elusive and challenging to be understood by researchers for many decades, because it defies a common or a precise definition and explanation. According to Dineen, Samuel, and Livesey (2005), creativity is a process of generating a consequence that is innovative or unique and applicable or appreciated. There are four significant components of creativity: a cognitive factor (intelligence or knowledge), a conative factor (personality or motivation), an emotional factor (the impact of emotional traits on creative potential), and an environmental factor (e.g., familial of school environments) (Ahmadi & Besançon, 2017). These components work together to define how creative an individual can be. Creativity is a crucial component of humanity. In the lives of learners, creativity is beneficial. Professionals in education widely accept it because applying creative ideas in teaching and learning situations can help develop learners' imagination and increase their discovery potential for future economic development (Cachia, Ferrari, Ala-Mutka, & Punie, 2010; Sternberg, 2015). Researchers such as Sawyer (2006) and Craft (2005) suggested that creativity should be an essential educational objective, as contemporary information societies pride schools that focus on training students for creativity. Wolfe and Bramwell (2008) established that creativity in education helps deliver suitable engagement to students and institutions, making students help institutions acquire innovative talents and knowledge. Creative programmes help transfer knowledge across domestic institutions and schools.

Cherry (2016) defined motivation as the process that initiates, guides, and maintains goal-oriented behaviours. Motivation is governed by an individual's need, intensity, and persistence towards the desired goal. Thus, motivation is a goal-directed mental energy that compels people to engage in behaviours that initially, they never had towards an identified goal. In explaining the value of motivation in education, Adamma, Ekwutosim, and Unamba (2018), Elliot and Dweck (2005), and Muola (2010) indicated that nurturing learning and maintaining motivation among students should be a prime area for every teacher because it is an integral part in the overall performance of students. According to Akpan and Umobong (2013), motivation substantially influences success.

The push for nurturing learners to become curious, creative, and motivated has been topical not only for the developed part of the world but those from developing countries. According to Amponsah, Mahama, and Wadieh (2022, p. 369), "the 21st century education system demands an educational model focused not necessarily on improving the intellectual abilities of students but also their ability to own and control their view of themselves through curiosity, creativity, and motivation ". This implies that, schools have a major role to play in training learners to become curious, creative, and motivated in their academic engagements. However, it is possible that the teachers who may be mandated by schools to nurture curiosity, creativity, and motivation in learners might not possess the requisite ability to execute their mandate. For instance, a study exploring in-service teachers' creative nurturing behaviours in Ghana by Mahama (2022) found that most teachers had low levels of creativity nurturing behaviours, hence their inability to nurture their learners to become creative in learning situations.

Empirical Evidence

It is noted that several factors influence academic performance of students (Colangelo & Davis, 2011), and such factors include curiosity, creativity, and motivation as they work hand-in-hand. Researchers have indicated that curiosity, creativity and motivation are intertwined. With this, curiosity is repeatedly related to motivation, novelty, and the quest for success in an academic environment (Barto et al., 2013; Kidd & Hayden, 2015; Gottlieb, Oudeyer, Lopes, & Baranes 2013; Oudeyer & Kaplan, 2007). Rinco (2011) explained that curiosity, creative thinking and motivation were factors that measured and influenced students' success. According to Alzoubi, Al-Qudah, Albursan, Bakhiet, and Abduljabbar (2016), students' creative thinking improved their curious abilities and motivational urges. In a study among Chinese students, Jeng, Hsu, Xie and Lin (2010) found that curiosity, creativity, and motivation worked together to improve students' academic performance and as well, promoted the efficacy of teaching, teaching approaches, and the individual

experiences of teachers. Sudarman (2020) conducted a study among high school students in Karawang, West Java, Indonesia. In the study, the researcher examined psychological behaviours such as curiosity, creativity, motivation, self-esteem, and Academic Performance. The study revealed that the psychological behaviours were related and jointly and positively influenced (predicted) students' academic performance in mathematics and natural sciences. Based on this, Sudarman (2020) advised that teachers should be made to develop students' curious abilities, creativity, and motivation through exploration, presenting challenging teaching materials to them, and providing them with flexibility in adapting to new situations. Likewise, Kashdan et al. (2017) examined students' curiosity, creativity, and motivation. Their study argued that when students were curious about the subject matter, they showed motivation and creativity, where they were able to manage their learning and achievement.

The Present Study

The present study aims to unravel the collaborative influence of curiosity, creativity, and motivation on students' academic performance in Ghana. Curiosity, creativity and motivation are psychological variables that can work in tandem to determine students' academic performance in any educational endeavour (Nauzeer & Jaunky, 2021). For instance, when learners become curious, they show higher motivation levels in attending to information presented to them, increase their effort in seeking and acquiring knowledge, and retain new information for use in the future (Kang et al., 2009). Taken together, several paired variable studies have been conducted among curiosity, creativity, motivation, and academic Performance (Dramanu & Aisha, 2017; Gajda, Karwowski, & Beghetto, 2017; Nami, Marsooli, & Ashouri, 2014; Nurishlah, Budiman, & Yulindrasari, 2020; Steinmayr, Weidinger, Schwinger, & Spinath, 2019; Surapuramath, 2014; Von Stumm, Hell, & Chamorro-Premuzic, 2011) but none of these studies considered merging the constructs, where all can work collectively to influence students' academic performance. The joint contribution of curiosity, creativity, and motivation is an indispensable panacea to learning outcomes of students but it appears such constructs are less saliently considered in developing curriculum for learners in Ghana. Although several educational reforms were made in Ghana since 1987, none captured issues of curiosity, creativity, and motivation until the New Standard-Based Curriculum was developed and implemented in 2019 (Adu-Gyamfi, Donkoh, & Addo, 2016; Mahama, 2022). Even with the New Standard-Based Curriculum, less is discussed about how to train teachers so that they could nurture learners on curiosity, creativity, and motivation (Mahama, 2022). However, it is expected that learners exhibit curious, creative, and motivation abilities in their learning situtaions because, these abilities are noted to have a great effect on their academic success.

Problem of Study

This study, therefore, sought to provide a lid on the knowledge vacuum by determining the combined effect of curiosity, creativity, and motivation on the academic performance of S.H.S students in the Central Region, Ghana, using the following questions:

- What is the combined effect of curiosity, creativity, motivation, and academic performance of S.H.S. students in the Central Region, Ghana?
- What is the predictive ability core mathematics and integrated science performance of S.H.S. two students in the Central Region, Ghana?

Method

Research Model

This research is in the survey model, which is one of the quantitative research types. The characteristics of some variables in a certain group can be accepted in relational survey model types since this study was conducted to determine their relationships with each other.

Participants

A sample of 652 students drawn from 25 Senior High Schools in the Central Region of Ghana was used. These students were in their second year and abreast with issues under investigation. All the students shared similar characteristics

regarding schools where they were drawn, which were not different from all the areas examined or assessed. The average age of the students was M_{age}=16.80±.98. In addition, the gender of students was considered, where female students dominated the sample with a frequency of 288 (50.7%) while male students had a frequency of 280 (49.3%). Comparing with the proposed sample size for the study, it is evident that 288 out of 323 female students made up a return rate of 89.0%, while 280 out of 329 male students made up a return rate of 85.0%.

Data Collection Tools

Five Dimensions of Curiosity Scale

The 5-Dimensions of Curiosity developed by Kashdan et al. (2018) was adapted. Students responded between 1-4 (Strongly disagree-Strongly agree) on a 4-point scale. The 5DC had five (5) dimensions with a total of 25-items. Dimension one (1) was named "Joyous Exploration"; it had five (5) items with a reliability coefficient of .80 and had statements like "I view challenging situations as an opportunity to grow and learn". Dimension two was named "Deprivation Sensitivity" with a reliability coefficient of .67 and had statements like "I work relentlessly at problems that I feel must be solved". Dimension three was named "Stress Tolerance" with a reliability coefficient of .72 and had statements like "I cannot handle the stress that comes from entering uncertain situations". Dimension four was named "Social curiosity with a reliability coefficient of .59 and had statements like "When around other people, I like listening to their conversations". Dimension five was named "Thrill-seeking" with a reliability coefficient of .79 and had statements like "Risk-taking is exciting to me". Some words were modified and a personal pronoun "I" was added to start each statement in order to meet the context of the study. Again, the original scale had scored from strongly disagree to agree strongly. The original scale had scored on a 7-point Likert-type scale but was modified to 4-point to avoid neutral points. This was done to ensure each respondent had a positive or negative opinion of the statements. The structure of the items on the instrument was closed-ended, where respondents were only allowed to select one response set. The scale had a composite reliability coefficient of .71 before data collection and produced a reliability coefficient of .76 after data collection.

Kaufman Domains of Creativity Scale (K-DOCS)

Kaufman Domains of Creativity Scale (K-DOCS) developed by Kaufman (2012) was adapted for the measuring creativity. Students responded between 1-4 (Strongly disagree-Strongly agree) on a 4-point scale. The scale had five dimensions with a total of 50-items. Dimension one was named "Self/Everyday Creativity" with a reliability coefficient of .86 had 11-items and statements like "Helping other people cope with a difficult situation". Dimension two was named "Scholarly Creativity" with a reliability coefficient of .86, had 10-items and statements like "Writing a nonfiction article for a newspaper, newsletter or magazine". Dimension three was named "Performance Creativity" with a reliability coefficient of .87, had 10-items and statements like "Playing music in public". Dimension four was named "Mechanical/Scientific Creativity" with a reliability coefficient of .86, had 10-items and statements like "Solving math puzzles". Finally, dimension five was named "Artistic Creativity" with a reliability coefficient of .83, had 9-items and statements like "Coming up with my interpretation of a classic work of art". Some words were modified, and a personal pronoun "I" was added to start each statement to meet the study's context. Again, the original scale had scored from strongly disagree to agree strongly. The original scale had scored on a 5-point Likert-type scale but was modified to 4-point to avoid neutral points. This was done to ensure each respondent had a positive or negative opinion of the statements. The structure of the items on the instrument was closed-ended, where respondents were only allowed to select one response set. The measure had a composite reliability coefficient of .86 before data collection and produced composite reliability of .79 after data collection.

Academic Motivation Scale (AMS-28)

The Academic Motivation Scale (AMS-28) developed by Vallerand et al. (1997) was adapted. Students responded between 1-4 (Strongly disagree-Strongly agree) on a 4-point scale. The measure had seven dimensions with a total of 28-items. Dimension one, named "Knowledge dimension", had 4-items with a reliability coefficient of .84 and had statements like "Because I experience pleasure and satisfaction while learning new things". Dimension two was named

"Accomplishment dimension", which had 4-items with a reliability coefficient of .78, and had statements like “For the pleasure I experience while surpassing myself in my studies". Dimension three was named "Stimulation dimension", which had 4-items with a reliability coefficient of .78 and had statements like "Because I like going to school". Dimension four was named "Identified dimension", had 4-items with a reliability coefficient of .81, and had statements like "Because eventually, it will enable me to enter the job market in a field that I like”. Dimension five was named “Introjected dimension", had 4-items with a reliability coefficient of .80, and had statements like "Because when I succeed in school, I feel important". Dimension six, named "Extrinsic dimension", had 4-items with a reliability coefficient of .71 and had statements like "Because I want to have 'the good life later on". Dimension seven, named "Amotivation dimension", had 4-items with a reliability coefficient of .84 and had statements like "I cannot see why I go to school and frankly, I could not care less". Some words were modified, and a personal pronoun "I" was added to start each statement to meet the study's context. Again, the original scale had scored from strongly disagree to agree strongly. The original scale had scored on a 7-point Likert-type scale but was modified to 4-point to avoid neutral points. This was done to ensure each respondent had a positive or negative opinion of the statements. The structure of the items on the instrument was closed-ended, where respondents were only allowed to select one response set. The measure had a composite reliability coefficient of .79 before data collection and produced a reliability coefficient of .82 after data collection.

Core Mathematics and Integrated Science Tests

Students' academic performance was measured using Core Mathematics and Integrated Science as proxies. Core Mathematics and Integrated Science were used in this study for several reasons. For example, Foley, Herts, Borgonovi, Guerriero, Levine, and Beilock (2017), Lyons and Beilock (2011) and Maloney, Schaeffer, and Beilock (2013) indicated that students habitually give negative emotions and motivations in mathematics and integrated science. Hence, the choice of these subjects was appropriate as curiosity, creativity and motivation could minimize negative emotions of students concerning mathematics and integrated science. Also, these subject areas were used because they are among subjects that are considered for students' progression from one stage to another in academia at the senior high level. For students to succeed in these subjects, there is a need for curiosity, creativity, and motivation. Again, these subjects are highly related to students' curiosity, creativity and motivation (Cutraro, 2012). For a student to pass well in any of the two subject areas, they must go beyond normal rehearsal or repetitions that come with other subjects like English Language and Social Studies. When pursuing subjects like integrated science and core mathematics, students need to explore, make efforts to come out with novel products and as well, must attach motivation in the process. Experts in the subject areas were contracted to develop the instruments at an agreed fee. The measures contained 100-items, mainly in multiple-choice format (4-options) with 50-items each for integrated science and core mathematics. The Kuder-Richardson (KR-21) reliability for core mathematics was .79, while that of integrated science was .77.

Data Analysis

The researcher performed multivariate regression for both core mathematics and integrated science. In this analysis, the predictor variable was combined curiosity, creativity, and motivation, while the criterion variables were core mathematics and integrated science. This sort of variable combination gives room for multivariate regression to be performed. In multivariate regression, there is the need for more than one dependent variable against one or more independent variable(s). The literature noted that multivariate regression is based on observation and analysis of more than one statistical outcome variable at a time (Hidalgo & Goodman, 2013; Olkin & Sampson, 2001).

Procedure

Ethical protocols such as ethical approval (CES-ERB/UCC/EDU/V14/20-09), informed consent, anonymity, and confidentiality were considered in this study. All students accepted to participate in the study voluntarily. The study was in two sessions. The curiosity, creativity, and motivation measures were filled first by the students, and it lasted for just a day. The second session was for the performance measures, which lasted for two days (a day each for a subject) with activity period of 60 minutes for each subject. The testing took place during regular classes in the selected schools. The researcher administered the tests with the help of trained research assistants.

Results

In this study, it was prudent to test the assumptions appropriately using descriptive statistics before performing the multivariate regression test for the hypothesis. The assumptions tested included the skewness of data, kurtosis of data, and means and standard deviations of the variables used in the study. Table 1 presents the results.

Table 1. *Descriptive Statistics for all the Scales*

	Min.	Max.	Mean	SD	Skewness		Kurtosis	
Measures	Stat.	Stat.	Stat.	Stat.	Stat.	Std. E	Stat.	Std. E
Curiosity Total	51.00	90.00	71.54	7.30	-.255	.103	-.098	.205
Creativity Total	92.00	200.00	143.75	16.50	.209	.103	.438	.205
Motivation Total	51.00	112.00	86.31	9.11	-.654	.103	.483	.205
Core Mathematics	10	48	31.08	7.26	-.080	.103	-.443	.205
Integrated Science	10	47	29.94	5.77	-.373	.103	.361	.205

Table 1 indicates that data skewness based on custom rule values ranged between +1 and -1, and kurtosis custom rule values ranged between +1 and -1 (Hair, Hult, Ringle, & Sarstedt, 2017). Referring to curiosity, it produced a skewness statistic of -.255 and a kurtosis statistic of -.098. This implied that distribution for curiosity was skewed to the left while kurtosis produced a negative value, making the data leptokurtic. This explained that most responses or cases are falling above the average/midpoint on the normal curve. Referring to creativity, it produced a skewness statistic of .209 and a kurtosis statistic of .438. This implied that the distribution for creativity was skewed to the right while kurtosis produced a positive value, making it platykurtic kurtosis. This explained that most cases are falling below the average/midpoint on the normal curve. Referring to motivation, it produced a skewness statistic of -.654 and a kurtosis statistic of .483. This implied that the distribution for motivation was skewed to the left while kurtosis showed positive value, making the data leptokurtic. This explained that most responses or cases are falling above the average/midpoint in the normal curve. Finally, referring to mathematics, it produced a skewness statistic of -.080 and a kurtosis statistic of -.443. This implied that the distribution was skewed to the left while kurtosis showed negative value, making the data leptokurtic. This explained that most responses or cases are falling above the average/midpoint in the normal curve. Integrated science produced a skewness statistic of -.373 and a kurtosis statistic of .361. This implied that the distribution was skewed to the left while kurtosis showed positive value, making the data platykurtic. This explained that most responses or cases are falling above the average/midpoint in the normal curve. Based on the results, it is assumed that the distribution was approximately symmetrical as a skewness value of zero (0) indicates a perfectly symmetrical distribution.

Combined Effect of Curiosity, Creativity and Motivation on Academic Performance

This question aimed to establish combined statistical relationships between the psychological constructs (curiosity, creativity, motivation) and academic performance in core mathematics and integrated science using the multivariate linear regression (MLR). The multivariate linear regression was chosen because the dependent variable, performance, had two dimensions against one combined independent variable. Before performing the test, normality test, linearity, homoscedasticity and multicollinearity assumptions were certified as preliminary test as indicated in the results of hypothesis one and hypothesis two. Because the test involved multiple dependent variables, it was necessary to set a higher alpha level so that the chance of committing Type error (rejecting the null hypothesis where there are no significant results) could be reduced. In doing this, the Bonferroni adjustment proposed by Pallant (2016) was applied. The researcher divided the number of dependent variables by the original alpha level; thus, .05/2=0.025, where .025 becomes the new alpha level. Table 2 presents the results.

Table 2. *Combined Multivariate Linear Regression Results for Psychological Constructs and Academic Performance*

DV	Parameter	B	S. E	t	Sig.	P E S	F	p
Core Maths.	Intercept	3.467	.826	4.199	.000	.030	258.612	.000
	IVs' Combined	.352	.022	16.081	.000	.314	92.367	.000
Int. Science	Intercept	5.943	.965	6.161	.000	.063	258.612	.000
	IVs' Combined	.246	.026	9.611	.000	.140	92.367	.000

R Squared = .314 (Adjusted R Squared = .312) R Squared = .140 (Adjusted R Squared = .139) Significant @ .025

Table 2 shows the results of the multivariate linear regression (MLR) test, where curiosity, creativity, and motivation were combined as one variable and used as a predictor of academic performance in core mathematics and integrated science. Wilk's Lambda test for the omnibus hypothesis that all beta values across the dependent variables equalled zero were statistically significant; thus, F (2, 565) =23.005, W=.925, p < .025. With core mathematics as the dependent variable, R^2 =.314, F=258.612, p < .025. This shows that 31.4% of combined curiosity, creativity and motivation explained the variance in core mathematics performance. With integrated science as the dependent variable, R^2=.140, F=92.367, p < .025. This shows that 14.0% of combined curiosity, creativity and motivation explained the variance in integrated science performance. Individual predictions combined with curiosity, creativity and motivation (Beta=.352) predicted higher core mathematics performance than integrated science performance (Beta=.246). The results produced a large effect size of .46 for core mathematics and a weak effect size of .16 for integrated science performance. This implies that the strength of the relationship in combined curiosity, creativity, motivation and mathematics performance was high.

In contrast, the strength of the relationship in combined curiosity, creativity, motivation and integrated science performance was low. In the two situations, combined curiosity, creativity and motivation predicted higher core mathematics performance than combined curiosity, creativity and motivation prediction in integrated science. On this note, the null hypothesis states that there will be no combined effect of (a) curiosity, (b) creativity and (c) motivation on the (d) academic performance (mathematics and science) of students in Senior High Schools in the Central Region, Ghana was rejected.

Predictive Ability between Core Mathematics and Integrated Science

Testing this hypothesis was to establish a bidirectional statistical relationship between core mathematics performance and integrated science performance using regression. The regression was chosen favouring Canonical Correlation and Pearson Product-Moment Correlation for the non-recursive prediction because it has the power to produce correlations and predictions among the variables, where each variable predicts the other. Table 3 presents results based on curiosity, creativity and motivation pairings.

Table 3. *Regression Results on Mathematics and Integrated Science Performances*

Variable	B	SE	*B*	R	T	Sig.	R^2	Ad R^2	F	p
Core Maths	.332	.030	.418	.418	10.9	.000	.174	.173	119.61	.000
Int. Science	.526	.048	.418	.418	7.45	.000	.174	.173	119.61	.000

*First Pairing Dependent=Int. Science; *Second Pairing Dependent= Mathematics

In testing whether mathematics ability and science ability could predict each other, the results show a moderate positive relationship between students' ability in core mathematics and integrated science (r=.418). The regression results indicate that students' mathematics ability explained 17.4% of the variance in their ability in science [R^2=.174, F (1, 565) =119.61, p=.000]. It was found that students' mathematics ability significantly predicted students' ability in integrated science (β =.526, p=000) better than students' ability in integrated science predicting students' ability in core mathematics. The results mean that a unit increase in students' mathematics ability will increase their ability in integrated science. For effect size contribution of students' mathematics ability to their ability in science, the results revealed an effect size of .21, which was weak using Cohen's (1988) formula. E.g. $f^2=R^2/1-R^2=.174/1-.174=.174/.826=.21$. This

implies that the strength of the relationship between core mathematics performance and integrated science performance is low. It is conclusive to note that students' ability in mathematics can influence their scientific or science ability.

Parsimonious Framework

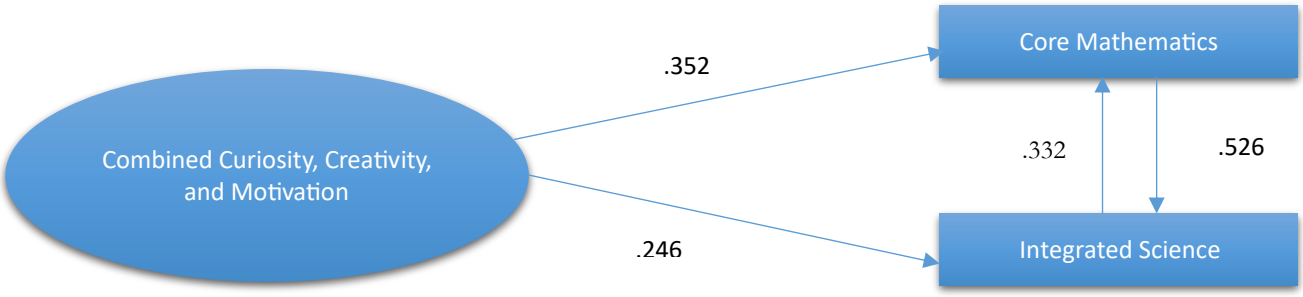

Figure 1. *Combined Curiosity, Creativity, Motivation, Predicting Academic Performance*

Figure 1 indicates the combined curiosity, creativity and motivation predictive ability in core mathematics and integrated science. It is revealed that combined curiosity, creativity, and motivation was better predictor of core mathematics performance than integrated science performance. It means that students' curiosity, creativity, and motivation working together contributed much to their core mathematics performance than integrated science performance. In contrast, core mathematics predicted integrated science better than integrated science predicting core mathematics.

Discussion

The questions one was about the combined predictive ability of curiosity, creativity, and motivation on students' academic performance in core mathematics and integrated science. The study revealed that combined curiosity, creativity and motivation predicted higher core mathematics performance than integrated science performance. The combined curiosity, creativity, and motivation produced a large effect size for core mathematics and a weak effect size for integrated science. This implied that combined curiosity, creativity and motivation had a strong relation with core mathematics performance, while the combined curiosity, creativity, and motivation relationship with integrated science was weak. The finding means that a combination of curiosity, creativity and motivation has the power to improve students' academic performance in core mathematics and integrated science. The revelation buttresses the fact that curiosity, creativity and motivation as psychological constructs work in tandem in the cognitive make-ups of students. With this, students with high levels of curiosity, creativity, and motivation working hand-in-hand may improve their intelligence, which may improve their school achievement. In this realm, schools must take necessary steps to harness the combined development of curiosity, creativity and motivation of students as they work collaboratively to improve upon outcomes of students in school and life in general. The current study's finding confirms Jeng, Hsu, Xie, Lin, and Huang's (2010) study finding revealed that curiosity, creativity, and motivation collaboratively predicted students' academic performance and promoted students' individual experiences.

Furthermore, the current study's finding supports the finding of Sudarman (2020). The study found that combined curiosity, creativity, motivation, and self-esteem significantly predicted students' academic performance. Based on this, Sudarman (2020) implored teachers to develop curiosity, creativity and motivation in students. More so, the current study's finding corroborates the finding of Kashdan, Doorley, Stiksma, and Hertenstein (2017). In their study, curiosity, creativity, and motivation jointly predicted students' learning behaviours and academic achievement.

The question two aimed at testing the predictive abilities of core mathematics and integrated science. In the testing process, both core mathematics and integrated served predictors and criteria on two occasions because the aim was to find out which would predict better. The study revealed that students' mathematics ability significantly predicted students' ability in integrated science much more than scientific abilities predicting mathematical abilities. The

revelation means that as students become mathematically promising, they can become scientifically better. Students' accuracy in calculating scientific principles may depend on their mathematical abilities. Hence, helping students excel in mathematics will go a long way to help them improve their scientific skills. Therefore, it is prudent that teachers in mathematics and science be aware of their relationship and collaborate to provide students with opportunities for meaningful connections between core mathematics and integrated science. Both core mathematics and integrated science produced a weak effect size. This effect size means that the relationship between core mathematics and integrated science was weak, though significant. The current study's finding supports that science incorporates mathematics by using mathematical functions to solve science problems or teach a science principle (Browning, 2011). Empirically, the current study's finding confirmed that of Shelley and Yildirim (2013), which found that students' knowledge in mathematics could be transferred to scientific knowledge, where mathematics and science seem to reciprocate in their interaction.

Furthermore, the current study's findings are in line with Oyedeji's (2011) study among high school students in Nigeria. The study established a positive relationship between the students' mathematics skills and science achievement. Students' mathematical skills significantly predicted their science achievement, where mathematical skills explained 37.4% of the variance in science achievement.

Conclusion

Students in Senior High Schools in the Central Region's curious behaviours, creative abilities and motivation are related and complement one another as students pursue their goals. As students become curious, their creative abilities are energised, and they become motivated when innovative products are realised. For students to become successful, their curiosity must be provoked, their creative abilities are honed, and their efforts be reinforced. Therefore, it is prudent for teachers and parents to find appropriate strategies where students' explorative behaviours could be harnessed, where students could be engaged in independent activities to realise their creativity and make an effort to reward students in the process. Students in Senior High Schools in the Central Region's abilities in mathematics could help in their abilities to study science-related courses or subjects because these broad subject areas are positively related. In this situation, mathematically good students may be scientifically better. It is acceptable that calculation in scientific principles will depend on their mathematical abilities. In realising the linkage, teachers in mathematics and science can collaborate to provide students with opportunities that can bring the two subject areas together as they may complement each other as students study them.

Recommendations for Policy and Practice

It is recommended that there should be a revised focus on training students to pass examinations but includes how knowledge acquired in the classroom can be applied outside the classroom. This can be done when the management of schools allows students to investigate issues in their environment, allow students to engage in personalised activities and provide them with stimulating consequences after academic processes. Also, there is a need for inter-subject area workshops, as mathematics and science are related. Organising these workshops will allow teachers with diverse subject areas to collaborate in finding common ground where different subjects can be taught to students in a complementary manner. Again, Ghana Education Service should take a step further in revising the way and manner they organise workshops for in-service teachers and make it inter-subjects related to include the various subject areas as they could complement each other and improve upon students' academic performance in most school subjects.

Furthermore, the Ghana Education Service, in collaboration with the Ministry of Education and Curriculum Developers, should harmonise curiosity, creativity and motivation in the syllabus so that teachers can teach students to become curious, creative and motivated. Lastly, training programmes for in-service teachers and pre-service teachers should be geared towards the inclusion of curiosity, creativity, and motivation to make it comprehensive for teachers as they engage students in current and future teaching and learning activities.

Limitations of the Study

The study surveyed only senior high students in the Central Region of Ghana, and the findings cannot reflect all other students in the country. Therefore, caution should be taken when discussing and implying the study findings because generalizability is limited.

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Conflict of Interest

There is no issue of conflict of interest in the process of conducting this study. Therefore, nothing of that sort appears to influence the study and its findings in any way.

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Research Article

A test for identification of math talent: developing a three-tier number sense test

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Abstract

Solving math problems requires inferential thinking skills, improved number sense, problem-solving strategies, deductive reasoning and computational skills. Mathematically talented students often use advanced number sense strategies to get the fastest and most accurate result. Although the existence of the number sense is known, it is difficult to describe it concretely. To materialize the intangible concept of number sense, a three-tier number sense test for secondary school students was developed and validated in this study. The developed test was carried out to 499 students studying in middle school in İzmir in Turkey. The first tier of the test consists of 25 multiple-choice mathematics questions. The second tier consists of the reason tier, which includes responses to the questions in the first tier (number sense-based, rule-based, misconception and guesswork). The third tier includes the confidence question, which measures the belief in the correctness of the response given to the question. The reliability of the test was calculated as .74 with the KR-20 formula. From the results of the analysis, it can be considered that the developed test is a valid and reliable measurement tool that can be used to determine the number sense levels of the students.

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Introduction

The specialists suggest that instead of the traditional approach in mathematics education, which has been adopted for a long time, which provides education by assuming the whole group equally, it is necessary to place the children in the right group in the classroom according to their individual characteristics and needs. The groups should be in a dynamic structure according to the learning speed of the young people and when necessary, the transition of the children between the groups should be ensured (New Trends in Mathematics: UNESCO, 1977, p. 96-97). The whole evaluation process with scales and tests is actually made for a definite and clear prediction about the student. Such a prediction is necessary in order to follow up more individuals with systematic observations and to be a guide in education and future studies (Hrich et al., 2019). The requirements for recognizing students' mathematical abilities by testing can be explained as follows; educational arrangement, identifying the areas of difficulty, preparing an individualized education program, following the development, assisting in future decisions such as career choice, comparing individuals according to certain norms and criteria, understanding the way of thinking mathematically (Chinn & Ashcroft, 1993, p. 18-19).

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According to researchers such as Gardner (1983) and Harling & Roberts (1988), some people are gifted in logical-mathematical thinking. Individuals with mathematical talented argue that they are rarely well understood in terms of mathematical thinking. Therefore, measuring mathematical ability is an important requirement (Gardner, 1983, p. 155).

In order to create the most appropriate goals and behaviors in a student, it is necessary to define the characteristics of the student instantly and in the process. A good educational assessment and evaluation tool should include questions about what the student knows and what he/she does not know, as well as how and why he/she learns (Whitfield, 1987, p. 151). Given these explanations, multi-tier tests are useful tools for assessing students' abilities.

Mathematical Talent and Number Sense

Wirtz (1974) noted long ago that number sense is difficult to define but easy to recognize. There are different definitions for number sense in the literature. Howden (1989) defines number sense as "the ability to grasp the meanings of numbers, develop multiple relationships between numbers, recognize the relative magnitudes of numbers, and know the relative effect of operations on numbers" (p. 6). McIntosh, Reys, and Reys (1992) defined number sense as "a person's general understanding of numbers and operations, and the ability to use this understanding in flexible ways to make mathematical judgments, and the tendency to develop useful strategies for dealing with numbers and operations" (p. 3).

On the other hand, Yang (2003) refers to "a person's general understanding of numbers and operations and their ability to handle everyday life situations involving numbers. This includes the ability to develop useful, flexible, and efficient strategies (i.e., mental calculation or estimation) for tackling numerical problems" (p. 116). Students with a good number sense can move seamlessly between the real world of quantities and the mathematical world of numbers and numerical expressions. They are able to invent their own strategies for executing digital operations. They can represent the same number in more than one way, depending on the context and purpose of this representation. They can recognize comparison numbers and number models, especially those that derive from the deep structure of the number system. They have a good sense of numerical magnitude and are able to recognize large numerical errors, that are inaccurate by order of magnitude. Finally, they can think or talk logically about the general properties of a numerical problem or expression without doing any calculations (Markovits & Sowder,1994).

Some researchers consider number sense as a skill or a kind of knowledge rather than an internal process and claim that it should be teachable (Robinson, Menchetti, & Torgesen, 2002). According to this claim, the number sense stems from our biological structure and its development can be supported. According to some hard-core theorists, number sense is fixed and unchanging because it is a specialized substratum component of the brain. It is thought that the emergence of the primitive components of the number sense in young children occurs spontaneously (Dehaene, 2001). There are some basic principles that support the development of numerical cognitive structures. It is thought that participating in numerical games and activities containing these principles will activate the number sense (Geary, 1995). Parallel to this point of view, it is stated that the development of number sense can be supported in both formal and informal teaching environments by using numerical facts effectively in board games starting from the pre-school period (Gersten & Chard, 1999).

Since number sense is an important topic in mathematics education, it has been a hot topic among mathematics educators, cognitive psychologists, researchers, teachers, and mathematics curriculum developers (Yang, 2005; Yang, 2003; Markovits & Sowder, 1994; McIntosh et al., 1992; Howden, 1989). Based on the definitions and studies on number sense, this study aims to develop a test to measure middle school students' number sense skills.

Giftedness and Number Sense

Mathematical talent consists of abstract thinking (algebraic thinking structure) and spatial thinking (geometrical mindset) skills and their combination. Although the ability to calculate quickly and memorize formulas are useful skills, they are not considered necessary conditions for mathematical ability (Krutetskii, 1976, p. 77). Mathematically talented students can see relationships between topics, concepts, and ideas without formal instructional interventions. They may

intuitively understand mathematical functions and processes because of their developed sense of numbers, skip the steps of operations, and may not be able to explain how they arrived at the correct answer (Rotigel & Fello, 2004).

When the literature is examined, it has been seen that there are studies evaluating the number sense skills of gifted students. Artut & Er (2022) examined the strategies used by gifted fifth-grade students in solving number sense problems. The results of the analysis of the data collected by qualitative research techniques showed that even gifted students could not reach a sufficient level in the use of number sense-based strategies. In another study, the relationship between high school students' number sense and their mathematics performance was examined (Wang et al., 2017). According to the results of the study, the probability of successful performance in mathematics increases for individuals with a developed number sense. However, the precision of number sense is not directly related to performing at a high level in advanced mathematics. Earlier basic math skills were found to be more associated with number sense. If this situation is interpreted, it was stated that better basic math skills support better developed math skills. Erdoğan & Erben (2020) examined gifted students' use of predictive strategies while measuring. Predictive strategy development is accepted as one of the indicators of number sense (Jordan et al, 2007). According to the results of the study, gifted students do not differ from their typical peers in creating predictive strategies. Similarly, in a study conducted by Montague & van Garderen (2003), it was stated that gifted students had low predictive measurement skills. When Baroody & Gazke (1991) examined the use of estimation strategies by potentially gifted preschool children, it was found that these children were quite successful. The contrasts in the findings related to the number sense skills of gifted students in the literature show that more studies should be done in this context.

Problem of Study

Number sense and components is within the abilities that express mathematical talent (Davis & Rim, 2004). Also, using stratiges in contex of number sense is an important real-life skill (Montague & van Garderen, 2003). As a result of the literature review, it was seen that there were limited and contradictory findings on the number sense skills of gifted students. There is a need for studies that measure the number sense skills of students at different grade levels. This study aimed to develop a three-tier test that identify mathematical talent in the context of number sense skill. Within the scope of the study, the answer to the question "Would a three-tier number sense test be developed to identify mathematical ability?" was sought.

Method

Research Model

In this research, validity and reliability analysis is performed for the development of the "Three-Tier Number Sense Test". The study was designed by survey method. In survey research, it is a scientific method applied by critically analyzing, interpreting, generalizing and estimating source materials (Salaria, 2012).

Participants

A total of 499 secondary school students (143 fifth grade, 126 sixth grade, 117 seventh grade, 113 eight grade) in Izmir in Turkey volunrarily participated in this study. The age range of the participants varies between 11-14 ages. The participants contained from schools with various levels of socioeconomic status. Data from the participants were collected in the 2019-2020 academic year.

According to the standards of National Council of Teachers of Mathematics [NCTM] (2000), students from pre-school to the end of the secondary education period must have gained number systems, the relationship numbers and operations, the meaning of operations, multiple representations of quantities, appropriate estimation, reasoning for solving math problems. In addition, it is deduced from these standarts, students should have acquired advanced number sense skills (Reys, 1991). Since a student is expected to have developed achievements in the context of number sense by the end of primary education, it was thought that the most appropriate time to evaluate number sense as a predictor of mathematical talent was secondary school age. Therefore, secondary school students were chosen as the target sample.

Instrument

Studies with tests evaluating number sense were examined and a conceptual framework was created. The most detailed classification for number sense was made by McIntosh et al. (1992). In this classification, he created a conceptual framework for the sense of number. The conceptual framework has three main components for number sense: Numbers, operations, applications of numbers and operations. The authors stated that it would not be helpful to describe all possible components of number sense as number sense, because number sense develops and expands with age (p.5). [NCTM] (2000) grouped number sense into 5 sub-components: Having a good sense of numbers, Developing multiple relationships between numbers, understanding the relative magnitudes of numbers, knowing the relative effects of operations on numbers, being able to develop references for measurements of objects and situations in their environment.

Resnick (1989) grouped possible indicators of number sense into 7 categories: Using well-known number effects, judging whether a number plausibly satisfies the solution of the problem, approaching a numerical answer rather than calculating the exact result, decimal of the number system to parse and recombine numbers in simple operations, making sense of situations involving numbers and quantities, talking about numbers and their relationships, having an understanding of the relative magnitudes of numbers and quantities, switching flexibly between different possible representations of a quantity.

Based on the definitions and characteristics of number sense in the literature, Markovits & sowder (1994) compiled the behaviors that occur in the presence of number sense: Combining and separating numbers, moving flexibly between different representations, comprehending the relative size of numbers, dealing with the absolute size of numbers, using reference points, combining numbering, operation and relation symbols in a meaningful way, understanding the effects of operations on numbers, making mental operations with "discovered" strategies to take advantage of numerical and operational properties, using numbers flexibly to predict numerical answers of operations, interpreting of numbers.

Reys et al. (1998) used some definitions in the framework they created to develop the number sense test: Understanding the meaning and magnitude of the number, understanding and using the equivalent representations of the number, understanding the meaning and effect of operations, use and meaning of synonyms, mental operation, written operation and calculator, flexible operation strategies, measurement references.

According to the conceptual framework Yang (2019) created: Understanding the meaning of numbers, understanding the magnitude of numbers, using measurement references appropriately, understanding the relative effects of operations on numbers, developing different strategies appropriately, and judging the reasonableness of answers.

Although there are many studies on the sense of number, it has been seen that the boundaries of the concept cannot be drawn and a common terminology cannot be established for the components. Different nomenclatures are used for components covering the same skill. In this study, while determining the components of number sense, a conceptual framework was formed by considering the cognitive characteristics of the age group, the official mathematics program and the purpose of the study.

The designed Three-Tier Number Test incorporates the aforementioned five number sense components based on earlier studies (Resnick, 1989; McIntosh et al., 1992; Markovits & Sowder, 1994; Reys et al., 1998; [NCTM], 2000; Yang, 2019). Each component consists of five items; therefore, the Three-Tier Number Test contains 25 items.

Treatment of Data

According to previous studies on the number sense two-tier test (Yang & Lin, 2015) and three-tier test (Peşman & Eryilmaz, 2010), the scoring rules were defined following the criteria in Table 1. Scoring of the test is done in three stages. The first stage of the questions is true and false; The second stage, called the causality section, is in the form of gradual scoring; The ratio between the answer given in the self-confidence section and the level of confidence was examined.

Table 1. Scoring Rules for the Three-tier Number Sense Test

1st ve 2nd Stages					
Number sense test (1st tier)	Correct answer 4 Points				Wrong answer 0 Points
Reason options (2nd tier)	Number sense-based 4 Points	Rule-based 2 Points	Misconception 1 Points	Guessing 0 Points	0 Points
Score given	8 Points	6 Points	5 Points	0 Points	0 Points
			3rd Stages		
Confidence (3rd tier)	Very confident	Confident	Neutral	Unconfident	Very Unconfident
Score given	5	4	3	2	1

The participants' number sense performance (first two-tier test) was divided into the following four groups: (1) high number sense (NS), in which the average score was 6-8; (2) medium number sense, in which the average score is 4-6; (3) low number sense, in which the average score is less than 4.

To summarize, the correct answer to the test question the student gets 4 points from the first stage. In the reason section, he gets 4 points if he chooses an explanation for the sense of number as the reason for solving the question, and 2 points if he chooses a rule-based explanation. Even if the student gave the correct answer, if he chooses the answer related to a misconception arising from a confusion of information, the score he will get from the second stage will be 1, and if the guess result has reached the correct result, the score he will get will be 0.

To explain through the sample question item in Figure 1, if the student marks option C, that is, the correct answer, he gets 4 points from the first stage. If he chooses option C in the second stage, that is, the solution based on number sense, he gets 4 points from this stage. The first-second stage total score is 8. The highest score a student can get from a question item is 8. The highest score to get from the whole test is 200. While the confidence stage shows the belief that the student has solved the question correctly, it is not included in the scoring.

Problem 1: 71008 = (8 × 1) + (□ × 100) + (7 × 10000) ise □ = ?

A) 0
B) 1
C) 10
D) 100

I chose option **A** Because:	1.	□ symbol represents the hundreds digit, so it must be zero.
	2.	The next digit in the analysis must be zero.
	3.	I made a guess.
I chose option **B** Because:	1.	□ symbol represents the thousands digit, so it should be 1.
	2.	The next digit in the analysis should be 1.
	3.	I made a guess.
I chose option **C** Because:	1.	10 should be written instead of 1 because it is multiplied by 100 instead of 1000. 1 × 1000 = 10 × 100
	2.	(8 × 1) + (□ × 100) + (7 × 10000) = 71008 square must be 10. well 70000+ 1000+8
	3.	The digits to be resolved are 7, 10 and 8. Therefore, the answer is 10.
	4.	I made a guess.
I chose option **D** Because:	1.	□ symbol represents the hundreds digit, so it must be 100.
	2.	7, 100 and 8 resolved. The next number in the analysis should be 100.
	3.	I made a guess.

How sure are you that your answer is correct?

Very Confident	Confident	Neutral	Unconfident	Very Unconfident

Figure 1. Three-Tier Number Sense Test Sample Item

Results

Cycles of the Action Research Process

Before the test questions were created, researches including number sense and its components were examined in chronological order. Then, tools developed to measure number sense skills were examined. In the first studies to determine number sense, researchers used written forms of information evaluation, aiming to save time. It was found appropriate for students to produce answers with their own formulas in terms of examining the variable to be measured (Berch, 2005). With this format, researchers were given the chance to observe students' misconceptions. However, over time, these forms began to be seen as insufficient to identify misconceptions (Whitacre, Henning, & Atabaş, 2020). It has been determined that students are reluctant to write full sentences and give detailed answers (Yang & Tsai, 2010; Yang, 2007). Due to time constraints, few open-ended questions can be asked to students. For such reasons, tests consisting of multiple choice questions have become popular among researchers over time (Çekirdekçi, Şengül, & Doğan, 2016). These research designs have been found to be very time efficient as they can cover a large number of topics and include many tasks (McIntosh et al., 1997; Singh, 2009). However, this format has been criticized for its high probability of predicting the correct answer (Yang, Li & Lin, 2008). For this reason, researchers have developed a new test form, namely tests consisting of two or three-tier tasks (Yang, 2019).

Two-tier tests consist of two parts. The first part contains content problems with multiple choice questions, while the second part contains a reasonable explanation of the problem presented in the first stage of the task. Multi-tier tests reduce the probability of students guessing the correct answer. The use of two-tier tests allows teachers and researchers not only to understand students' misconceptions, but also to discover the logic behind them (Peşman & Eryılmaz, 2010). In addition, these tests facilitate efficient and simple examination and assessment of misconceptions in a wide range of subjects, as they are practical and the time required to take place keeps the available teaching time to a minimum. Since the results obtained through two-tier tests were not considered sufficient to show the difference between misconceptions and lack of knowledge, and between understanding and lucky guesses, a new layer called the "confidence" stage was added in addition to the "content" and "reason" stages, and three-tier tests were added. (Caleon and Subraminiam, 2010; Yang and Lin, 2015).

Adding the third stage to the tests provides valuable information about students' self-confidence (Peşman & Eryılmaz, 2010). If the student is not sure about the answers given in the first and second tiers, it can be concluded that the correct answers are the result of guesswork. On the other hand, it is thought that a student who gives the correct answer at only one stage and states that he is sure of his answer may have a misconception (Milenković, Hrin, Segedinac, & Horvat, 2016). Three-tier tests greatly reduce students' misconceptions and lack of scientific knowledge and significantly increase the validity of study results (Stankov & Crawford, 1997; Sia, Treagust & Chandrasegaran, 2012). As a result of the theoretical information and literature review, it was decided to develop a number sense test suitable for the secondary school mathematics curriculum of Turkey, based on the three-tier number sense test developed by Yang (2019).

During the development of the test;

- Determining the sub-components of the three-stage number sense test,
- Determining the achievements in the middle school mathematics program of Turkey that are related to the number sense,
- Creating mathematical questions for the achievements found to be related to the number sense,
- The steps of making the reliability and validity of the test were followed.

A literature review was conducted to decide on the sub-components of the three-tier number sense test. Although number sense has been defined in various ways by researchers, it has been observed that there is a great deal of consensus on its sub-components (Sowder, 1992; Markovits and Sowder, 1994; McIntosh et al., 1997; Yang and Li, 2008; Faulkner and Cain, 2009; Yang, 2019). These subcomponents are,

- Ability to understand the basic meanings of numbers and operations,
- Ability to recognize number sizes,
- Ability to use multiple representations of numbers and operations,
- Ability to recognize the relative effects of operations on numbers,
- Ability to develop different strategies as appropriate and evaluate the reasonableness of an answer.

The process cycle after deciding on the number sense sub-components is given in the figure 2.

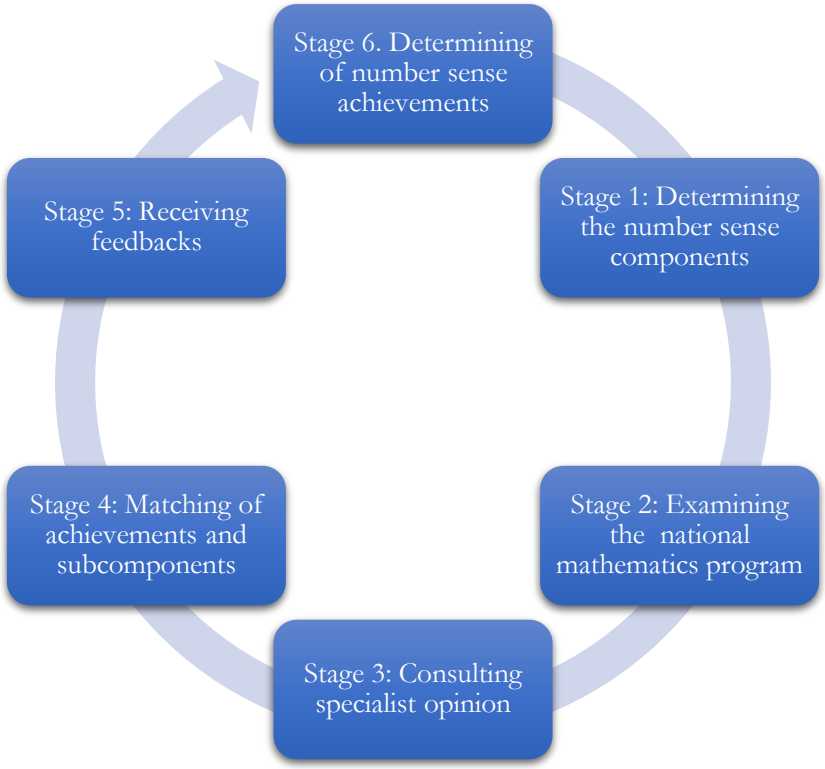

Figure 2. Determining the Achievements Related to Number Sense in the National Mathematics Program

After determining the number sense components, the achievements related to number sense in mathematics programs from the fifth to the eighth grade were examined. Opinions were received from a mathematician and a mathematics teacher for the compatibility between the achievements and the sub-components of number sense. Opinions were collected with a form in which the achievements and number sense components were included. In this form, compatible, incompatible and explanation boxes are included for each achievement and related number sense subcomponent. It was accepted that the common achievements found compatible by the researcher, mathematician and mathematics teacher were related to the sense of number. At the end of the process, it was concluded that in the middle school mathematics curriculum, 31 acquisitions of the fifth grade, 33 acquisitions of the sixth grade, 28 acquisitions of the seventh grade and 25 acquisitions of the eighth grade were related to the number sense.

Reliability and Validity

Number sense questions was collected in the question pool by the researcher. A total of 60 questions were selected from various mathematics books. Opinions were received from two mathematician on the appropriateness of the questions. In addition, opinions were received from two special education professionals, a mathematic teacher and a special education teacher for the number of questions expected to be included in the test. For the first tier, a total of 40 items, eight for each sub-component of number sense, were determined.

Opinions were received from three mathematics teachers, a special education professional and a mathematician for the validity of the test. Professionals and teachers were asked to evaluate the items in the draft test in terms of content validity. Professionals opinions on the validity of the questions were obtained using an professional evaluation form consisting of open-ended questions. The expert evaluation form was prepared using a two-response format as

"appropriate" and "not appropriate". If the answer is not suitable, it is requested to write the reason in the explanation section. In accordance with the feedback of each, the questions in the test were reviewed and necessary corrections were made. Considering professionals opinions, it was decided that the test would consist of a total of 25 items, 5 for each sub-component. The distractors of the multiple-choice questions were created with three mathematics teachers by making use of the misconceptions in the literature.

The pilot application of the test was applied with a total of 106 students, including 32 students attending 5th grade, 28 students attending 6th grade, 29 students attending 7th grade and 17 students attending 8th grade. The results of the item difficulty and item discrimination index calculated through the Excel program after the pilot application are given in Table 2.

Table 2. Item Analysis of the Three-tier Number Sense Test

Item	Difficulty	Discrimination Values
1	0,64	0,46
2	0,28	0,33
3	0,51	0,36
4	0,64	0,49
5	0,51	0,50
6	0,76	0,50
7	0,58	0,63
8	0,77	0,45
9	0,29	0,42
10	0,46	0,39
11	0,65	0,54
12	0,74	0,40
13	0,45	0,55
14	0,72	0,43
15	0,65	0,45
16	0,52	0,49
17	0,35	0,37
18	0,46	0,49
19	0,72	0,51
20	0,41	0,39
21	0,30	0,41
22	0,44	0,45
23	0,25	0,53
24	0,78	0,35
25	0,59	0,33
$\bar{x}$	0,54	0,45

As the item difficulty value approaches zero, the question becomes more difficult, and when it approaches one, the question becomes easier. In order to strengthen the reliability of the test, it is expected that the item difficulty will be at the level of 0.5, that is, the questions of the test will generally consist of questions of medium difficulty. In addition, easy and difficult questions are also included in the tests (Büyüköztürk et al., 2010). The items in the test are grouped according to their difficulty levels in the table 3. The average difficulty of the three-tier number sense test was calculated .54. Since the value found was close to 0.50, it was considered as a medium difficulty test.

Table 3. Difficulty Levels of the Questions in the Three-tier Number Sense Test

	Easy	Medium	Hard
Items	1,4,6,8,11,12,14,15,19,24	3,5,7,10,13,16,18,20,22,25	2,9,17, 21,23

The fact that the discrimination indexes of the questions are between 0.30-0.40 indicate that they distinguish the students in the lower and upper groups at a good level with their answers to the test, and that the index scores of .40 and

above indicate that the discrimination is at a very good level (Büyüköztürk et al., 2010). When the item discrimination indexes of the three-tier number sense test are examined, it is seen that all 25 questions have good and very good discrimination.

After the preliminary analysis of the test with the pilot study was completed, the three-tier number sense test was applied to 499 middle school students. The reliability coefficient of the first tier items of the test, which was calculated as .81 with the Kr-20 formula. The Kr-20 reliability coefficient of the test was calculated together with the second tier items was found .74.

Conclusion

In the study, item analysis, validity and reliability processes of the three-tier number sense test were included. The three-tier number sense test consists of 25 items. The first tier of the test consists of multiple-choice questions, the tier stage consists of items containing the reasons for the answers given in the first tier, and the items to measure the confidence in the answer given to the third tier question. The analysis of the data obtained in the study was made in the SPSS 21 program. The KR-20 confidence coefficient of the test was calculated as .74. From the results of the analysis, it is seen that the developed achievement test is a valid and reliable measurement tool that can be used to measure the number sense levels of middle school students.

Considering the findings obtained from the study, it is thought that, provide the necessary feedback to researchers to create a three-stage achievement test, the three-tier number sense test can provide teachers with necessary information about the number sense development of students, the introduction of the three-tier number sense test to the use of teachers will play an important role in increasing the mathematics achievement of middle school students.

Limitations of Study

This study was applied in several schools in Izmir in Turkey. Data collection from a single city is a limitation for the study. Similar studies can be diversified with data collected from different regions. Another limitation of the study was that the number sense test only included secondary school children. Since the sense of number is a developing and changing structure, studies on different age groups will contribute to the field. It is difficult to define the existence of the sense of number, so the tests created with different questions and structures will defeat the studies in this scope.

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Sıla Doğmaz Tunalı has been a research assistant of special education department at the Dokuz Eylul University since 2013. She graduated from the special education doctorate program in June 2022. She is interested in mathematics talent, mathematics learning disability and metacognitive skills. One of the future research goals is to investigate the ways gifted students use their number sense skills.

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Appendix 1. Turkish Version of Three Tier Test for Number Sense (for Secondary School Students)

Üç Aşamalı Sayı Hissi Testi-Ortaokul Düzeyi İçin

Sınıf: **Cinsiyet** : Kız ( ) Erkek ( )

Açıklama: Soruları çözün ve cevabınızı işaretleyin. Ardından açıklamalardan işaretlediğiniz cevabı seçme nedeninizi seçiniz. İşaretlediğiniz açıklama, sorunu çözmek için kullandığınız yöntemi içermelidir. Bu adımdan sonra cevabınızın doğru olduğundan ne kadar emin olduğunuzu işaretleyiniz.

Soru 1. 796 + 484 = 1280 olduğuna göre 7,96 + 4,84 işleminin sonucu kaçtır?

A) 1,28
B) 0,1280
C) 12,8
D) 1280

A şıkkını şeçtim Çünkü:	1.	7,96 + 4,84 = 1,280 virgüllü olacaksa bu şekilde olur.
	2.	Bir tahminde bulundum.

B şıkkını şeçtim Çünkü:	1.	7,96 + 4,84 = 0,1280 çünkü 4 basamak virgül ile sola ilerlenir.
	2.	Bir tahminde bulundum.

C şıkkını şeçtim Çünkü:	1.	Soldaki işleme göre 2 basamak virgül atmak yeterli olacaktır. Yani 12,8 olur.
	2.	7,96 + 4,84 = 12,80 yani 12,8 olur.
	3.	Bir tahminde bulundum.

D şıkkını şeçtim Çünkü:	1.	7,96 + 4,84 = 1280 olur.
	2.	Bir tahminde bulundum.

Cevabınızın doğruluğundan ne kadar eminsiniz?				
Çok eminim ( )	Eminim ( )	Kararsızım ( )	Emin değilim ( )	Hiç Emin Değilim ( )

Soru 2. 1234 ÷ 5 × 6 işlemine göre aşağıdakilerden hangisinin sonucu bu işlem ile aynıdır?

A) 1234 ÷ (5 × 6)
B) 1234 × 6 ÷ 5
C) 1234 ÷ 6 × 5
D) 5 × 6 ÷ 1234

A şıkkını şeçtim Çünkü:	1.	İşlemde ki sayıların yerleri aynı olduğu için.
	2.	Sayıları paranteze almak sonucu değiştirmez.
	3.	Bir tahminde bulundum.

B şıkkını şeçtim Çünkü:	1.	İşlemde, bölü 5 ve çarpı 6 'nın yerlerinin değişmesi sonucu etkilemez. Bölme ve çarpmanın birbirine göre işlem önceliği yoktur.
	2.	Öğretmenimiz çarpma ile bölmenin yer değiştirebileceğini söylemişti.

	3.	Bir tahminde bulundum.

C şıkkını şeçtim Çünkü:	1.	5 ve 6 rakamların yerlerinin değişmesi sonucu etkilemez.
	2.	Bir tahminde bulundum.

D şıkkını şeçtim Çünkü:	1.	Aynı işlem sadece rakamlarının yerleri değişmiş.
	2.	Bir tahminde bulundum.

Cevabınızın doğruluğundan ne kadar eminsiniz?				
Çok eminim ( )	Eminim ( )	Kararsızım ( )	Emin değilim ( )	Hiç Emin Değilim ( )

Soru 3. Aşağıdaki işlemlerde yer alan "□" şeklinin temsil ettiği sayı hangi işlemde en büyüktür?

A) □ + 39 = 195
B) □ – 39 = 195
C) □ x 39 = 195
D) □ ÷ 39 = 195

A şıkkını şeçtim Çünkü:	1.	Toplama işleminde artış olduğu için □ en büyüktür.
	2.	Bir tahminde bulundum.

B şıkkını şeçtim Çünkü:	1.	□ 'den 39 çıkarılmış yine 195 olmuş. O halde en büyük çıkarmada olmalıdır.
	2.	Bir tahminde bulundum.

C şıkkını şeçtim Çünkü:	1.	Çarpma işleminde sayılar hep büyüyor. O halde çarpmada □ en büyüktür.
	2.	Bir tahminde bulundum.

D şıkkını şeçtim Çünkü:	1.	□ 39 parçaya bölünmüş ve 195 çıkmış. □'nin baya büyük olması gerekir.
	2.	Bütün işlemleri yaptım. □ en büyük bölme işleminde çıktı.
	3.	Bir tahminde bulundum.

Cevabınızın doğruluğundan ne kadar eminsiniz?				
Çok eminim ( )	Eminim ( )	Kararsızım ( )	Emin değilim ( )	Hiç Emin Değilim ( )

Soru 4. 755 ◊ 5 = 151
36 □ 3 = 108
71 ○ 17 = 54
Verilen eşitliklerde dörtgen, kare ve daire şekillerinin yerine aşağıdakilerden hangisi gelmelidir?

	◊	□	○
A)	÷	×	-
B)	x	-	÷
C)	-	+	-
D)	÷	+	-

A şıkkını şeçtim Çünkü:	1.	İlk işlemde sayılar arasındaki fark fazla ancak bölme ile olur. İkinci işlemde sayı çok artmış çarpma olabilir. 3. Adımda az küçülmüş çarpma olabilir.
	2.	Bütün işlemleri deneyerek yaptım.
	3.	Bir tahminde bulundum.

B şıkkını şeçtim Çünkü:	1.	Sonuncusu bölme olacağı için.
	2.	Bir tahminde bulundum.

C şıkkını şeçtim Çünkü:	1.	1. ve 3. İşlemde azalma 2. İşlemde artma var o yüzden -,+,- olmalıdır.
	2.	Bir tahminde bulundum.

D şıkkını şeçtim Çünkü:	1.	Birinci işlem çok azalma yani bölme, ikinci işlem artma yani toplama, 3. İşlem azalma yani çıkarmadır.
	2.	Bir tahminde bulundum.

Cevabınızın doğruluğundan ne kadar eminsiniz?				
Çok eminim ( )	Eminim ( )	Kararsızım ( )	Emin değilim ( )	Hiç Emin Değilim ( )

Soru 5. İki basamaklı bir sayı ile üç basamaklı bir sayının çarpımının sonucu için aşağıdakilerden hangisi söylenebilir?

A) Daima 4 basamaklı bir sayıdır
B) 3 veya 4 basamaklı olabilir
C) Daima beş basamaklı bir sayıdır
D) 4 veya 5 basamaklı bir sayı olabilir

A şıkkını şeçtim Çünkü:	1.	10 x 100 =1000 yani dört basamaklı bir sayıdır.
	2.	Bir tahminde bulundum.

B şıkkını şeçtim Çünkü:	1.	İki basamaklı bir sayı üç basamaklı bir sayının çarpımının 3 basamaklı olması gerekir.
	2.	Bir tahminde bulundum.

C şıkkını şeçtim Çünkü:	1.	90 x 900 = 81000 yani beş basamaklıdır.
	2.	Bir tahminde bulundum.

D şıkkını şeçtim Çünkü:	1.	Sayılardan birisi 3 basamaklı olduğu ve diğeri 1 basamaklı olmadığı için 3 basamaktan fazla olacağı kesindir. 3 den daha büyük bir rakamla başlayan sayıların çarpım sonucu 1 basamak daha fazla olur. (30 x 300 =900, 40 x 300 = 12000) yani 4 veya 5 basamaklı olabilir.
	2.	10 X 100 = 1000 99 X 999 = 98 901 yani 4 veya 5 basamaklı olabilir.
	2.	Bir tahminde bulundum.

Cevabınızın doğruluğundan ne kadar eminsiniz?				
Çok eminim ( )	Eminim ( )	Kararsızım ( )	Emin değilim ( )	Hiç Emin Değilim ( )

Appendix 2. English Version of Three Tier Test for Number Sense (for Secondary School Students)

Three Tier Number Sense Test (for Secondary School Students)

Grade: **Gender :** Female ( ) Male ( )

Instruction: Solve the problems and mark your answer. Then, select the reason for choosing the answer you marked from the explanations. The description you mark should include the method you used to solve the problem. After this step, mark how sure you are that your answer is correct.

Q 1. Since 796 + 484 = 1280, what is the result of 7.96 + 4.84?

E) 1,28
F) 0,1280
G) 12,8
H) 1280

A Reason for choosing	1.	7,96 + 4,84 = 1,280 If there is a comma, it will be like this.
	2.	I guessed.

B Reason for choosing	1.	7,96 + 4,84 = 0,1280 because 4 digits move to the left with a comma.
	2.	I guessed.

C Reason for choosing	1.	According to the operation on the left, it will be sufficient to throw 2 digits of commas. So it would be 12.8.
	2.	7,96 + 4,84 = 12,80 so 12,8.
	3.	I guessed.

D Reason for choosing	1.	7,96 + 4,84 = 1280
	2.	I guessed.

How sure are you that your answer is correct?				
Very Confident	Confident	Neutral	Unconfident	Very Unconfident

Q 2. According to the operation 1234 ÷ 5 × 6, which of the following has the same result as this operation?

E) 1234 ÷ (5 × 6)
F) 1234 × 6 ÷ 5
G) 1234 ÷ 6 × 5
H) 5 × 6 ÷ 1234

A Reason for choosing	1.	Because the places of the numbers in the operation are the same.
	2.	Bracketing the numbers does not change the result.
	3.	I guessed.

B Reason for choosing	1.	In the operation, swapping the places over 5 and times 6 does not affect the result. Division and multiplication have no precedence over each other.
	2.	Our teacher said that multiplication and division can be replaced.
	3.	I guessed.

C Reason for choosing	1.	Changing the places of the 5 and 6 digits does not affect the result.
	2.	I guessed.

D Reason for choosing	1.	It's the same process, only the places of the digits have changed.
	2.	I guessed.

How sure are you that your answer is correct?				
Very Confident	Confident	Neutral	Unconfident	Very Unconfident

Q 3. In which operation is the number represented by the shape "□" in the following operations the greatest?

E) □ + 39 = 195
F) □ – 39 = 195
G) □ x 39 = 195
H) □ ÷ 39 = 195

A Reason for choosing	1.	Since there is an increase in addition, □ is the largest.
	2.	I guessed.

B Reason for choosing	1.	39 was subtracted from □ and it became 195 again. So it should be in the greatest subtraction.
	2.	I guessed.

C Reason for choosing	1.	In multiplication, numbers always get bigger. Then □ is the largest in multiplication.
	2.	I guessed.

D Reason for choosing	1.	□ It was divided into 39 parts and 195 came out. □ has to be pretty big.
	2.	I did all the operations. □ is output in the largest division operation.
	3.	I guessed.

How sure are you that your answer is correct?				
Very Confident	Confident	Neutral	Unconfident	Very Unconfident

Q 4. 755 ◊ 5 = 151
36 □ 3 = 108
71 ○ 17 = 54
Which of the following should replace the quadrilateral, square and circle shapes in the given equations?

	◊	□	○
A)	÷	×	-
B)	x	-	÷
C)	-	+	-
D)	÷	+	-

A Reason for choosing	1.	In the first operation, the difference between the numbers is large, but this happens with division. In the second operation, the number increased a lot, this multiplication may be possible. The number decreased in the third operation. The reason may be the multiplication.
	2.	I tried all the steps.
	3.	I guessed.

B Reason for choosing	1.	I think the last operation is division.
	2.	I guessed.

C Reason for choosing	1.	There is a decrease in the 1st and 3rd processes, there is an increase in the 2nd process, so it should be -,+,-.
	2.	I guessed.

D Reason for choosing	1.	The first operation is much reduction, that is, division, the second operation is increase, that is, addition, the third operation is decrease, that is, subtraction.
	2.	I guessed.

How sure are you that your answer is correct?				
Very Confident	Confident	Neutral	Unconfident	Very Unconfident

Q5. What can be said about the result of multiplying a two-digit number with a three-digit number?

A) It is always a 4-digit number
B) It can be 3 or 4 digits
C) It is always a five-digit number
D) It can be a 4 or 5 digit number

A Reason for choosing	1.	10 x 100 =1000 that is a four digit number.
	2.	I guessed.

B Reason for choosing	1.	A two-digit number multiplied by a three-digit number must have 3 digits.
	2.	I guessed.

C Reason for choosing	1.	90 x 900 = 81000 5 digits.
	2.	I guessed.

D Reason for choosing	1.	Since one of the numbers has 3 digits and the other is not 1 digit, it is certain that it will be more than 3 digits. Multiplying numbers starting with a digit greater than 3 is 1 digit more. (30 x 300 = 900, 40 x 300 = 12000) so it can be 4 or 5 digits.
	2.	10 X 100 = 1000 99 X 999 = 98 901 four or five digits
	2.	I guessed.

How sure are you that your answer is correct?				
Very Confident	Confident	Neutral	Unconfident	Very Unconfident

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Research Article

Cooperation between gifted students and university staff: a micro case study of the Preliminary Academic Research Project (PARP) in Germany

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Abstract

The Preliminary Academic Research Project (Besondere Lernleistung, abbreviated as BeLL) is a self-chosen, but also self-responsible contribution of a student to increase the ability to study and to prepare for university studies. By working on a Preliminary Academic Research Project (PARP), students demonstrate complex action competence and further develop their communicative and cooperative skills. This micro case study highlights the importance of working with external partners at universities and shows, from the perspective of an external supervisor, what is expected of actors in the process of creating a PARP and how such work can contribute to the promotion of gifted and high-achieving students in the form of enrichment. To this end, the content and formal requirements of a PARP are presented and placed in the context of the timeline of the work process from a praxeological angle. Based on the theoretical and legal framework of a PARP as well as experience, this micro case study aims at making suggestions on how to support the mentees in the work process in order to provide the external supervisors with a clearer picture of the requirements for their role.

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Introduction

For over a decade, most German states have offered academic high school students the opportunity of completing a Preliminary Academic Research Project (PARP) as part of attendance at the upper secondary level (*Gymnasiale Oberstufe* or *Sekundarstufe II*, Years 11-13) and including it as an achievement within the general higher education entrance qualification (*Allgemeine Hochschulreife*, commonly referred to as *Abitur*). In such a complex achievement, students are expected to work independently in a subject area and address a question in accordance with scientific requirements (as far as this is possible at school). A PARP is particularly suitable for promoting gifted and high-achieving learners as it takes a lot of time and requires a high degree of motivation and perseverance. In the long run, however, it brings a great gain with a view to later life, since it promotes independent work and prepares students for

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the demands of scientific studies.

The Current State of Research: School-University Partnerships in Gifted Education

By establishing an elective element of pre-academic training such as the Preliminary Academic Research Project (PARP) at the upper secondary level, educational officials have emphasized recognizing and rewarding youngsters who are considered exceptionally gifted. Various organizations, from parent associations to charitable endowments, work together to satisfy the unique needs of gifted and high-achieving children, fostering communication and collaboration within themselves and with other institutions as well as organizations. For the case of Germany, Fischer and Müller (2014) claim that the country does not have a unified national policy for gifted education or talent assistance due to being challenged by networking on educational matters across the separate federal states (pp. 34, 50-51). The 16 states might gain insight from one another if they shared information and ideas on how they put ability promotion into practice. The authors emphasize that the integration of the ideas of gifted education and talent support into many contexts, such as inclusive education or the results of international comparative research, could lead to further development. On the other hand, Abdrafikova et al. (2014) look at how other states have dealt with the challenge of educating exceptional children in the modern era. One of the most effective education methods for working with gifted children is engaging them in projects and research (p. 54). Their article illustrates how the "school-university" paradigm (as represented by the collaboration of a student with a university instructor within the context of a PARP) can be used by (student-)teachers and students in gifted and high-achieving classrooms to organize integrated projects and research activities. Abilities, brilliance, and talent are all classified according to the same standard: the level of achievement (p. 55). Consequently, according to the authors, the modern understanding of giftedness is that it is not a fixed characteristic but rather a dynamic one, denoting a skill that exists only in motion, in development, and as a result, its growth necessitates particular environments such as the academic context of universities and other research institutions.

In his 2021 contribution to a compilation, Tortop (2021) delves into the *Education Program for the Gifted Students' Bridge with University* (EPGBU) a vital example of school-university collaboration. Turkey's school system has catered to the gifted for a considerable amount of time since the country acknowledges the gifted to be its brightest students and some of its most valuable assets. Currently, many Turkish students who are considered to be gifted and/or high-achieving have access to mentorship and E-mentoring programs (pp. 145-146). Practical examples of how to improve self-regulation, scientific creativity, thinking skills, the scientific process, and research skills are abundant in the EPGBU program described by Tortop (2021), making it a valuable model for interventions with the gifted and/or high-achieving all over the world (pp. 176-177). Furthermore, the researchers Piske et al. (2021) have recently published a comprehensive guide to recognizing and nurturing talent in gifted learners. Each chapter invites readers to consider the evolution, philosophy, and current state of gifted education and high IQ programs worldwide.

While everyone may agree that not every partnership is the same, existing partnership hierarchies assume some alliances are healthier than others . Research done by Behrens and Roberts (2021) provides a new classification system for describing educational partnerships, one that is grounded in the results of a comprehensive study of charter schools across the United States. The findings by Behrens and Roberts (2021) and Mofield and Phelps (2020) note that different types of partnerships can be identified by the means by which they are formed, the nature of the services they provide, and the degree of organizational participation. According to the latter, their monograph offers practical ideas for making collaborations among gifted teachers and professionals beyond being well-mannered to each other. To encourage students to study, teachers might rely on several types of enrichment pedagogy that could serve as an illustration of the nature of a PARP (Reis et al., 2021). In their article, they list measures such as differentiation and curriculum compacting, interest-based learning pedagogy, project-based learning, the application of creative productivity to student learning, and open-ended choice along with the contributions of gifted education to the development of these strategies.

Research Question

The field of gifted education spans a broad range of different approaches, models and theories. This variety is also

reflected in the diverse body of people who are involved in it. Academic staff such as university instructors and researchers can serve as agents of change for school education by establishing specific practices related to the promotion of science propaedeutics in gifted and high-achieving students (Mannewitz, 2020) . However, the number of respective programs tailored to the needs of the aforementioned target group is limited in terms of their scope and variety at a local as well as global level (Tortop, 2021). Therefore, examining such practices in detail can contribute to the dissemination and sustainability of the assets these programs hold for the expansion of gifted education to the realms of academia. This micro study is aimed at considering the case of the Preliminary Academy Research Project (PARP) as one potential approach to school-university collaboration in Germany. Accordingly, this article focuses on the following research question:

- Which affordances (potentials) does a PARP offer to university staff as well as to gifted and high-achieving school students regarding its value for the promotion of pre-academic learning and science propaedeutics within the context of the German education system?

Method

The topic presented in this article is mainly pertinent to the praxeological research paradigm as this approach often serves to make the tacit dimensions of what is experienced visible (Herbert & Kraus, 2013). Based on relevant literature, the German PARP regulations as well as on experience, this micro study sets out to explore this type of project work for school students as a model for school-university collaboration. Departing from the provisions made by legal documents, the article describes the general structure and process of a PARP. Moreover, it offers experience-based reflections on the educational affordances originating from the completion of such a project. In line with the Affordance Theory (Gibson, 1979; Gaver, 1996), attention is drawn to the productive links of the perceptions made in the process of supervising a PARP to the actions derived from those perceptions by the (external) supervisor, e.g. at a university. These links are primarily established by considering the needs as well as the prior knowledge that school students bring to the learning setting once they embark on the journey of working on such a formal research project. Finally, the scientific format of the micro case study was chosen for presenting the affordances of a PARP as it combines the pithiness of a scientific overview with the conventionalized procedures of qualitative research. Even though this term might not be frequently used in educational research, a micro case study can be defined as the analysis of cases "that occur in a brief time frame, [... as well as] in a confined setting, and are simple and straightforward in nature" (Alpi & Evans, 2019, p. 2). Consequently, such a study is very brief and relates to a clear problem of interest. Moreover, it can be adapted to reflect the praxeological perspective as it does not necessarily need to rely on a multitude of artifacts, interviews, or observations. On the contrary, its richness of description facilitates the understanding of the findings from the case when considering various aspects within the context of a PARP.

Results

On the Classification of the Preliminary Academic Research Project (PARP) in the Context of the German Education System

In 1997, the Standing Conference of the Ministers of Education and Cultural Affairs (*KMK*) agreed that a Preliminary Academic Research Project (PARP) can be included in the *Abitur* examination. This agreement is part of measures to ensure the quality of the general higher education entrance qualification (Kultusministerkonferenz, 1997). This means that PARPs are not only to be found in the Free State of Saxony as shown here but are also envisaged in other federal states. The associated goals can be roughly described by the terms study ability, scientific propaedeutics and individualization of school education (Martin-Beyer & Mergenthaler-Walter, 1999). It should be noted that due to the aforementioned German educational federalism, the regulations for the implementation of PARPs differ in the respective federal states with regard to duration, period, scope, admission of group work and choice of topic. However, as a fundamental approach, preparation for later study forms the unifying element and thus assumes great importance. This is because, as in other countries, there are repeated complaints in Germany that school graduates are increasingly

less able to meet university requirements because they do not bring the respective knowledge and skills with them from school (Hoffmann & Henry-Huthmacher, 2016, pp. 5-6).

The Preliminary Academic Research Project (PARP) as an Element of the Academic High School (*Gymnasium*) Education

By working on a Preliminary Academic Research Project (PARP), students demonstrate complex action competence and further develop their communicative and cooperative skills. The students work their way into a subject-related topic, demonstrate as well as further develop their skills in the process of obtaining, processing, documenting and presenting information. They plan and structure their work independently over longer periods of time, present their work results coherently in writing and orally in different work phases and in different demand situations. The demands associated with the development of a PARP result primarily from the requirements that colleges and universities place on students. The PARP must be documented in writing and defended in a colloquium (Sächsisches Staatsministerium für Kultus, 2008, p. 2). In the case of Saxony, three different types of projects are permitted as part of the PARP (Sächsisches Staatsministerium für Kultus, 2021, p. 47):

- a comprehensive paper in an academic competition event sponsored by the Free State of Saxony, a comparable federal benchmark event, or an international benchmark event,
- an extensive work with scientific propaedeutic claim, as well as
- the completion of a comprehensive, also interdisciplinary project or internship.

In Saxony, there is no obligation to complete a PARP, so the decision to present it as part of the *Abitur* examinations (as a substitute for an oral examination in a subject from the school canon) is made individually by each student. Precisely because of this voluntary nature, the PARP is an ideal instrument for promoting giftedness in the sense of enrichment.

The PARP can include a practical component (e.g. independently developed artistic results, series of experiments, simulations or computer programs). Normally, each student has an internal supervisor who is a schoolteacher for the subject to which the chosen topic of the PARP can be most closely assigned. In many cases, however, the young researchers also look for an external supervisor at a university or research institution. In addition, there is also the possibility of contacting agents from various industries, administration or politics. On the one hand, these kinds of cooperation relieve the teachers at the school, for whom the supervision means a high degree of additional workload and responsibility. On the other hand, cooperation with such partners possibly contributes to the consolidation of study and career aspirations, because researchers at universities can engage with the needs of gifted students in a completely different way due to the academic setting.

The University as a Place for Promoting Giftedness

In this context, cooperation with universities and other research institutions makes a special contribution to strengthening the promotion of giftedness in schools. It picks up on the willingness of gifted young people to deal with specific subject problems and issues. In this way, work at a university cannot only enable learners to deepen their own knowledge in an interest-driven manner, but also foster independent problem-solving strategies and a keen interest in research-based activities. Beyond the material of traditional school subjects regulated by curricula, they experience a scientific discipline as a dynamic continuum with different contents, methods and approaches. The Preliminary Academic Research Project (PARP) as a new format of learning and working at school can be seen as a form of qualifying enrichment with regard to gifted education. The enrichment takes place with reference to a specific school subject, which is enriched, but the young people dealing with topics or subjects that are less common in the classroom. However, it is not only the internal supervisors (schoolteachers) and the learners concerned who are expected to meet certain requirements. It is also important for university instructors and researchers to be prepared to be engaged in this unique form of supervision of scientific work.

At the organizational level between school and university, clear arrangements from the beginning (e.g., drawing up a supervision agreement with achievable goals), regular exchange (e.g. discussion rounds with student, internal and

external supervisor) as well as the definition of time frames for certain work steps contribute to the successful completion of the PARP. In this context, it can be helpful for university researchers to bear in mind that many of these students likely have little knowledge of scientific work. More importantly, unlike university students, they have virtually no experience with inquiry-based learning and work. Therefore, it seems important to provide school students with clear formal guidelines for their work as well as content orientation in the form of joint literature research, etc. from the very beginning in order to enable them to learn independently in the long term and to support their development. In the sense of promoting giftedness, a mentor at the university should strengthen the learners' own ideas and give them freedom to work on the PARP without becoming nervous if it does not develop as desired at some point in relation to the work status. Many learners complete their PARP alongside the assessments, homework and extracurricular activities that usually characterize their school day.

The Process of the Preliminary Academic Research Project (PARP) from the Point of View of the External Supervisor

The development of a Preliminary Academic Research Project (PARP) is normally a long-term endeavor, so that approximately two years of supervision should be planned for the external supervisor at a university.

While some schools already have established partners, it is not unlikely that students will choose to contact an institute of a university by e-mail and ask about possibilities of supervision by an academic employee. At best, the candidates already have a concrete idea of a topic at this point, which would narrow down the selection of possible supervisors. Often, however, they do not yet know in which direction their research should move. It would therefore be desirable for the external supervisor (a university instructor/researcher) to first meet with the student to draw up a supervision agreement and a work plan. The agreement and plan will help to specify concrete work steps and deadlines. The following aspects can be included among others:

- choice of a research area and topic identification,
- agreement on the nature of the collaboration (reliability, responsibilities, rhythm of work meetings, etc.), and
- milestone plan for the completion of the PARP.

In order to provide guiding process support, it is desirable for the learner to meet with their external supervisor on a regular basis. Meetings at intervals of two to four weeks are possible. In order to create free space and prevent overload, the external supervisor should react flexibly if they notice that their protégé is confronted with numerous tasks at the same time at a certain point, or if the research work needs more time. After about half a year, roughly these steps should be completed:

- literature research, acquisition, selection and evaluation,
- structuring of the material, and
- determination/creation of a research design.

At this point, many schools require a concept defense. This concept defense may take the form of presenting an abstract or synopsis of the proposed PARP. The majority of internal supervisors at schools will be grateful to external supervisors for assistance at this point and will rely on the expertise of university staff. After successfully defending the concept, learners will enter a work phase in the second semester of working on the PARP, which will include these sub-steps:

- adapting the research design to the feedback on the concept,
- carrying out the investigation and evaluating the results, and
- consultation and discussion of the work with external and internal supervisors (if necessary, with the involvement of further experts).

At the end of the first year, the supervised student should start writing the rough version of their PARP. After the

summer break, they will complete the first version with its appendices. At this point, students in many federal states must also make the important decision as to whether they would like to replace another examination subject in the *Abitur* examinations with their PARP. They should be given regular opportunities to attend a consultation meeting and to discuss completed chapters of the written documentation, as in many cases there will still be a great deal of uncertainty in the area of scientific work due to their own inexperience - this applies not only to content, but above all to formal aspects (e.g. uniformity, references, bibliography). The work must be completed and revised by the end of the third semester. This is followed by the submission to the student's school of origin.

The final phase of supervision is the evaluation of the PARP, which in the case of the Free State of Saxony consists of the written documentation and the colloquium as a substitute for an oral *Abitur* examination in a ratio of 1:2. The external supervisor has only an advisory function in both parts of the examination, i.e. they can be asked for their vote with regard to the examination performance in the form of an expert opinion. In the end, however, the respective examination board of the school determines the partial grades for the overall grade. Even in this situation, however, many schools are guided by the expertise of the external supervisor and respect their opinion.

The overview below illustrates the process of a PARP using a concrete example focusing on Anglicisms in the present-day Albanian language based on the text corpora various contemporary magazines provide:

Table 1. Timeline for a Preliminary Academic Research Project

Time frame	Work phase
September 2021	➢ Contact on the part of a student (L1: Albanian, L2: English, German) from an academic high school with the university's Institute of British Studies ➢ Confirmation of supervision on university supervisor's part ➢ Discussion of possible topics in the fields of literary studies, cultural studies and linguistics ➢ Determination of the topic and the working language (English)
October/November 2021	➢ Joint tour of the university library to introduce the organization and working methods of a scientific library ➢ **Introduction to scientific propaedeutics (1):** formal uniformity, citation styles, formats of scientific writing (exposé, abstract), compiling a bibliography ➢ Development of concrete research questions: How often are Anglicisms used in contemporary Albanian-language magazines? What types of Anglicisms are found in these magazines? ➢ Cooperation meeting with internal supervisor (subject teacher for English) for further arrangements ➢ **Practical task (1):** compiling a bibliography on the topic of the PARP
December 2021-February 2022	➢ Familiarization with the research literature ➢ Procurement of data material in the form of Albanian language magazines from different domains (youth, fashion, economy/politics, sports) ➢ **Introduction to scientific propaedeutics (2):** relationship between theory and own work, developing a research design based on existing models ➢ **Practical task (2):** elaboration of a research design for the developed questions ➢ **Practical task (3):** writing an abstract on the subject of the PARP in English and German
March-June 2022	➢ **Introduction to scientific propaedeutics (3):** dealing with quotations in continuous text, scientific writing style ➢ **Practical task (4):** writing a theory chapter based on the state of research on the linguistic development of the Albanian language ➢ Work on refining the research design ➢ **Practical task (5):** carrying out the research and evaluating the results
June-September 2022	➢ Further work on the first version of the PARP ➢ **Introduction to scientific propaedeutics (4):** formal and content-related requirements for scientific presentations ➢ **Practical task (6):** creation of a scientific presentation on the subject of the PARP

October-December 2022	➢ Completion and revision of the PARP ➢ **Introduction to scientific propaedeutics (5):** finalization of scientific work, appropriate presentation of own research results ➢ Submission of the PARP to the school
January-April 2023	➢ **Introduction to scientific propaedeutics (6):** formal and content-related requirements for a colloquium/scientific poster ➢ **Practical task (7):** preparation of a scientific poster on the working topic ➢ **Colloquium training:** presentation techniques, preparation of possible questions by the examination board

Conclusion

Although university supervision of a Preliminary Academic Research Project (PARP) may seem challenging at first glance, it is an enriching and fulfilling experience overall. This means enrichment for a gifted and high-performing learner and enrichment of the work at universities. By supervising a gifted learner's project, university teachers are given a better insight into the level of performance and knowledge of school students. This experience allows them to develop a better sense of what can be expected of university students in their first years of study. Especially for didacts and educators such a mentoring situation can be interesting as they can identify possible desiderata based on observations and experiences and initiate new research regarding teaching and school development. By creating ongoing working partnerships between schools and universities, it would further be possible to establish a more efficient theory-practice transfer. For example, scientists and researchers could go to schools before the start of upper secondary education and the work on a PARP in order to design and support training focusing on study skills and/or conduct several days of scientific work at academic high schools. The students would then develop a better understanding of the requirements of university learning and work, so that they would have an experience-based decision-making aid with regard to their career and study orientation. In terms of desiderata, it can be stated that more empirical research needs to be carried out to corroborate and expand the experience-based findings of this micro case study. Focusing on the PARP process, the underlying motivations and attitudes, qualitative research could provide deeper insights into the perspectives of supervisors and mentees alike, whereas quantitative research could be aimed at determining the overall prevalence of school-university collaboration and the specific distribution of school subjects involved in such pre-academic endeavors. In conclusion, it can be said that the completion of a PARP contributes to the promotion of gifted and high-achieving students in general. The cooperation between internal and external supervisors creates a variety of educational networks which could possibly be exploited beyond the limited scope of collaborating on a PARP. Finally, there is also potential for preparing students for their university studies, and scientific content is consequently reinforced in school curricula.

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Research Article

The theoretical roots of gifted and talented youth education programs: The CTY case example

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Abstract

The aim of this study is to examine past literature from a reductionist approach of findings derived from academically gifted and talented youth research, and to examine the factors explaining the roots of such abilities. Also explored are common human development theories of social information processing perspective, social cognitive, attachment and behavioral genetics. This analysis explores these theories and how they can be combined to allow for the best understanding of gifted ability. Detailed here is also the Johns Hopkins University Center for Talented Youth program as a model to show a current example of how theory is being applied to practice in a gifted youth setting. The writing concludes by discussing how research of combined theories on gifted abilities can further inform practice and understanding of gifted children's abilities. Further, research suggestions are provided for meeting the gaps in literature on the roots of gifted youth abilities.

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Introduction

Since 1972 The Johns Hopkins University has been conducting a talent search to identify, challenge and reward academically precocious youth. This emergence led to the formation of the *Center for Talented Youth* (CTY) in 1979, which globally seeks out students of the highest academic ability in order to offer them rigorous educational opportunities. Consistent with the proliferation of literature supporting ability grouping (i.e., Durden, & Mills, 1993; Mills & Durden, 1992; Mills & Tangherlini, 1991; Ireson, & Hallam, 2009; Robinson, 2008; Preckel, Gotz, & Freznel, 2010), CTY unites academically talented children in its three week summer programs where they engage in challenging coursework for six hours a day. In 2009 there were a total of 30 CTY locations in the United States and internationally and the program had served students from every US state and 118 other countries (Ybarra, 2009), making it one of the most well known and respected gifted youth programs worldwide. A Google search inquiry of "Gifted and Talented

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Youth Summer Programs" reveals results from various organizations across the world, typically with university affiliations, thus exhibiting at the very least that such programs are widely marketed and available.

While it is evident that ability grouping of gifted youth has become common in the United States, it remains less clear what the causation of academic giftedness in children is. By contrast, previous research has provided some useful findings in which the results may provide some answers to the addressed dilemma. For example, much literature is provided on sex differences in gifted youth (i.e., Brody, Barnett, & Mills, 1994; Durden, Mills, & Barnett, 1990; Stumpf, 1995; Brody, Fox, & Tobin, 1980). Research on the parents of the gifted youth has also been explored, (i.e. Ablard, & Parker, 1997; & Blackburn, & Brody, 1994. Other factors yet include self-perception (i.e., Ablard, 1997; Ablard, 2002; Ablard, & Mills, 1996), perfectionism (i.e., Ablard & Parker, 1997; Parker, & Adkins, 1995; Tsui, & Mazzocco, 2007), and personality and learning styles (i.e., Mills, & Bohannon, 1980; Mills, 1981; Mills, 1983; Mills, 1993; Mills, & Parker, 1998; Mills, Moore, & Parker, 1996; McCrae, et. al 2002; Parker, & Stumpf, 1998; Runco, & Okuda, 1993). Still, fewer studies address factors such as birth order (i.e., Parker, 1998), and parenting style influence (i.e., Steinberg, Darling, & Fletcher, 1995).

Importance and Aim

Quality gifted youth educational programs are informed by theory to develop their approaches towards meeting both the educational and social needs of their participants. In models where this is not the case, the capacity for these programs to nurture giftedness to its fullest extent becomes limited, and possibly weakens the youth's ability to reach their full potential. In this study, first of all, the theoretical foundations and roots for raising gifted youth will be examined. In addition, the reflection of these theoretical roots in practice will be analyzed through the example of CTY. The questions guiding this study are:

- What theoretical roots can help underpin and guide gifted educational program approaches towards meeting the optimal training needs required for responding to and elevating these youth's unique abilities?
- How does the CTY gifted education program implement theory to guide its practice in the nurturing of gifted youth's unique abilities?

Method

The relevant literature has been analyzed in determining the foundations of academically gifted youth. A search of the literature included keywords such as gifted youth, gifted and talented youth summer programs, and precocious youth. The search yielded previous research related to the influences of sex, parenting styles, and personality and learning styles. After identifying and framing the theoretical roots for raising gifted youth, CTY was chosen as an example demonstrating the harmony and consistency of applying theoretical foundations of gifted youth to practice. The purpose of determining CTY as a model case example for review is due to its reputation of being one of the most revered and largest gifted education programs in the world. Various resources on the CTY program were evaluated, including websites, podcasts. The authors own experience as a former CTY staff member informed the understanding of the program and interest in the topic. In line with the purpose of the research, common human development theories of social information processing perspective, social cognitive, attachment and behavioral genetics were evaluated within the context of giftedness.

Results

Influences

Sex Differences in Gifted Youth

Female and male differences in gifted youth have been well documented. In one study, researchers David Lubinski and Camilla Benbow conducted a longitudinal analysis using data collected over a 20-year period from 1972 through 1991 on over 1 million seventh and eighth graders tested on the SAT- Mathematics section. Talent searches were conducted at various gifted youth programs across the country (e.g., Duke, Iowa State, Johns Hopkins, Northwestern, and

University of Denver). The findings of the study show that a greater number of males than females will qualify for advanced training in disciplines in which mathematical reasoning is of significance (Lubinski, & Benbow, 1992). Similar results were found in another study in which academically talented students in grades 2-6 were given a test of mathematical ability. In this study, boys outperformed girls on algebraic rules and algorithm tasks, and those in which mathematical concepts and number relationships was necessary (Mills, Ablard, & Stumpf, 1993). Despite these findings, it is still difficult to determine what accounts for such differences between males and females. Further research is needed to explore reasons for differences found in sex specific gifted abilities.

Parenting Style Influences

CTY documents that its summer programs have served students from over 118 countries. Is it possible that the parenting styles of gifted youth are different than their non-gifted peers? In a 2004 study, Dwairy found that authoritative parenting style positively relates to the mental health of gifted and non-gifted adolescent Arabs, whereas authoritarian parenting style may negatively influence psychological adjustment (Dwairy, 2004). Despite the negative connotation of the authoritarian style, it has been found to be the primary form of parenting among cultures whose children are quite intelligent. Chao for example, explains that the parenting style of Asians has typically been seen as "controlling" or "authoritarian." This parenting style has been found to be a predictor of poor school performance in Americans and Europeans. Results of the study showed that authoritative and authoritarian parenting styles are ethnocentric and don't illustrate the importance of Chinese child rearing. Thus other factors such as the "training" of the importance of education may be of more influence than parenting style (Chao, 1994). The results of this research show that parenting style in a culture may not be a moderator in academic achievement, but rather is a result of the cultures milieu and serve as a mediator. That is, parenting style is not the sole factor contributing to gifted abilities, yet it does impact children's value and attainment of education. Therefore, forecasting of gifted ability based upon parenting style alone is inconclusive.

Personality and Learning Styles

Studies have shown personality and learning differences in gifted students compared to their general population peers. In a 1993 study from Mills, academically talented students expressed greater introversion, intuition and thinking, higher achievement motivation, and lower on interpersonal and social concerns (Mills, 1993). A later study showed that gifted males were more likely extraverted and by contrast, females were introverted. Younger students in general also showed greater extraversion, sensing, feeling and perceiving (Mills, Moore, & Parker, 1996). A 2000 study rendered similar findings suggesting that gifted student's preference imaginative thinking styles, whereas non-gifted students prefer a more practical style. Paradoxically to previous research, gifted and non-gifted students did not show a significant difference in extroversion and introversion, organized-flexible, and thinking-feeling styles. Sex differences were still however present as boys displayed stronger preferences for flexible thinking styles while girls preferred organized and feeling styles. Girls also frequently preferred imaginative thinking styles over boys. In addition, while boys typically preferred thinking over feeling, non-gifted boys showed a stronger preference for thinking that gifted boys (Oakland, Joyce, Horton, Glutting, 2000). The study is misleading by what "stronger preference for thinking" means. That is, it is unclear what type of thinking the researchers were refereeing to. Yet again, the results shown are specific differences between gifted and non-gifted youth, males and females, and even between ages of gifted youth, however, the uncertainty remains as to the root of such differences. Perhaps exploring the perspectives of common human development theories could aid in providing a clearer explanation.

Theoretical Perspectives

As theory is the driving force behind practice, this section will highlight how several theories would likely account for gifted youths abilities. Given the authors background in human development, the theories explored in this writing are limited to some common theories of the human development field. Subsequent sections will discuss how the literature and theory can be integrated into practice.

Social Information Processing Perspective

Social Information Processing Perspective (SIP) has emerged from the mechanistic world view as a way to predict how children learn. The idea is that mental activity can be attributed to the process of sensory input through symbols and structures (Klahr, 1989). In one explanation Dodge (1986), proposes that children engage in four mental steps of thinking and responding to cues. These are (a) encoding of situational cues, (b) representation and interpretation of those cues, (c) mental search for possible responses to the situation, and (d) selection of a response. Thus the view is that knowledge is not random activity, but can be predicted based upon how humans best meet each step in the process. Over time, our ability to process grows with experience. Nelson (1993) proposes that parents play a significant role in helping to regulate the development of processes. From his vantage point, parents are able to scaffold in these experiences by talking about what is going to happen, what is happening, and what previously had happened in different ways.

Sternberg also provides a helpful understanding of SIP. In his systems approach to intelligence, he proposes his triarchic theory of intelligence, and argues that intelligence is directed toward three goals. These are, (1) adaptation to the environment, (2) shaping of an environment, and (3) selection of an environment (Goldhaber, 2000). The difference in environments from person to person, and because the development of adaptation, selection, and shaping can differ in cultures, the nature of intelligence is significantly contextual. What is seen to be intelligent behavior is dependent upon what is valued as intelligent in a particular environment or culture. To Sternberg, we balance analytical abilities, creative abilities and practical abilities (Goldhaber, 2000). The more these abilities can complement each other, the greater one would be seen as intelligent in different contexts. Contextual environments emphasize the importance of each of these abilities, which in turn correlates with the ability for a child to develop these skills (Bain, Flanagan & Harrison, 2005). That is not to take from the mechanistic view of the information processing perspective, rather that the act of intelligence is done with a purpose and in a sequence, but the context in which this is done cannot be ignored.

Sternberg believes that intelligence measurement is best determined by the ability to handle new tasks and demands, and the ability to automatize them, thus effective measurement focuses beyond solely contextual factors. In more simple terms, a child may be able to complete a task easily in a familiar environment, but the ability to replicate the behavior in another location may differ. The ability to adapt and still perform highly in this new context would be a more appropriate measurement of intelligence from Sternberg's perspective. In fact, the ability to do so is what Sternberg notes as the determinant from the truly gifted to everybody else (Goldhaber, 2000). In an example, Sternberg, Clinkenbeard, and Zhang studied gifted children and found that their uniqueness is most evident on tasks requiring insightful behavior (Sternberg & Clinkenbeard, 1995; Sternberg & Zhang, 1995). Still, the exploration of the roots of how children are unique in this insightful behavior is quite limited. Therefore, while social information processing perspective is useful in predicting how children will learn through processes, it cannot be used as a theory to predict giftedness. Rather, the extent to which biological and social influences interact to aid in coding and processing of input may contribute to deeper intellectual abilities, yet it is unclear whether this predicts giftedness or further develops the already established abilities.

Social Cognitive Theory

Albert Bandura's social cognitive theory can also provide insight into the abilities of gifted youth. Bandura holds that knowledge is best acquired through our social learning experiences. The theory acknowledges the relationship between the person and biological, cognitive, and the external environment to influence learning. The ability to think about past experiences guides how we react to future events. Bandura describes learning capability in terms of regulating processes, which are: symbolizing capability, forethought capability, vicarious capability, self-regulatory capability, and self-reflective capability (Bandura, 1986). Following the mechanistic perspective of information processing, Bandura believes that over time the way in which we process information changes as we find new ways to accommodate the information through our social learning experiences (Goldhaber, 2000).

In the symbolizing capability process, Bandura believes that children learn though observational learning. They use words for representation of objects and experiences that are specific to their culture. Social learning experiences guide

the forming of culture-specific grammatical rules (Goldhaber, 2000). Following the emphasis on modeling in Bandura's theory, he notes the importance of parents playing a critical role in language acquisition. Parents can model more sophisticated language, provide feedback, rephrase sentences, question, inform, answer and label what is being talked about (Bandura, 1989). Doing so improves the child's language ability and will allow for improved intellectual ability and automatization.

Parental influence is also seen in the vicarious capability process. This process refers to learning through observing others. In as early as infancy, parents imitate behavior and the child learns that imitation is an effective way to maintain parental responsiveness. Parents attend to certain infant responses, thus the infant learns social interactions for representing information (Goldhaber, 2000). In a more practical sense, parents serve as motivators for having their child fit into cultural norms. Gender roles are a good example of this, as children learn the characteristics of being masculine or feminine primarily through parents. The degree to which a child exhibits more typical masculine or feminine characteristics is to some extent dependent on the vicarious reinforcement of cultural norms and modeling from the parents.

Forethought ability in children is important because it can serve as a motivator and director of a behavior (Goldhaber, 2000). As children develop the ability to think about how actions have consequences, it can either motivate them to do or not do something. Bandura believes this ability is developed through social experiences. Children eventually can link past experiences to what will likely happen in the future. It could be said then that as children are reinforced with the reasons why academics matter, the result would be that they are motivated to achieve more in school. Children see the benefits of learning and value it by modeling and following the lead of those close to them that do the same.

In the self-regulatory capability process Bandura argues that there are two processes within this capability. These are the motivational regulators and the moral and social regulators (Goldhaber, 2000). Motivational standards relate most closely with studying learning ability. Thorough motivational standards, we set standards for ourselves as to what we think we are able to accomplish. Our self-efficacy is the sense of if we can live up to the standards we have of ourselves (Goldhaber, 2000). Parents can play a vital role in helping shape the efficacy of their children. From a social cognitive perspective, if children have higher standards for themselves then they are likely to not give up when they do poorly on a task, but rather are motivated to improve to meet their personal expectations. Once this expectation is met, their standard is then raised to the next level. When children have role models to follow that have positive self-efficacy, those that view themselves positively and don't give up on the onset of failure, then the likelihood that they follow this lifestyle is high. Parents can provide remedial instruction, accompanied with modeling in order to foster a deeper internalization of high standards.

The self-reflective capability in regards to self-efficacy is key to human behavior. Reflecting on experiences allows for evaluation of thinking and the ability to alter it appropriately (Bandura, 1989). Being able to have control over the events that affect us is important in how we respond to them. We have the ability to make change in our lives as we see fit. This is important because it tells us that observation of a phenomenon doesn't mean there will be an automatic response. Instead, humans have the ability to process how they are going to use the information. Depending on ones efficacy, they may respond differently. If a child is at school and the teacher introduces a new concept that is difficult, the child has the ability to decide if they are going to seek more or less help in mastering the topic, or potentially give up. Children with a high self-efficacy would likely want to master the new task, thus making the choice to do so. It can then be seen how it is important it is to aid in children's development of this task.

Bandura would likely be highly critical of the *Center for Talented Youth* because of the programs ability grouping, which he believes instills a low sense of intellectual efficacy. In order for intellectual efficacy to be more highly developed, Bandura is supportive of individual instruction that allows children to compare their skills with their personal standards (Goldhaber, 2000). Rather than viewing CTY as a way to nurture gifted children's abilities in an environment that fosters academic and social development through inclusion of like peers, Bandura would likely focus on the competition

that he believes exists in these types of programs. It is this competition that he would view as an inappropriate educational practice as it is likely to instill a low sense of intellectual efficacy that is difficult to reverse once established.

Attachment Theory

Attachment theory posits that a bond exists between an infant and the primary caregiver, typically the mother (Bowlby, 1988). This bond has been shown to be important not only in general well-being (i.e., Kreppner & Ullrich, 1998), but also influences how relationships are formed and are successful across the lifespan (i.e., Waters, Merrick, Treboux, Crowell, & Albershein, 2000). While the caregiver attachment has been frequently explored, other research has made use of attachment theory to explain non-caregiver dyads. For example, research on interpersonal child-teacher relationships has utilized an attachment theory framework (i.e., Bowlby, 1973; Bowlby, 1980, & Bowlby, 1982). It seems logical to explore attachment influence on children's development given the close relationships they are likely to form with other adults. These adults can have a significant impact on a child's life thus impacting their development. Perhaps the most influential person in a child's life outside of her or his parents is the teacher. In fact, secure relationships with teachers may compensate for an insecure attachment relationship with the parent-child relationship (Van Ijzendoorn & Tavecchio, 1987). Perhaps this compensation is because the nature of the child-teacher relationship is in many respects similar to the parent-child relationship (Howes & Hamilton, 1992; Pianta, 1992). Connecting this relationship to academic achievement, findings suggest that children who have secure relationships with their teachers have been found to be more academically competent than those with insecure child-teacher relationships (Howes, Matheson, & Hamilton, 1994). Particularly, gifted students have been found to be even more affected by the interactions with their teachers than their non-gifted peers (Croft, 2003). Also discussed by Croft (2003) are several characteristics listed by the National Association for Gifted Children (NAGC) for successful teachers of gifted youth. NAGC suggests that the highly effective teacher is able to inspire and motivate, reduce tension and anxiety, and appreciate the high levels of sensitivity for gifted and talented youth (Croft, 2003).

Given the findings of the significance of attachment relationships, attachment theory would suggest that gifted youth could not have their abilities expressed without an attachment figure of some form in their lives. By contrast, the attachment figure most likely incorporated NAGC characteristics for effective teachers into the relationship regardless if they are the "school teacher." While the theory allows us to see the value of attachment figures in nurturing gifted youths abilities, it does not allow for a conclusion to be drawn on the causation of the abilities. Perhaps acquiring a secure attachment is one aspect of the development of gifted abilities, allowing for their expression, but it cannot be noted as the cause because we know of children with securely attached relationships, yet they are not academically gifted. That is, a secure attachment may aid in helping the gifted child reach her or his full potential, but it doesn't create the ability. Further research is needed to explore how the intensity of securely attached relationships correlates with the level of abilities within the gifted youth population. For example, does having multiple secure relationships allow for further expression of abilities?

Attachment theory fits excellently into ways to support gifted children's abilities, yet the theory is unable to explain the roots of such abilities. From this, it is unsafe to say that securely attached relationships forecast gifted abilities, rather children with securely attached relationships have an increased likelihood of expressing their gifted abilities while also having them nurtured, and thus further aiding in the child to master her or his full potential.

Behavioral Genetics Theory

A behavioral geneticist perspective of the roots of gifted youth abilities would be a biological explanation. That is, the stance would be that the child was born with her or his gifted abilities. Many studies have addressed the genetics of brain structure and intelligence by behavioral geneticists (i.e., Toga, & Thompson, 2005; Deary, Spinath, & Bates, 2006; Deary, Penke, & Johnson, 2010). In one particular study, major white matter fiber pathways were found to be highly genetically controlled, and diffusion anisotropy was linked with advanced intellectual performance in many key systems. Researchers hope that these results may lead to future studies to distinguish individual genes contributing to fiber architecture, white matter integrity and cognition (Chiang, et al., 2009). These results show evidence of gene correlation

with intelligence which comes close to answering the question of this writing regarding the roots of gifted abilities. Yet although the results show evidence of gene correlation with intelligence, there is no mention of the contributing factors that allow expression of the gene, or phenotype. Given this, it is important to look to the other explored theories to explain how they interact to forecast gifted ability.

While this research is in its infancy, it is providing crucial insight into understanding biological influences on intellectual ability, and future research of brain structure of gifted children may provide more clarity on such roots of intelligence.

Integrating Practice

The above theoretical perspectives provide frameworks for which to explore the roots of gifted children's unique academic abilities, yet none can directly answer the question as to the causation of the abilities. By comparison, when researchers explore the similarities and differences within gifted children (e.g., sex differences, parenting styles, self-perception, perfectionism, personality and learning styles, birth order, and cultural context) the results merely show differences within the already talented population. Thus, while similarities and differences are provided, the answer for the cause of the differences is lost. Despite the lack of a single theory or characteristic to define the roots of the abilities, what may be more reasonable is to explain how the interaction of such perspectives and individual child characteristics further increase the likelihood of the abilities being identified. Doing so will allow for the child to express her or his abilities, allowing those that work with gifted youth to properly nurture and help them reach their full potential.

The Johns Hopkins University *Center for Talented Youth* program is an excellent example of how research of gifted youth has been integrated into practice. The goal of this program is to nurture gifted children's intellectual abilities, enhance their personal development, and foster better understanding of the needs of the talented youth (Center for Talented Youth, n.d.). CTY utilizes a strong research component in order to evaluate the overall effectiveness of the program, as well to ensure the proper nurturing of the whole child from both an academic and social perspective. Hence both academic and residential staffs understand that not all gifted children are the same, as they come from many diverse backgrounds and have thus had different experiences. CTY professionals realize that because of the diversity of their students, they will have likely had differences in parenting styles, learning styles, birth order, cultural expectations, etc. All of which would then have likely impacted the degree of secure attachment relationships, experiences that were observed and modeled, how information is processed, and structuring of the brain. As a senior residential administrator for the *Center for Talented Youth*, the author now explores his experiences of how theory has informed professional practice of the summer program.

CTY and Social Information Processing Perspective

CTY academic and residential staffs play a significant role in aiding in the development of processes. As mentioned, Nelson (1993) proposes that parents are able to scaffold in these experiences by talking about what is going to happen, what is happening, and what previously had happened in different ways. Similarly, CTY staff aid in the development of these processes through explaining to the children expectations in the classroom and in the residential halls. Residential and academic staffs collaborate to maintain consistency of expectations. Thus, there is no confusion with why things are happening, why they did happen, or why something will happen in the future. Doing so supports Dodge (1986), perspective that children engage in four mental steps of thinking and responding to cues. As children (a) encode situational cues, (b) represent and interpret of those cues, (c) do a mental search for possible responses to the situation, and (d) select of a response, they will have a better development of processing thoughts and knowledge (Goldhaber, 2000). CTY professionals scaffold in this thinking process. As mentioned, Sternberg theorizes that we balance analytical abilities, creative abilities and practical abilities (Goldhaber, 2000). The high complementation with these abilities correlates positively with ones level of intelligence. CTY integrates the balance of these abilities within its program through academic staff that encourage logical and abstract thinking, and residential staff that develop activities to aid in the development of creative and practical thinking, through directive and non-directive play.

CTY and Social Cognitive Theory

As previously stated, Bandura is supportive of individual instruction that allows children to compare their skills with their personal standards (Goldhaber, 2000). Due to this, Bandura would likely be critical CTY grouping children together because of the possibility for competition to exist between these children which could decrease their intellectual-efficacy. On the contrary, an exhaustive body of literature disregards Banduras perspective and is quite grounded in the benefits of grouping gifted children (i.e., Brody, 2004; Fiedler, Lange, & Winebrenner, 2002; Kulik, 1992; Loveless, 1998; Rogers, 2006; Rogers, 2002, & Tieso, 2003) for examples. These studies show evidence that children learn best from peers that learn and think in ways similar to themselves. However it is not the act of being grouped that in itself is beneficial. Rather, what educators do to nurture the gifted children within this group is crucial. Thus, while Bandura may disagree with ability grouping, perhaps he may be able to compromise on how CTY professionals nurture giftedness within the group.

In an example, it was previously stated that Bandura believes that the way in which we process information changes over time as we find new ways to accommodate the information through our social learning experiences (Goldhaber, 2000). Social learning experiences are at the heart of the CTY experience for the children enrolled in the program. CTY staff works to foster a comfortable, safe and all inclusive family like atmosphere within its programs. This is done through social learning experiences in the academic setting and residential setting. CTY believes that nurturing the full potential of the children they serve could not be accomplished without providing opportunity for exceptional social learning experiences.

Further supporting social cognitive theory, CTY staff understands the importance for the children to have reflection time. Reflecting on experiences allows for evaluation of thinking and the ability to alter it appropriately (Bandura, 1989). CTY professionals speak with students about experiences they are having in the classroom as well as outside of the classroom, especially since what will happen in one setting will likely impact the other. Staff members also hold interdisciplinary team meetings to reflect on the experiences the children are having in order for all professionals to be on the same page for modeling consistency in practice.

In addition, it would be difficult for Bandura to dispute the claim that CTY improves the self-efficacy of the children they serve. Using a strength-based approach, CTY professionals nurture the child's gifted abilities through providing rigorous academia to match the child's academic ability. Further, CTY provides opportunities for students to develop in other ways that they perhaps were not so confident in prior to coming to a CTY program. Through rapport building CTY professionals are able to get to know the students they work with quite well, which allows for the staff members to be in tune with areas in which their students could improve. For instance if a CTY Resident Assistant notices that one of her students is excelling in the classroom yet is struggling socially with other students, the professional is likely to provide opportunity and encouragement of the child to be included with other children. Over time, the goal is that the student's efficacy of making friends will increase.

CTY and Attachment Theory

Center for Talented Youth Students form close relationships with their teachers, teaching assistants, resident assistants, and fellow peers. These relationships influence their ability to learn and form future relationships as they leave the program. CTY is familiar with the earlier presented findings that gifted students are even more affected by the interactions with their teachers than their non-gifted peers (Croft, 2003). CTY provides such a place for gifted students to be nurtured by a team of professionals and peers that they form interact and form close relationships with. As mentioned, children who have secure relationships with their teachers have been found to be more academically competent than those with insecure child-teacher relationships (Howes, Matheson, & Hamilton, 1994). CTY professionals would agree with this finding and go even further in saying that it provides validity for CTY given that CTY further strengthens the gifted child's relationship with teachers, which could correlate to continued future academic competence.

CTY and Behavioral Genetics

The Center for Talented Youth recognizes that gifted children's brains have unique abilities. While CTY recognizes that its students are not merely "little adults," they also recognize that these children have a unique ability for understanding adult academic rigor. That is, CTY recognizes that its students are behaviorally and cognitively still children, while also recognizing and nurturing the aspect of their academic ability that is superior to their same age counterparts. While the brains of CTY children are able to be superior in some academic aspects, CTY professionals would argue that the phenotypes of these genotype abilities would not be possible without nurture. Gifted children are just as at risk of not reaching their full potential as other children are of dropping out of school (Ybarra, 2009). The theories previously mentioned can fit within the behavioral genetics perspective if one considers that that the theories can be combined to provide a framework for helping the gifted child to express her or his biological abilities.

Conclusion

This writing has explored literature regarding academically gifted and talented youth, and common human development theoretical perspectives that might explain the roots of such abilities. This review provided findings from gifted youth gender differences, parenting style influences, self-perception, personality and learning styles, birth order and cultural influences. While the findings of the studies show variation of differences between the listed variables, they do not show for a direct moderation of gifted ability. Likewise, the human development theories of social information processing perspective, social cognitive, and attachment rendered results that could be used at most to help nurture children with their gifted abilities, but they fail to explain the causation. The closest theory found to explain the roots of gifted abilities is behavioral genetics. This biological perspective is providing a unique insight into brain structure to explain intelligence. The theory is different than the others mentioned in that it is able to show links between the brain and intelligence. For instance a 2009 study revealed that, major white matter fiber pathways were found to be highly genetically controlled, and diffusion anisotropy was linked with advanced intellectual performance in many key systems (Chiang, et al., 2009). While the other mentioned theories can be used to explain how to properly nurture gifted children, they do not provide sufficient links between utilizing the theory to show causation of the abilities in a way that behavioral genetics does.

In providing a direction for future research, studies should explore the extent to which the other mentioned human development theories can account for roots of gifted abilities. For example, how much modeling and observation accounts for acquiring gifted ability vs. does having the genotypes for advanced intellectual capability allow for further expression of these genes through observation and modeling? Similar nature vs. nurture questions could be formed with social information processing perspective and attachment theory to further inform practice.

The Johns Hopkins University *Center for Talented Youth* program was also explored in this writing as a way to show an example of theory being applied to practice in the realm of gifted children. The author provided examples of how CTY has utilized social information processing perspective, social cognitive, attachment and behavioral genetics as a way to nurture its gifted students. Although there is mention of the prevalence of gifted youth educational programs worldwide, details of these models in comparison to CTY and their theoretical groundings was left unexplored.

The author speculates that there is no sole causation of gifted abilities, but rather the combination of biological and social theories are contributors that can be combined in a way to better forecast giftedness. It is thought here that the degree to which gifted abilities are expressed are because of how well they are nurtured through social information processing, social cognitive theory, and attachment. Yet, argued here is that nurturing these abilities would not be possible without the child first providing the readiness to learn at a higher level. The child's brain must be developed in a way that allows them to learn at the sophisticated level, without adult pressure and high expectations.

Further, the author disregards any arguments that any racial or ethnic group is biologically smarter than another, and agrees with a 2007 study that suggests there is an over-representation of ethnic minority students (Chinese, Indian and mixed ethnicity) in gifted classification because of these groups affluence rather than ethnicity (Campbell, et al., 2007).

That is because of their wealth, these ethnic groups likely have more resources available to them to aid in their educational attainment, thus allowing for certain ethnic groups to be overrepresented in the gifted status. This then provides explanation for why some lower class ethnic groups are not well represented in the gifted status, and further provides evidence that resources must be available to nurture the gifted child's abilities. Without support of these abilities, they are likely to fade because they have not been nurtured in a way that allows for full developmental potential. Further research would benefit from comparison of brain scans of children from different cultural educational practices. An example could be to see if different educational practices render differences in children's brains, and if these educational practices structure the brain in such a way to allow for a higher order of thinking. This would allow for a distinction between educational practices that lead to or "teach" giftedness, or if these educational practices better support the child in her biological abilities.

Also not explored in this review is the impact of early adversity on children's development. Future researchers may wish to explore gifted children that had experienced early adversity compared to their gifted peers that had not, in a way to explain differences in brain development. Likewise, such research would be beneficial for explaining the importance of positive early experiences that impact the child across the lifespan. Further, one may wish to explore correlations between academic achievement and other talents (e.g., musical, athletic, etc.) to determine the degree to which one may impact the other as this was not explored here. It should also be emphasized that although the author explored many relevant theoretical perspectives to aid in the explanation of gifted youths' abilities, one should not limit the ways to explain gifted abilities to the theories presented here. Future reviews and studies should explore a variety of perspectives in order to best explain the roots of such abilities.

It is evident throughout this review that it is not always possible to explain phenomena with a single explanation. Multiple contextual factors linking research, theory and practice must be considered when attempting to provide best practice explanation for why something occurs. Without researchers and practitioners making the connections between theoretical perspectives, research and practice, the result is a limited understanding of what is trying to be explained. Such connections provide a lens for which to understand a phenomenon in the most valid manner. Therefore as researchers continue to explore the roots of academically precocious youth, they must consider all theoretical approaches to best guide their studies and to show for all factors that may contribute to gifted abilities.

Biodata of Auhor

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Research Article

Investigating the relationship between creativity and mental health and spiritual happiness and the parent's popularity of high school students and designing a model of spiritual happiness

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Abstract

This study aimed to investigate the relationship between creativity and mental health and spiritual happiness, and the parent's popularity of high school students and design a model of spiritual happiness. The present study was correlational. The statistical population in this study was all high schools in Tehran, and Sepehr Maarefat school was selected as the available sample. The sample size in this study was 200 female students. The tools used in this study were: The creativity test, Mental health test, Spiritual Happiness test, and Parental Popularity test. In this study, the obtained data from the questionnaires were analyzed by SPSS software version 26 and Smart PLS software version 3. Finally, the model of spiritual happiness was designed using the GOF index. The results showed that these variables have a significant relationship with a 95% confidence Interval ($p<0.05$).

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Introduction

The field of creativity is one of the basic and key concepts in psychology. After decades of studying in this field, its relationship with mental health is still much debated. Creativity is one of the complex concepts related to human beings. There are different ideas between mental health and creativity. Humanistic approaches in psychology consider creative thinking and action as a tool for self-fulfillment.

Creativity is generally described as the ability to create authentic and consistent products (Simonton, 2021). However, authenticity alone is not enough. To be considered a creative output, it should also be practical and useful for existing issues (Hennessey & Amabile, 2010). According to Cropley (1990), one aspect of creativity is a general feature that is different in each person and is called everyday creativity. Because of this, we can call creativity an everyday

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phenomenon that all human beings can benefit from and it guarantees the mental health of individuals. People can guarantee their mental health to some extent by cultivating their creativity. Creativity and well-being are common topics in psychological studies (Akare et al., 2021).

Creativity is enumerated as one of the necessities of life and people need it for spiritual happiness, innovation, and dynamism. However, less research attention has been paid to creativity than intelligence in academia. Lack of attention in this field has created problems in the field of measuring creativity (Bonnie & Furnham, 2006). Among the elements related to creativity, just a little research has been done on creativity and mental health. It is worthwhile to do more research in this field in the future to witness the flourishing of the creative society. Research has also shown that creativity and health mental are correlated (Martin & Leki, 2011).

Dastjerdi and Dehshiri (2010) in their research achieved a positive relationship between creativity and mental health. Khosravani and Gilani (2007) emphasized the relationship between mental health and creativity and showed that creative people experience less anxiety and depression during their life. Good mental health can be defined as a state of mental health that allows individuals to cope with normal life stresses and have productive performance (Fussar et al., 2020). Parenting styles play a mediating variable in the relationship between digital creativity and academic performance (Fuentes et al., 2019). There is a good agreement among researchers about parenting styles that influence creativity (Oliwa et al., 2008, Fuentes et al., 2015, Riquelme et al., 2018). Pelegrina et al. (2002) stated that parental affection and communication is a necessary conditions for achieving creativity, desirable self-esteem, and self-confidence.

Maslow (1954) stated that there are two categories of basic and primary needs and non-basic and secondary needs on the path of growth and flourishing of human personality. He considered the basic and primary needs in five categories, including physiological (natural) needs, safety needs, the need for love and affection, the need for respect, and the need for self-fulfillment. According to Maslow, one of the basic needs of everyone is the need for love and affection. Human is thirsty for emotional connection with others, that is, he seeks to find a foothold and backrest to meet the needs of self-reliance (Maslow, 1954 & Core, 2013). According to Afrooz (2010), parental affection for each other can lead to self-esteem, self-confidence, happiness, mental health, overcoming narcissism, and positivity in children. Mahdavi et al. (1401) showed that parental affection plays an important role in positive perfectionism. Safaei Rad et al. (2015) showed that there is a relationship between maternal mental health and the creativity of girls.

One of the important factors influencing creativity is the spiritual happiness that governs the family atmosphere. By definition, spiritual happiness means a feeling of peace, devotion, and hope through deliverance, forgiveness, and enjoying inner freshness and clarity and heartfelt belief in the creator of the universe (Afrooz, 2016). Abolhari et al. (2012) showed that students who live in a family full of love and have spiritual happiness, and mental health, can flourish in their creativity.

Problem of Study

In fact, the current research was trying to answer the question that does creativity have a relationship with factors of mental health and spiritual happiness and popularity of parents of high school students,and if there is a relationship with which of these factors is it most related? And finally, from the relationships obtained between these variables, the model of spiritual happiness was designed, which is an innovative model.

Method

Research Model

The present study was correlational research. The statistical population was of all high schools in Tehran and Sepehr Marefat School was selected as the available sample. The sample size in this study was 200 female students and the measurement tools used were creativity, mental health, spiritual happiness, and parental popularity scale. In this study, the obtained data from the questionnaires after classification through SPSS software and Smart PLS software were analyzed, and finally, the model of spiritual happiness was designed using the GOF index.

Data Collection Tools

Goldberg Health Questionnaire

Goldberg's mental health questionnaire (GHQ28) was designed by Goldberg in 1972 and is used to identify non-psychotic disorders in various conditions. This scale has acceptable validity and reliability. It includes 28 questions that have four subscales, each of the subscales consists of 7 questions.

These 4 subscales of Goldberg's Mental Health Questionnaire are; Physical signs and symptoms, Anxiety signs and symptoms, Social dysfunction signs and symptoms, Depression signs and symptoms.

Questions 1 to 7 are related to the physical symptoms subtest, questions 8 to 14 are related to the anxiety and insomnia subtest, questions 15 to 21 are related to the social dysfunction subtest, and questions 22 to 28 are related to the depression subtest. Scores are on the Likert scale.

Torrance Creativity Thinking Test, Figurative Form B

It was developed in 1974 by Torrance, has a visual nature, and includes three activities. In each activity, four scores are awarded for each elaboration, fluency, flexibility, and originality variable. The sum of scores of these components constitutes the creativity score. The validity of this test is reported to be 0.51 (Pirkhaefi et al. 2012).

Afrooz Spiritual Happiness Questionnaire

It was made by Afrooz in 2018 and has 2 subscales of beliefs of 20 items, and feeling and behavior of 40 items. Scores are on the Likert Scale. Cronbach's alpha of this questionnaire is reported to be 0.95, which indicates high validity and reliability (Mehrivartiab, 2017).

Parents' Popularity Questionnaire

It is developed by Asadi et al. in 2013. It consists of two 30-question items and must be answered by the student in each item separately. The reliability of this tool has been evaluated by Cronbach's alpha and has been reported to be 0.63 (Asadi et al., 2013). In previous studies, the psychometric properties of this tool are also examined in the research sample. In previous studies, Cronbach's alpha is 0.78 and at the same time, a questionnaire was administered to 30 students after an interval of 7 days and the correlation between two runs was equal to 0.65.

Data and information obtained from the questionnaires were analyzed by SPSS software and Smart PLS software.

Results

The values of descriptive indicators for the variables of creativity, parental popularity, mental health, and spiritual happiness and their dimensions are given in Table 1.

Table 1. Descriptive Indicators Regarding Research Characteristics

Variable	N	Ave	Median	Mode	SD	Min	Max
Originality	200	114/95	116	116	1/48	110	118
Fluency	200	27/64	28	28	6/26	22	114
Elaboration	200	26/92	28	28	1/62	20	28
Flexibility	200	26/93	28	28	1/63	20	28
Creativity	200	196/44	196	198	7/19	176	286
Beliefs	200	56/94	59	63	7/01	15	63
Emotion & Behavior	200	123/4	127/5	134	13/29	41	134
Spiritual happiness	200	180/34	186	197	20/04	56	197
Somatic symptoms	200	3/28	3	1	2/12	0	9
Anxiety symptoms	200	4/1	4	4	1/51	0	11
Social dysfunction	200	13/21	13	13	1/001	10	16
Depression	200	3/11	3	3	1/63	0	14
Mental health	200	25/97	26	25	3/41	17	42
Father's popularity	200	92/56	93	90	5/41	61	120
Mother's popularity	200	87/53	88	88	3/64	62	97

Parent's popularity	200	90/04	90	89	3/74	61/5	104

According to the results, It is observed that the average of the initiative is 114.95, which indicates a high initiative according to the maximum amount of initiative (116). The average expansion is 26.92. The average fluidity is 27.64, which indicates high fluidity according to the maximum amount of fluid (28). The average flexibility is 26.93, which also indicates flexibility is high according to the maximum amount of flexibility (28); and in general, creativity with an average of 196.44 shows a high rate. Furthermore, the average of beliefs is 56.94 and the average of feelings and behaviors is 123.4, which means that the average total spiritual happiness is 180.34, and because it is more than 160, shows an excellent level of spiritual happiness. On the other hand, the average of physical symptoms is 3.28, anxiety symptoms 4.1, social disorder 13.21, depression 3.11, and mental health, in general, is 25.97 and shows a low rate which indicates good mental health of sample people. The popularity of the father is 92.56 and the popularity of the mother is 87.53, which indicates that in the sample, the popularity of the father is higher than the popularity of the mother. In general, the popularity of parents with a rate of 90.04 indicates an appropriate value and is above average (75).

Normality of Tests

The values of skewness and kurtosis were calculated for each of the research variables. But skewness and kurtosis coefficients for fluidity variables, creativity, beliefs, feelings and behavior, spiritual vitality, anxiety symptoms, depression symptoms, mental health symptoms, father popularity, mother popularity, and parents' popularity are not between 3 and +3, and therefore the normality of these variables are rejected, therefore the nonparametric test of Spearman correlation coefficient and structural equations using Smart PLS3 software is used to test the assumptions.

Correlation Coefficients

In this part of the research report, the relations between independent variables and their dimensions with the dependent variable are tested. Spearman correlation coefficient is used to investigate the relationship between research variables (creativity, spiritual happiness, mental health, and parents' popularity) considering that some variables do not have a normal distribution. The results are shown in Table 2:

Table 2. The Result of the Pearson Correlation Coefficients between Variables

Variables	1	2	3	4
Creativity	1			
Spiritual happiness	0/479*	1		
Mental health	-0/548*	-0/205*	1	
Parent's popularity	0/295*	0/171*	-0/288*	1

Assumption 0: There is no significant relationship between the two variables. Assumption 1: There is a significant relationship between the two variables.* At the level of 0.05 significant

Considering the significant values in Table 3, it can be seen that these variables have a significant relationship with each other with 95% confidence ($p<0.05$.) It is also observed that the correlation coefficients between creativity with spiritual happiness, creativity with parent's popularity, and spiritual happiness with parents' popularity are positive, so it can be said that as each of the variables increases the other variable increase, and as one of them decreases the other one decreases, but the correlation coefficients of mental health with creativity, mental health with spiritual happiness and mental health with parents' popularity are negative and they are the opposite of each other (because an increase in mental health score indicates a mental disorder and as it increases, the creativity, spiritual happiness, and popularity of parents decrease).

The General Model of Research Using Smart PLS Software

To analyze the developed model, Smart PLS 8.2.3 software was used. In this model, a total of 118 items (spiritual happiness: 60 items, mental health: 28 items, parents' popularity: 30 items) were included in the model. The spiritual happiness variable has two components, the creativity variable has 4 components, the mental health variable has 4 components and the parents' popularity variable has 2 components. First, first-order factor analysis (items as index) and

then second-order factor analysis (components as index), and then structural equations were performed for the components. The model analysis was performed in three stages: in the first stage, the external model (measurement model), in the second stage, the internal model (structural model), and in the third stage, the whole model.

After fitting the first model, if an item with a factor load of less than 0.4 was removed (in our model, m12, m13, m21, m24, m25, m26, m27, m6, mm22, mm21, mm23, mm27, mm28, mm29, mm30, mm8, mm7, mm5, n7, s11 and s26 items were removed from the model) and then the final model was fitted. The final model is shown in Figures 1 and 2.

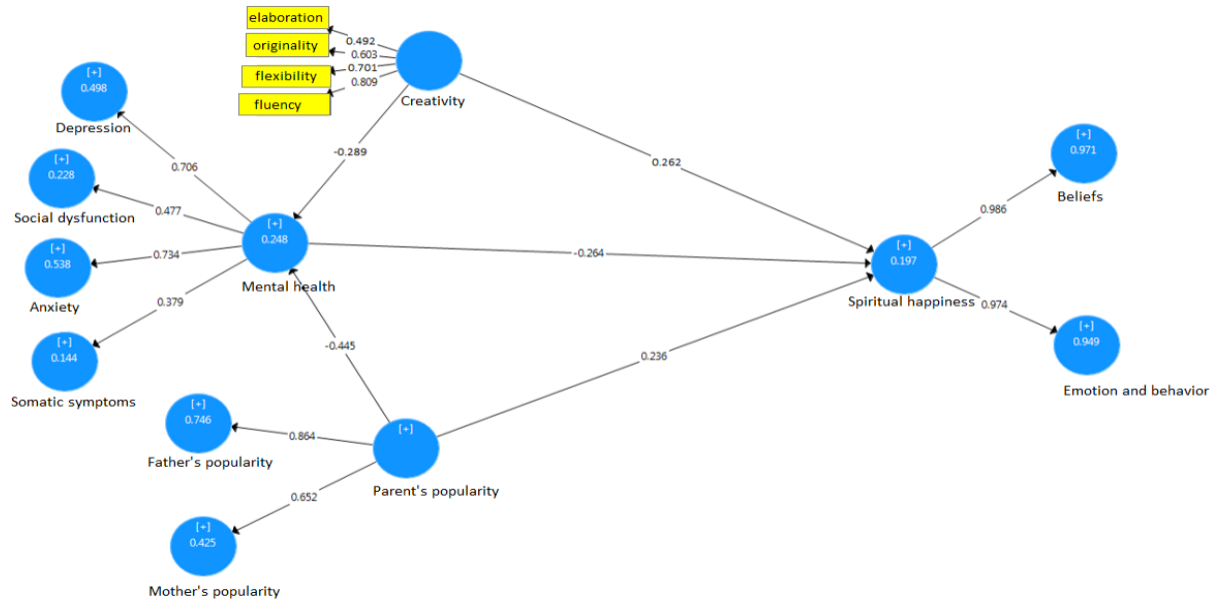

Figure 1. Path Diagram Along with Standard Coefficients in the Final Model

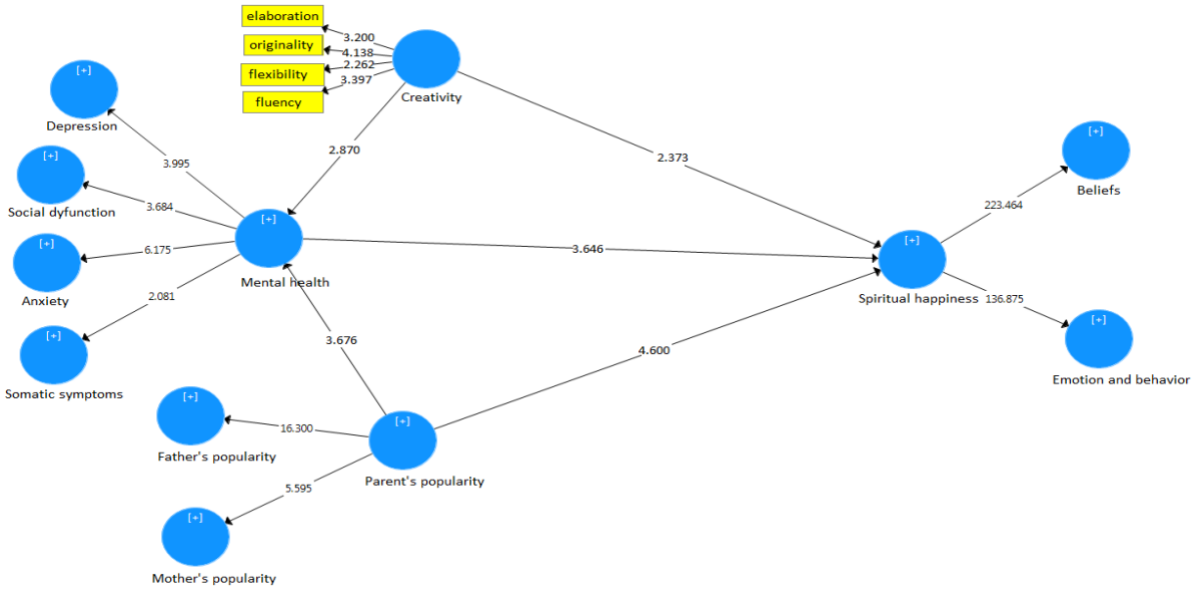

Figure 2. Diagram Along with T coefficients in the Final Model

Measurement Model

Three criteria including reliability, convergent validity, and divergent validity were used in the study of external models. The reliability of the reagent was evaluated by measuring the factor loads and the reliability of the latent variables was evaluated by the combined reliability.

Reliability at the indicator level is the factor loads square of the items, which must be at least 0.4; it means that at least half of the variance of the index is explained by the latent variable. Therefore, the factor loads greater than 0.7 are desirable and the factor loads below 0.4 need to be eliminated. Factor loads between 0.4 and 0.7 can be eliminated if removing them can increase the value of convergent validity (AVE) (Nonali and Bernstein, 1994). Given that in reflective

variables, the indicators are related to a domain and have a high correlation with each other, it is possible to replace them, and deleting one or more items does not have much effect on content validity. The results indicate that all retained items have good reliability.

An analysis of study instruments' reliability and validity illustrated that the Combined Reliability (CR) of all constructs within the model recommended for this study was more than 60% and their Cronbach's alpha was also higher than 70%. Moreover, the Average Variance Extracted (AVE) for all the constructs within the study's recommended model was higher than 50%. In addition, the whole range of latent variables within the same recommended model was of acceptable reliability and validity.

Table 3. Confirmatory Factor Analysis Results for the Measurement Model

Variables	Items	β	t	Items	β	t	Items	β	t
Creativity	Expansion	0/492	3/2	Flexibility	0/701	2/262	Fluid	0/809	3/397
	Innovation	0/603	4/138						
			AVE: 0/58	CR: 0/745		α: 0/731			
Depression	S22	0/441	2/99	S23	0/478	3/17	S24	0/422	2/78
	S25	0/619	3/95	S26	0/5	3/56	S27	0/536	3/35
			AVE: 0/53	CR: 0/76		α: 0/703			
Social disorder	S15	0/416	3/61	S16	0/567	2/36	S17	0/428	2/29
	S18	0/615	3/19	S19	4/69	0/615	S20	0/47	2/98
	S21	0/532	2/16			2/16	0/532	S21	
			AVE: 0/52	CR: 0/762		α: 0/732			
Anxiety symptoms	S8	0/56	2/37	S9	0/684	2/083	S10	0/588	2/13
	S11	0/485	2/13	S12	0/478	2/505	S13	0/416	2/61
			AVE:0/594	CR: 0/709		α: 0/718			
Physical symptoms	S1	0/467	2/52	S2	0/538	2/88	S3	0/596	3/99
	S4	0/461	2/52	S5	0/694	4/02	S6	0/604	2/78
	S7	0/4	2/19						
			AVE: 0/574	CR: 0/711		α: 0/761			
Father's popularity	M1	0/47	4/95	M2	0/403	4/89	M3	0/534	10/43
	M4	0/493	3/42	M5	0/42	2/13	M7	0/675	5/28
	M8	0/408	4/77	M9	0/499	7/22	M10	0/481	4/303
	M11	0/429	2/3	M14	0/571	12/59	M15	0/629	6/64
	M16	0/439	6/66	M17	0/558	12/16	M18	0/42	5/2
	M19	0/414	3/92	M20	0/408	2/34	M22	0/454	3/23
	M23	0/741	4/94	M28	0/709	4/35	M29	0/566	3/21
	M30	0/623	3/48						
			AVE: 0/572	CR:0/887		α: 0/865			
Mother popularity	Mm1	0/533	3/27	Mm2	0/609	3/7	Mm3	0/445	2/49
	Mm4	0/405	2/2	Mm6	0/412	2/37	Mm9	0/421	2/4
	Mm10	0/418	3/37	Mm12	0/441	2/11	Mm13	0/43	3/37
	Mm14	0/42	2/6	Mm15	0/432	2/1	Mm16	0/438	3/15
	Mm17	0/602	7/006	Mm18	0/509	3/94	Mm19	0/59	6/73
	Mm20	0/566	7/45	Mm24	0/72	8/13	Mm25	0/514 6/14	
	Mm26	0/595	6/84						
			AVE: 0/538	CR: 0/848		α: 0/809			
Beliefs	N18	0/576	9/85	N19	0/549	5/85	N20	0/562	7/79
	N21	0/59	7/46	N22	0/592	7/47	N23	0/469	5/35
	N24	0/478	5/4	N25	0/542	9/56	N46	0/665	11/52
	N47	0/551	8/23	N48	0/571	9/09	N49	0/569	10/33
	N50	0/571	7/27	N51	0/642	8/38	N54	0/617	9/24
	N55	0/573	9/78	N56	0/724	11/62	N57	0/565	7/67
	N58	0/525	8/03	N59	0/655	12/7	N60	0/576	8/99
			AVE: 0/539	CR: 0/914		α:0/901			

Feeling & Behavior	N1	0/429	5/37	N2	0/491	5/92	N3	0/583	7/38
	N4	0/549	6/701	N5	0/563	7/87	N6	0/49	5/408
	N8	0/42	3/33	N9	0/405	2/33	N10	0/563	7/34
	N11	0/54	8/27	N12	0/615	9/904	N13	0/529	8/02
	N14	0/616	12/13	N15	0/43	6/13	N16	0/495	5/45
	N17	0/55	8/84	N26	0/526	6/89	N27	0/508	7/34
	N28	0/633	10/63	N29	0/48	4/85	N30	0/539	8/05
	N31	0/608	9/67	N32	0/582	7/703	N33	0/633	12/18
	N34	0/57	8/31	N35	0/598	11/29	N36	0/582	9/87
	N37	0/598	11/28	N38	0/606	8/83	N39	0/626	12/34
	N40	0/618	8/15	N41	0/705	23/45	N42	0/47	5/68
	N43	0/596	9/32	N44	0/563	7/25	N45	0/569	10/22
	N52	0/583	8/91	N53	0/52	6/28			
			AVE: 0/51	CR: 0/944		α: 0/939			

To study the latent variables, Cronbach's alpha and combined reliability (CR) have been applied. However, due to the conservative nature of Cronbach's alpha as well as the consideration of similar weight for all the nominators, CR is the most used solution in Partial Least Square (PLC) approach (Azar, Gholamzadeh, & Ghanavati, 2012). A value of 0.7-0.9 is considered the satisfactory range for CR and values lower than 0.6 are considered unfavorable. In this model, all the variables include a CR> 0.7, thus, it can be inferred that the study model is of good reliability. The next stage concerning the analysis of the external model is the analysis of convergent validity. The AVE is the main criterion for analysis of convergent validity, meaning the average covariance of the latent variable and its nominators and its minimum value is 0.5 (Davari & Rezazadeh, 2014).

It can be argued in this model that variables' convergent validity has been obtained higher than 0.5, and all the latent variables are of appropriate convergent validity.

Table 4. Fornell and Larcker Matrix to Check Divergent Validity

		1	2	3	4	5	6	7	8	9	10	11	12
1	**Depression**	0.503											
2	**Belief**	-0.328	0.582										
3	**Emotion And Behavior**	-0.324	0.28	0.557									
4	**Social Dysfunction**	0.229	-0.23	-0.245	0.49								
5	**Creativity**	-0.071	0.14	0.139	-0.145	0.508							
6	**Mother's Popularity**	-0.365	0.461	0.45	-0.136	0.12	0.488						
7	**Father's Popularity**	-0.393	0.303	0.257	-0.364	0.022	0.345	0.521					
8	**Parent's Popularity**	-0.451	0.378	0.32	-0.318	0.082	0.251	0.174	0.872				
9	**Anxiety Symptoms**	0.22	-0.235	-0.204	0.306	-0.172	-0.172	-0.218	-0.25	0.542			
10	**Somatic Symptoms**	0.138	-0.185	-0.187	0.085	-0.147	-0.153	-0.077	-0.139	0.262	0.523		
11	**Spiritual Happiness**	-0.336	0.248	0.27	-0.242	0.141	0.464	0.293	0.363	-0.22	-0.182	0.986	
12	**Mental Health**	0.406	-0.383	-0.376	0.477	-0.226	-0.363	-0.397	-0.461	0.341	0.379	-0.387	0.558

Divergent validity is the third criterion for the analysis of external models' goodness of fit. Divergent validity is the value illustrating how well any construct is distinguished from others based on an experimental criterion. This validity is to be calculated in two levels of nominator and latent variable. At the nominator level, cross-loads are applied to calculate the divergent validity, requiring that any construct's corresponding nominator would be higher than a total load of that nominator on other study constructs. This condition has been met for all the nominators; however, due to space constraints, it has been removed from the table. Fornell-Larcker criterion has been applied for latent variables, such that the square root of AVE for any latent variable must be higher than the correlation of that constructs with other constructs within the study model. The main logic behind this construct is that any construct must include a higher variance with its nominators than other constructs (Fornell-Larcker, 1981). The results displayed in Table 5 illustrate that all the latent variables are of an acceptable divergent validity. Besides, considering the reliability, convergent and divergent validity results, one can argue that the external models are highly capable of measuring the study's latent variables. Therefore, the study's internal (structural) model is to be studied in later sections of this paper.

Findings and Discussion

The main purpose of this study is to investigate the correlation between creativity, mental health, the parent's popularity of high school students, and spiritual happiness as well as design a model of spiritual happiness. To study the correlation between study variables (i.e. creativity, spiritual happiness, mental health, and parents' popularity), Spearman's Correlation Coefficient has been used because some of the variables weren't of a normal distribution. Study variables are significantly correlated within a 95% confidence interval ($p < 0.05$). Moreover, it has been observed that the correlation coefficient between creativity and spiritual happiness, creativity and parent's popularity, spiritual happiness and parent's popularity are positive. Thus, it can be argued that any increase within any of these variables would lead to an increase in another, and any decrease in a variable would lead to a decrease in another. Meanwhile, the correlation coefficients between mental health and creativity, mental health and spiritual happiness, and mental health with parents' popularity are negative and are inversely correlated (since any increase in mental health score suggests the presence of a mental disorder and its decrease would lead to lower levels of creativity, spiritual happiness, and parents' popularity.

The results displayed in Table 6 have been derived based on the following hypotheses:

Hypothesis 1: there's a significant correlation between students' creativity and their spiritual happiness.

According to Table 6, the significance value of this path is 0.015 and is lower than 0.05. Thus, with a 95% certainty, one can conclude that creativity would significantly increase spiritual happiness. Thus, this hypothesis is validated. Therefore, one would argue that there's a positive significant correlation between students' creativity and their spiritual happiness.

Hypothesis 2: there's a significant correlation between parents' popularity and students' spiritual happiness.

According to Table 6, one can decipher that the significance value of this path is 0.001 and is lower than 0.05. Thus, it can be argued with 95% confidence that parents' popularity is significantly correlated with students' spiritual happiness. Further, considering the path coefficient of 0.236, it can be concluded that this correlation is positive. Therefore, this hypothesis would be accepted and one can argue that there's a positive significant correlation between parents' popularity and students' spiritual happiness.

Hypothesis 3: there's a significant correlation between students' mental health and their spiritual happiness.

According to Table 6, one can observe that the significance value of this path equals 0.001 and is lower than 0.05. Thus, it can be argued with 95% confidence that mental health is significantly correlated with spiritual happiness. Moreover, considering the path coefficient value which is equal to -0.264, one can conclude that this correlation is negative. Therefore, this hypothesis is accepted. This, it can be argued that there's a negative significant correlation between students' mental health and their spiritual happiness.

Hypothesis 4: There's a significant correlation between creativity and students' mental health.

According to Table 6, one can observe that the significance of this path is 0.008 and is lower than 0.05. Thus, it can be argued with 95% confidence that creativity is significantly correlated with mental health. In addition, considering the value of the path coefficient (i.e. -0.289), we can conclude that such correlation is negative. Thus, the hypothesis would be accepted and it can be argued that there's a negative significant correlation between students' creativity and their mental health.

Hypothesis 5: there's a significant correlation between parents' popularity and students' mental health.

According to Table 6, the significance of this path equals 0.001 and is lower than 0.05. Thus, it can be argued with 95% confidence that parents' likeability is significantly correlated with students' mental health.

Also, according to the value of the path coefficient, which is equal to -0.445, it is concluded that this effect is negative. Therefore, the hypothesis is confirmed. Hence, it can be said that there is a negative and significant relationship between parents ' popularity and students' mental health.

Hypothesis 6: Mental health plays a mediating role between students' creativity and spiritual vitality.

According to Table 6, it can be seen that the significant value of this path is equal to 0.276 and more than 0.05. Therefore, it can be said with 95% confidence that mental health does not play a mediating role between creativity and spiritual happiness. But considering the value of the path coefficient which is equal to 0.076, it is concluded that this effect is positive and non-significant. Therefore, the hypothesis is not confirmed. It can be said that creativity has no significant effect on spiritual happiness due to the mediating role of mental health.

Hypothesis 7: Mental health plays a mediating role between parents 'popularity and students' spiritual happiness.

According to Table 6, it can be seen that the significant value of this path is equal to 0.021 and less than 0.05. Therefore, it can be said with 95% confidence that mental health plays a mediating role between parents' popularity and spiritual happiness. Also, considering the value of the path coefficient, which is equal to 0.117, it is concluded that this effect is positive and significant. Therefore, the hypothesis is confirmed. Therefore, it can be said that the parents' popularity has a positive and significant effect on spiritual happiness due to the mediating role of mental health.

Table 5. Results of Hypotheses

Hypothesis	γ	t	P Value	Result
H1: creativity ➔spiritual happiness	0/262	2/373	0/015	Accept H1
H2:Parent's popularity➔ of spiritual happiness	0/236	4/6	0/001	Accept H2
H3: Mental health➔ spiritual happiness	-0/264	3/646	0/001	Accept H3
H4: creativity➔ mental health	-0/289	2/87	0/008	Accept H4
H5: parent's popularity➔ of mental health	-0/445	3/676	0/001	Accept H5
H6: creativity➔ mental health➔spiritual happiness	0/076	1/09	0/276	RejectionH6
H7: parent's popularity➔ mental health➔spiritual happiness	0/117	2/33	0/021	AcceptH7

In the internal model section, the relation between latent variables of the research is examined. The evaluation criteria of the internal model are path coefficients; the self-management procedure has been used to study their significance. These coefficients, along with T-values, have a significant level in Table 6.

Table 6. R2 and Q2 Indicators (Redundancy) of the Internal Research Model

Variable	R2	Q2
Spiritual Happiness	0/124	0/184
Mental Health	0/248	0/036

The next criterion, coefficient of determination (R^2), is the most common criterion for evaluating the internal model which indicates the accuracy of the model prediction. The three values of 0.19, 0.33, and 0.67 are considered the criterion values for the weak, medium, and strong values, respectively (Chin, 1998). As the results of Table 7 show, the coefficients of determination for both variables are average. The last criterion for evaluating the internal model is Q^2 Stone-Geisser (1974) which indicates the predictive fit of the model. This criterion is calculated by the ignore procedure where data points in the endogenous variable reagents are omitted and parameters are estimated using the residual points. For an endogenous latent variable, the Q^2 value greater than zero indicates the predictive fit of the path model for this particular structure. The results of this criterion are presented in Table 7 and are desirable.

Checking the Overall Model

After evaluating the measurement and structural models, the general model (sum of measurement and structural models) should also be considered. For this purpose, Tenenhaus et al. (2004) have introduced the GOF index. This index is obtained from the geometric mean of commonalities (Communality) and the coefficient of determination. The closer this index is to one, the higher the strength and quality of the model.

As can be seen in the table above, the GOF criterion value was 0.366 and more than 0.36, which is a strong fit for the overall research model.

$$GOF = \sqrt{\overline{Communalities} \times \overline{R^2}}$$

Table 7. R2 and Q2 Indexes (redundancy) of the Internal Model of the Research

Variable	R^2	Communality	GOF
Spiritual happiness	0/184	0/664	0/366
Mental health	0/248	0/583	
Average	0/216	0/623	

In short, it can be said that the first descriptive statistics of research variables including central indicators and dispersion and correlation coefficients were presented. Then, the validity and reliability of the research measurement model were evaluated and then the normality test of variables was pointed out. Then, a preliminary estimate of the model was obtained; after applying the necessary modifications, the main research model was obtained and through path analysis, the research hypotheses were examined to finally reflect the results.

The results of this study are consistent with many results, including Than et al. (2021) who concluded that there is a significant relationship between creativity and spiritual happiness; Bo Jacks et al. (2014) in their research showed engaging in a creative work reinforces both positive emotions (hedonistic well-being) and good performance.

Dirzite et al. (2021) also showed that there is a statistically significant relationship between spiritual happiness and creativity. Ski et al. (2016) that creativity capacity was not significantly correlated with spiritual happiness, but it was significantly correlated with positive and negative emotion scales and their absolute sum. Kar and Sharma (2021) showed that all scopes of creativity and happiness have a positive correlation with each other. Stearns (2019,)indicated that there is a correlation between parents' popularity and their children's happiness. Mamghani et al. (1398) showed that there is a relationship between parents' creativity and popularity and parenting styles. Ahmadi Gatab et al. (2011) showed that there is a relationship between mental health and spiritual happiness. Lombardo et al. (2018) showed that there is a correlation between mental health and spiritual happiness. The study of Eligbileh and Zachariah et al. (2011) showed that participation in creative activities prevents mental disorders. Kalantar Qureshi et al. (2012) stated that conscience, openness to experience, and agreeableness have a direct and positive relation with creativity and neuroticism has an inverse and significant relationship with creativity.

The results of the study do not agree with the results of some researchers, including, Fink (2014) showed that there is no relation between mental health and creativity. He showed that some creative thoughts of schizotypal and schizophrenia people can be the same as creative people. Fink has many opponents and the majority of researchers questioned his research. One of the limitations of this research is gender. In this study, only female students have been

studied, for future research, it is suggested to compare these variables in both sexes. One of the strengths of this research is the development of the spiritual happiness model, which is an innovative model, and schools and children and adolescents' psychiatric clinics can benefit from its results.

Limitations of Study

All researches have limitations in addition to their strengths. One of the limitations of this research was gender. The present research was conducted only on female students. As a result, caution should be taken in generalizing the results to boys. The next limitation of this research was age. This research was conducted on female students in the first grade of high school. As a result, caution should be taken to generalize the results to other age groups.

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Interview Article

An interview with James Kaufman: creativity as we approach 2023 !

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Abstract

The elusive construct of "creativity" remains a major focus of empirical and investigative concern. In this interview, James Kaufman, one of the leading figures in the field responds to singular questions about the construct of creativity, the measurement of creativity and the current "state of the art" of creativity evaluation and assessment as we approach the year 2023.

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Introduction

Prof. Shaughnessy: James, I understand that you and Robert Sternberg have just co-edited a book on Creativity- How did this come about?

Prof. James Kaufman*: Bob and I edited the second edition of the Cambridge Handbook of Creativity and were pleased with the contributions and thought that a modified, shorter version with more curricular elements could be a great textbook. It was hard selecting the key topics, but ultimately, we are happy with the result. Bob was my graduate advisor, and I love that I still get to collaborate with him.*

Prof. Shaughnessy: E. Paul Torrance- is supposedly the " father of creativity". What do you or the authors see as his contributions?

Prof. James Kaufman*: Torrance's contributions are enormous; obviously, there are his famous tests, but there is also so much more. His interest and research on so many dimensions of creativity is sometimes overlooked because his tests are so well-known. To give but one example, his work on equity and how creativity could help gifted programs be more fair and diverse was decades ahead of its time.*

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In addition, Torrance's encouragement of multiple generations of scholars is hard to overstate. I have heard so many stories of his generosity and kindness – and experienced it as a graduate student and young professional – that I think he was just as remarkable a human being as a pioneering researcher. I have heard many stories of his kindness and sometimes paying graduate student tuition and stipends out of pocket.

I remember I discovered creativity in my third year of graduate school and did a thesis on creative writing (a synthesis of the literature). My father suggested that I send it to Torrance (they were friends when they were both at Georgia).

I felt a little silly; he was the biggest name in the field and I was a complete novice. But I did, and Torrance wrote me back a generous, encouraging letter that I still have to this day. We kept in some level of touch for the rest of his life and I think about him often.

In general, I think mentoring is often overlooked. I was lucky enough to have a great undergraduate mentor in John Horn (and, in creative writing, T. Coraghessan Boyle) and an amazing graduate mentor in Bob Sternberg. Plus, of course, my folks informally mentored me.

Prof. Shaughnessy: How did you get interested in creativity?

Prof. James Kaufman*: I was a creative writing major in college and wanted to write novels. At some point, I realized I just wasn't quite good enough. I shifted to plays (and wrote plays and musicals for many years thereafter), but wasn't at the point of wanting to risk everything on the chance I would make it and support myself. I turned my psychology minor into a major and applied to several graduate schools and was lucky enough to get in to work with Sternberg at Yale. Even then, I didn't gravitate toward creativity.*

Near the end of my second year of graduate school, I was struggling a bit – I hadn't discovered my passion yet. I decided to explore creativity and Sternberg gave me a recommended reading list – his in-press 1999 Handbook of Creativity, plus works by Csikszentmihalyi, Simonton, Amabile, and others. I spent the summer in my parents' basement, reading everything cover to cover, and I was hooked!

Prof. Shaughnessy: How do we currently study this elusive construct called creativity?

Prof. James Kaufman*: I think there's a lot of exciting work being done in measurement. I do feel like we are still a bit too reliant on divergent thinking as the primary mode of assessment, but there is exciting new work being done: physics-based games that stealthily measure divergent thinking (by Val Shute and Ahmad Rahimi), new approaches to figural divergent thinking (by Baptiste Barbot), and a lot of advances on automatic scoring not only of divergent thinking but actual text production (by Dan Johnson, Roger Beaty, and others).*

I still am a fan of the Consensual Assessment Technique and am hoping that continued advances in machine learning allow us to be able to automatically score a wide variety of domains. My enthusiasm is tempered by the awareness that any high-stakes use of such method will immediately be set upon by rich folks trying to game the system, but... I remain optimistic.

Prof. Shaughnessy: What are some of the positive outcomes of creativity?

More and more I have become interested in this question!

Prof. James Kaufman*: It feels almost silly on one hand because creativity is generally considered a positive attribute or ability. But I did a paper with Marie Forgeard a few year back where we found that in general the field is not good at addressing this issue; most articles look at what factors might enhance creativity, not how creativity might enhance specific positive outcomes.*

I just finished a new book for Cambridge, The Creativity Advantage. I group the existing work into five categories: Self-insight, Healing, Connection, Drive, and Legacy.

Self-insight is all about identity, how narratives can help us organize and understand our lives while freeing up cognitive resources. Healing was a fascinating topic to dive into – some great work by Marie Forgeard, Jennifer Drake, Hod Orkibi, Daisy Fancourt, and many others. Creativity is associated with post-traumatic growth, it can help restore emotional equilibrium, reduce stress and anxiety.... So much more.

Connection is how creativity brings people together, whether by creating together, experiencing art together as in Jeff Smith's Museum Effect, or simply how a core cluster of creative traits are also associated with prosocial tendencies. Drive is passion, flow, motivation, and progress. Legacy I found quite interesting because it's how we deal with the fact that we know we're going to die. We can cope with this grim news with symbolic immortality. Otto Rank, Robert Jay Lifton, and many others have written about this issue and the different pathways we can find, but Stephen Sondheim put it most succinctly in Sunday in the Park with George, when he has a character sing about how everything comes down to children and art.

Prof. Shaughnessy: What are some of the positive personality traits/characteristics that seem to emanate from creativity?

Prof. James Kaufman*: Creative people tend to be more open to new experiences and new ideas. They tend to be better able to tolerate ambiguity or uncertainty. As a result, there are a number of positive attributes that can also be associated with creativity. Perhaps the most interesting is that creative people may be less likely to show prejudice, stereotypes, or bias.*

There have been several promising studies on this, mainly in Europe, and one of my graduate students, Sarah Luria, is doing her dissertation on this broad topic. I've also been doing some theoretical work with Vlad Glăveanu on this broader topic (positive creativity-related traits) as well.

Prof. Shaughnessy: Thanks for this interview

About Dr. James C. Kaufman

Dr. James C. Kaufman is a Professor of Educational Psychology at the University of Connecticut. He is the author/editor of more than 50 books, including Creativity 101 (2nd Edition, 2016) , the Cambridge Handbook of Creativity (with Robert Sternberg; 2nd Edition, 2019), and the forthcoming The Creativity Advantage for Cambridge Press. He has published more than 400 papers, including the Four-C Model of Creativity (with Ron Beghetto. He is a past president of Division 10 (Society for Psychology of Aesthetics, Creativity, & the Arts) of the American Psychological Association (APA) and a former present of the American Creativity Association. James has won many awards, including Mensa's research award, the Torrance Award from the National Association for Gifted Children, and APA's Berlyne, Arnheim, and Farnsworth awards. He co-founded two major journals (Psychology of Aesthetics, Creativity, and the Arts and Psychology of Popular Media Culture). He has tested Dr. Sanjay Gupta's creativity on CNN, appeared in the hit Australian show Redesign Your Brain, and narrated the comic book documentary Independents. He wrote the book and lyrics to Discovering Magenta, which had its NYC premiere in 2015. He has co-authored a book on bad baseball pitchers with his father and a book on Pseudoscience with his wife. He is finishing a book on theatre and creativity with composer Dana Rowe, Taking Center Stage: Lessons in Creativity from Hamilton, Gypsy Rose Lee, and more!

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