Creativity Quotient of Undergraduate Students in Higher Education Institutes within Thailand

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Abstract

The creativity quotient (CQ) is an essential competency strongly linked to the innovation of a person's future development. Creativity quotient scores are calculated by ideational fluency scoring and are derived from the fluency and flexibility of the responses. A total of 1,200 undergraduate students from various types of universities (public and autonomous, Rajabhat University, Rajamangala University of Technology, and private) within Thailand were tested using a classical divergent thinking task to measure CQ. The purpose of this study was to evaluate and compare the demographic characteristics, and the CQ of undergraduate students in Thailand. The results revealed a statistically significant difference ($p < 0.01$) among the type of university, gender, field of study, year of study, and Grade Point Average (GPA). The highest CQ score among undergraduate students was 18, and the lowest score was 0. The total average CQ score was 5.74, and the standard deviation was 2.82. Moreover, the results indicated that students who studied in the Rajabhat University had the highest CQ scores. The study also showed that year 4 and above female students in Humanities and Social Sciences with GPAs between 3.51 and 4.00 had the highest CQ scores. These findings may be used as the primary data for educators and administrators in higher education to develop strategies to enhance students' creativity and innovation.

Keywords

Creativity quotient; fluency and flexibility; higher education institute

Introduction

International education systems place great importance on developing the creativity of learners at all levels, especially in higher education. The students need to think and work creatively in digital and non-digital environments to develop unique and useful innovations (Stauffer, 2020). In Thailand, the government specified in the 12th National Economic and Social Development Plan for 2017–2022 that in order to drive the country, the focus of its future national development must be on innovation and creativity (NESDC, 2017). The plan highlighted creativity and the development of innovation by focusing on designing new inventions, products, and service formats with added economic value. Additionally, Thailand established the National Research Agenda with a clear, specific, and consistent focus on national development goals using new commercial use strategies for innovation development to integrate research and development. Human development, especially the creative competency of students in higher education systems, is also considered the primary goal of Thailand's educational reform (NESDC, 2017). This competency must be developed for Thai citizens, seeing as upon graduation higher education students will pursue various careers in society that will be a part of the future national development (OHEC, 2018).

The Ministry of Higher Education, Science, Research and Innovation (MHESRI) has determined a vital mission to prepare Thai people for the 21st century, and to use knowledge and innovation to develop the country. Higher education is the educational level that continues from the secondary level. It has a duty to promote and support people to keep up with global changes, keep in line with the country's needs, supervise the research and innovation of higher education institutions, and promote cooperation in producing a specialized high-level workforce (OHEC, 2018).

Higher educational institutions in Thailand are comprised of four main university groups. The first is the public and autonomous universities, consisting of two subtypes (government system and autonomous universities). The second type is the Rajabhat University system, located in the central and regional parts of the country, which were established for local development. The third type is the Rajamangala University of Technology system, which focused on producing students for the labor market and produce professional graduates to serve the country. The last type is the private universities that operate under the management of private agencies in Thailand (OHEC, 2018).

However, according to the importance of students' creativity in all types of universities, the basic knowledge of creativity has not been investigated in Thailand. Therefore, this result of the study provides essential knowledge about the creative capability of the future workforce, the nation's youth. Also, it gives a characteristic of the creative competency among students in higher education and is a reference for evidence in developing their students.

The creativity quotient (CQ) is a cognitive competency linked to the successful criteria of innovation (Runco & Acar, 2012). It is considered the critical aspect of divergent thinking, which is the key indicator that can measure and predict an individual's creativity. The measurement for the creative product itself, as proposed by Snyder et al. (2004) and Bossomaier et al. (2009), is an objective approach to calculating ideational fluency. Ideational fluency is the sum of calculations derived from the fluency and the number of varying response categories or flexibility. According to this method, the test subjects are presented with familiar stimuli. The results of the responses are counted and grouped under the

principle that an equal score should not be given to every answer. If the responses are different from the other categories, the score should be given greater weight than answers that fall into the same category.

A literature review related to the state of creativity revealed that the creativity of students in kindergarten, primary, and secondary schools tended to be stable and decreasing with age (Kim, 2011). This study by Kim (2011) was a longitudinal study using the Torrance Tests of Creative Thinking with the result of this study to likely impact the outcome of education to promote creativity. Besides, a previous thorough investigation of the CQ testing to explore the state of student creativity at different levels of education revealed that the CQ of students at primary, secondary, and higher levels in Iceland were significantly different (Leahy, 2016). This result of Leahy's (2016) study reflected the educational conditions that enhance the creative ability at each education level within Iceland. The study by Lucas et al. (2013), which focused on design students, revealed the importance of creativity in the education system and the effort to develop a more useful measure of divergent thinking.

Moreover, previous studies have shown that some demographic characteristics, including gender, age, and GPA, are related to the level of creativity ability (Awamleh et al., 2012; Gajda, 2016; Lucas et al., 2013; Tanujaya et al., 2017). For instance, a study in Jordan revealed that female students who showed fluency and flexibility in creative thinking scored higher than male students. The study also showed that seven to eight-year-old students had higher creative thinking scores than six-year-old students. The study also indicated that students who had a GPA of 3.20 or above had creative thinking scores higher than students with lower GPAs. This study used demographic questionnaires and the Torrance Formal Test Form B (TFTFB) to explore the relationship of selected variables (sex, age, and GPA) with the creativity ability of 63 students (Awamleh et al., 2012). From the above studies, the crucial characteristics of students should be recognized and explored to explore ways to support the students to have a high creativity ability.

The objectives of this study were to evaluate the CQ among students in each type of higher education institutions and to compare the demographic characteristics, including the type of university, year of study, field of study, gender, and age, with the CQ among students among all types of higher education institutes in Thailand. It was hypothesized that students in different types of universities, years of study, field of study, gender, and age had statistically significant differences in CQ.

Method

Study design and setting

This finding is a part of research titled "Psychological antecedence variables of innovative behavior of the students in higher education." This analysis used a descriptive study that allowed the researcher to search for an explanation of the CQ of undergraduate students from various types of universities within Thailand. The sample consisted of four types of universities under the MHESRI (public and autonomous universities, Rajabhat University, Rajamangala University of Technology, and private universities).

Participants and sampling

In this study, the sampled population were male and female undergraduate Thai students in the academic year 2019 in universities under the MHESRI. Multi-stage random sampling was employed from each sector in Thailand; North, South, Northeastern, and Central. First, the universities within Thailand were classified into four types. Second, four universities in each of the four types were randomly selected in each sector of Thailand. In total, 16 universities were selected. Next, each university selected must have general education classes, and those classes must have undergraduate students who were registered at all levels. Then, the classes were randomly selected from those students to collect data.

After the research ethics committee approved the research proposal, the researchers sent an official letter to the selected universities to request data collection. The researchers coordinated with the teaching staff to collect the data in available classes. Purposive sampling was used to recruit the participants. There were 1,200 participants who met the inclusion criteria in the study. The inclusion criteria were: 1) undergraduate student, 2) proficient at reading and writing Thai, and 3) willing to participate in the study. Exclusion criteria were undergraduate students with a physical illness or disability that impinged their ability to answer the questionnaire. However, no student met the exclusion criteria in this study.

Research instruments

Instruments in this study consisted of two parts. First, the researchers developed the demographic characteristics that included the type of university, gender, age, GPA, year of study, and field of study. Second, the instrument in this study was a CQ test initially developed by Snyder et al. "to access the potential creativity of an individual and is based on ideational fluency, where a person is asked to generate all possible uses for a familiar item like a piece of paper" (2004, p. 415). Besides, CQ scoring led to a more objective and easier to interpret CQ of the sample. The CQ test was used in this study. The CQ test has a question that is "What are the benefits of a piece of paper?" The researchers applied this test in this study to describe the CQ of undergraduate students in Thailand. The test was focused on measuring the creativity capacity in terms of (i) fluency, which accounts for the number of ideas, and (ii) flexibility, which is the number of definite categories the ideas hit by the person included.

For verification of the reliability of the CQ test, the stability coefficient analysis was used in the study. The researchers conducted an initial CQ pilot test with 40 university students and a retest 15 days later with the same group. The CQ scores of 1st and 2nd rounds were analyzed using the Pearson product-moment correlation coefficient (r). The finding showed that the CQ score of the first test was positively significant (p = <.01) related to the second test at a high level. The reliability of the CQ test was .85, while the reliability of fluency and flexibility was .61 and .83, respectively. Details are presented in Table 1.

Table 1: Metric Coefficient of CQ Scores and Indicators of Test-Retest

Indicator	CQ_{t1}	CQ_{t2}	FLU_{t1}	FLU_{t2}	$FLEX_{t1}$	$FLEX_{t2}$
CQ_{t1}	1.00					
CQ_{t2}	.85**	1.00				
FLU_{t1}	.54	.50	1.00			
FLU_{t2}	.73	.82	.61**	1.00		
$FLEX_{t1}$	.43**	.35*	.04	.08	1.00	
$FLEX_{t2}$	.26	.17	.08	.08	.83**	1.00
M (n =40)	9.98	9.85	4.23	4.35	4.83	4.53
SD	5.58	5.55	1.51	1.40	2.08	1.88

*Note: ** p-value = .01; M =mean; SD =Standard deviation; CQ_{t1} = Creativity quotient score 1st time; CQ_{t2} = Creativity quotient score 2nd time; FLU_{t1} = Fluency in the 1st time; FLU_{t2} = Fluency in the 2nd time; $FLEX_{t1}$ = Flexibility in the 1st time; and $FLEX_{t2}$ = Flexibility in the 2nd time.*

The creativity capacity score is considered as the response to stimuli of the test subject. The response should not be influenced by learning or benefiting from the use of something familiar. The creativity capacity score was categorized into groups of answers. Then, the scores were analyzed to describe fluency and flexibility. In this study, the CQ score was analyzed from the (i) fluency, which was analyzed by counting the number of ideas within 5 minutes, and (ii) the flexibility, which was analyzed using the CQ formula (Snyder et al., 2004), as shown in Equation 1 below,

$$CQ = 1.44 \ln \{(1+u1)\ (1+u2)\ldots\ldots\ (1+uc)\} \qquad \text{Eq. 1}$$

where u1 is the number of answers in group 1, u2 is the number of responses in group 2, and uc is the number of responses in group c. Details of examples of the CQ calculation are in Table 2.

Table 2: Examples of the CQ Calculation

Utilization group							
surface making	**toy/game**	**utensil**	**clothes**	**wrapping**	**strange use 1**	**strange use 2**	**strange use 3**
take note	ball	tube	hat	wrapping paper	lure the attention of dogs	amplify sound	
write	aircraft	box	pants	envelop			
draw	flying kite	bookmark	arm loop	paper bag			
paint	origami	clean the glass	absorb sweat				
print							
u1 = 5	u2 = 4	u3 = 4	u4 = 4	u5 = 3	u6 = 1	u7 = 1	-

Note: Strange use 1-3 = The response lists cannot be classified into any group.

Calculate the number of responses in each group according to the following formula.

$$CQ = \log_2 \{(1+u1)\ (1+u2)\ldots\ldots\ (1+uc)\}$$

Example of calculations from the above responses

Fluency = 22
Flexibility = 7
CQ = log2 {(1+5) (1+4) (1+4) (1+4) (1+3) (1+1) (1+1) }..... (1)
CQ = log2 {(6 x 5 x 5 x 5 x 4 x 2 x 2)} .....(2)
CQ = 1.44 In 12000 .....(3)
CQ = 13.55 .....(4)

Data collection

Data collection began after the review board on Human Subjects of Chulalongkorn University approved the research proposal. Data collection took place at the 16 universities in the four regions of Thailand from December 2019 to February 2020. Before data collection, the researchers sent the official letter to the president of each respective university for permission to collect data. Then, the researchers made an appointment with the teaching staff at the available time of the participants to collect data. At that point, the demographic data and CQ test were distributed to the participants. In total, 1,200 participants individually read and answered all test questions. The researchers then collected and completed the tests for the data analysis.

Statistical analysis

In this study, descriptive statistics and CQ formula analysis were used. Descriptive statistics were performed for the demographic data, including the mean, percentage, standard deviation (SD), coefficient of variation (CV), Skewness, Scheffe, and Dunnett's T3. Also, ANOVA was used to compare the CQ of the undergraduate students classified by each demographic characteristic.

Results

Demographic characteristics

The participants in this study were 1,200 undergraduate students from four university groups (public and autonomous, Rajabhat University, Rajamangala University of Technology, and private universities). Most participants were undergraduate students from the public and autonomous university group (42.91%), followed by the Rajabhat University group (32.00%), with more females (65.14%) than males (34.28%) subjects. Most participants were aged ≤ 19 years old (36.75%) and were studying in their second year (33.19%), followed by those in the first year (29.20%), and most had a GPA between 2.51–3.00 (28.12%) followed by 3.01–3.50

(26.96%). The main field of study was Humanities and Social Sciences (39.10%). The demographics of the subjects are summarized in Table 3.

Table 3: Summary of Sample Characteristics

Characteristics (N = 1,200)	Number (n)	Percentage (%)
Type of University		
Public and autonomous university	515	42.91
Rajabhat University	384	32.00
Rajamangala University of Technology	109	9.08
Private university	192	16.00
Gender		
Male	412	34.28
Female	783	65.14
None identified	5	0.58
Age		
19 years old or less	441	36.75
20 years old	352	29.33
21 years old	255	21.25
Greater than 21 years old	152	12.67
Year of Study		
1st year	351	29.20
2nd year	397	33.19
3rd year	311	25.87
4th year and above	141	11.73
GPA		
2.00 and below	52	4.33
2.01 - 2.50	215	17.89
2.51 - 3.00	336	28.12
3.01-3.50	324	26.96
3.51-4.00	171	14.23
Non-identified	102	8.49
Field of study		
Science and Technology	291	24.21
Health Sciences	90	7.49
Humanities and Social Sciences	468	39.10
Other	351	29.20
Total	**1,200**	**100.00**

The CQ of participants classified by demographic characteristics

The CQ of undergraduate students in the different university types was found to be distinctive. There were two components of CQ among undergraduate students in this study. The first was fluency, where participants had a fluency thinking score of 13.32 ± 7.35 (mean ± SD) with a CV of 55.18%. The Kurtosis value (Ku) of the fluency was 2.37, which means that the participants' fluency value had a Ku level higher than the normal level. Moreover, the skewness value of fluency (Sk) was skewed right (1.22), meaning that most participants had a lower fluency score than the mean level.

The second component was flexibility thinking, where the participants had a flexibility value of 3.95 ± 1.43, with a CV of 36.02%. The Ku value of 0.17 means that the data distribution was

close to a moderate level. The Sk value of the flexibility was close to the normal level (Sk = 0.16), meaning that most participants had flexibility thinking close to the mean level.

The participants' total average CQ score was 5.74 ± 2.82, with a CV of 49.10%. The Ku value was close to the normal level (Ku = 0.93), while the CQ data distribution was skewed to the right (Sk = 1.15), meaning that the majority of the participants had a lower CQ score than the mean. Also, the results show that the participants from the Rajabhat University group had a higher CQ mean score (M = 6.57, SD = 3.18) than other universities; female participants had a higher CQ mean score (M = 5.89, SD = 2.89) than male participants; the age of the participants who were > 21 years had a higher CQ mean score (M = 5.98, SD = 3.03) than other young participants; for the participants who were in the 4th or above year of study had a higher CQ mean score (M = 6.24, SD = 2.91) than the participants in other years of study; the participants who got GPA of 3.51-4.00 had a higher CQ mean score (M = 6.80, SD = 2.74) than the participants who got GPA in other levels; and the participants who studied in the Humanities and Social Science field had a higher CQ mean score (M = 6.32, SD = 2.82) than the participants who studied in other fields. The results are presented in Table 4.

Table 4: Creativity Quotient of Participants Classified by Demographic Characteristics

Characteristics		n	Fluency		Flexibility		Creativity Quotient	
			M	SD	M	SD	M	SD
Type of University	Public and autonomous university	515	13.22	6.72	3.99	1.48	5.22	2.53
	Rajabhat University	384	14.17	8.57	3.96	1.47	6.57	3.18
	Rajamangala University of Technology	109	12.54	6.40	3.77	1.18	5.49	2.45
	Private university	192	12.11	5.61	3.97	1.44	4.97	2.14
Gender	Male	412	12.61	6.51	3.87	1.45	5.46	2.67
	Female	783	13.70	7.73	4.00	1.42	5.89	2.89
	None identified	5	13.00	7.85	3.00	1.41	5.29	2.43
Age	19 years or less	441	13.56	7.50	3.86	1.37	5.67	2.80
	20 years	352	13.56	7.52	4.03	1.43	5.66	2.84
	21 years	255	12.71	6.64	3.97	1.44	5.85	2.71
	greater than 21 years	152	13.11	7.63	3.98	1.62	5.98	3.03
Year of study	1st year	351	13.33	7.01	3.91	1.37	5.87	2.63
	2nd year	397	13.53	8.17	3.94	1.47	5.24	2.96
	3rd year	311	12.79	6.36	4.01	1.38	6.02	2.72
	4th year or more	141	13.88	7.74	3.94	1.60	6.24	2.91
GPA	≤ 2.00	52	11.88	5.82	3.60	1.46	4.35	1.84
	2.01 - 2.50	215	11.97	6.70	3.76	1.53	4.93	2.34
	2.51 - 3.00	336	12.79	6.91	3.92	1.36	5.58	2.63
	3.01-3.50	324	14.25	8.42	3.94	1.34	6.05	3.20
	3.51-4.00	171	14.84	7.29	4.41	1.50	6.80	2.74

Characteristics		n	Fluency		Flexibility		Creativity Quotient	
			M	**SD**	**M**	**SD**	**M**	**SD**
Field of study	Non-identified	102	13.21	6.46	3.87	1.51	6.00	2.86
	Science and Technology	291	13.05	7.86	3.82	1.49	5.65	2.97
	Health Science	90	12.25	7.02	3.92	1.65	5.64	2.70
	Humanities and Social Science	468	14.00	6.86	4.10	1.32	6.32	2.82
	Others	351	12.91	7.57	3.85	1.46	5.06	2.55
Total		**1,200**	**M**	**SD**	**M**	**SD**	**M**	**SD**
CQ Min = 0.00 Max = 18.00			13.32	7.35	3.95	1.43	5.74	2.82
Flu Min = 0.00 Max = 50.00			**Sk**	**Ku**	**Sk**	**Ku**	**Sk**	**Ku**
Flex Min = 0.00 Max = 9.00			1.22	2.37	.16	.17	1.15	.93

Note: M = mean, SD = Standard Deviation, Sk = Skewness, Ku = Kurtosis

Comparison of the CQ with the participants' demographic characteristics

Comparison of the CQ against the demographic characteristics, including the type of university, field of study, year of study, GPA, age and gender, was performed. A one-way ANOVA of the variation in the CQ value between participants in each group was performed. If the variation was equal, the data were compared between pairs using a Scheffé Test, but if unequal, then Dunnett's T3 test was used. The results revealed that the participants studying in different universities, fields of study, year of study, gender, and GPA were all significantly different ($p < 0.01$) in their CQ score. However, the age of participants was not significantly different ($p < 0.59$). The results are summarized in Table 5.

Table 5: Comparison of Creativity Quotient in Undergraduate Students in Thailand

Creativity Quotient	n	M	SD	Homogeneity of variances test		ANOVA		Pair Comparison
				Levene	***p*-value**	**F**	***p*-value**	
Type of university				22.38**	.00	24.79**	.00	U2 > U1, U3, U4
Public and autonomous university (U1)	515	5.22	2.53					
Rajabhat University (U2)	384	6.57	3.18					
Rajamangala University of Technology (U3)	190	5.49	2.45					
Private university (U4)	192	4.97	2.14					

Creativity Quotient	n	M	SD	Homogeneity of variances test		ANOVA		Pair Comparison
				Levene	*p*-value	F	*p*-value	
Field of study				8.79**	.00	13.97**	.00	M3 > M1, M2, M4
Science and Technology (M1)	288	5.65	2.97					
Health science (M2)	88	5.64	2.70					
Humanities and Social Sciences (M3)	469	6.32	2.82					
Others (M4)	348	5.06	2.55					
Year of Study				1.17	.32	6.96**	.00	C3 > C2 C4 > C2
1st year (C1)	350	5.94	2.89					
2nd year (C2)	397	5.46	5.35					
3rd year (C3)	309	6.02	2.72					
4th year (C4) and above	138	6.24	2.91					
GPA				11.62**	.00	12.47**	.00	1) G3 > G1, G2 2) G4 > G1, G2 3) G5 > G1, G2, G3 4) G6 > G1, G2
less than and 2.00 (G1)	52	4.35	1.84					
2.01 - 2.50 (G2)	212	4.93	2.34					
2.51 - 3.00 (G3)	337	5.58	2.63					
3.01-3.50 (G4)	324	6.05	3.20					
3.51-4.00 (G5)	166	6.80	2.74					
None (G6)	102	6.00	2.86					
Age				0.62	0.61	0.65	.59	Not difference
19 years or less	441	5.67	2.80					
20 years	352	5.66	2.84					
21 years	255	5.85	2.71					
Greater than 21 years	152	5.98	3.03					
Gender				7.35	.01	2.58**	.01	Female > Male
Male	412	5.46	2.67					
Female	783	5.89	2.89					

*Note: ** p-value = .01; F = F-test (Analysis of variance)*

Discussion

The results of this study revealed that most participants had an average CQ of 5.74. This is essential educational information that should be recognized. In Thailand, there are different types of universities under the MHESRI. The MHESRI focuses on the development of creativity capacity among students, including undergraduate students. A major goal in developing students' creativity capacity is to develop students with the characteristics and 21st century skills required to be creative and innovative (OHEC, 2018). Also, the result of this study reflected a positive outcome of educational management in promoting the creativity of university students in each region of Thailand.

However, this study revealed that the CQ score of most of the participants was lower than the average. This deficiency suggests that this student group urgently needs to develop their creative competency. A comparison of the CQ among the participants classified by demographic data revealed a significant difference in the average CQ value of students in each type of university, field of study, year of study, GPA, age and gender. These findings are discussed below.

(i) Type of university. There was a significant difference in the average CQ of students in the different types of universities. Even though the universities apply the same educational policy from the MHESRI for educational management, including creativity capacity promotion among the students, there may have been different contexts in each type of university in Thailand (OHEC, 2018). Another critical issue is that there were differences in the educational management systems, including the teaching approach, class environment, and other facilities that may influence creativity promotion (Saengpanya, 2018). Educational management focusing on creativity promotion should be recognized and employed to enable the students' characteristics, especially their creativity and innovative thinking, apart from their knowledge and academic skills (Leahy, 2016; Runco, 2017).

(ii) Year of study. There was a significant difference in the average CQ scores among the participants at different years of study. Those in their third and fourth years of study had a higher average CQ score than the participants in their first and second years. This finding may reflect the effectiveness and the focus on desirable student characteristics in each curriculum among universities in Thailand. Besides, the participants who were in their fourth year had learned and experienced more in their field. They were taught to reach a learning outcome in each semester and year. They also had more time to learn in various curriculums focused on creativity learning and teaching (Saengpanya, 2018). This finding supports the focus on the creativity development of the MEHSRI in Thailand for Thai students to develop innovation. As well, this finding supports the recommendations for driving the education system in Thailand to focus on the development of learners to be creative at all levels through the use of an innovative curriculum, course, teaching and learning, and education administrators (ICER, 2019). This finding also reflects the success in clearly developing the creative competencies of Thai universities when comparing between the first and final years of university study.

(iii) Field of study. The CQ scores varied significantly between participants who were in different fields of study. Humanities and Social Sciences students had higher CQ scores than those in other study fields (i.e., Science and Technology, Health Sciences, and others). This finding showed that the focus on creative promotion in each study group was different. Simultaneously, the characteristics that act as indicators of creativity in each field are also different. Therefore, that the students in the humanities and social sciences group had higher CQ scores than those in the other groups does not mean that they are more creative. However, they may have more aptitude in writing than other groups, which facilitates the ability to take a divergent test that uses language responses. Although the provocative questions in the CQ test will try to reduce the influence of learning as much as possible by using trigger stimuli with all groups of students are already familiar.

(iv) Grade Point Average. The result showed a significant difference in the CQ scores among the participants who had different GPAs. Students with a GPA of 3.01–4.00 had higher CQ scores than those with lower GPAs (2.51–3.00, 2.01–2.50, and ≤ 2.00). Indeed, there was a strong association between the GPA and CQ scores. Students with GPAs in the top two ranges (3.01–3.50 and 3.51–4.00) did not have significantly different CQ scores. These results describe the connection between the academic achievement (i.e. GPA) and the CQ scores, where the GPA

is the sum of the students' learning outcome that primarily reflects the ability of students to learn at some point of time, the ability to study, and the attention and responsibility to study as well (Kanjanawasri, 2019). The GPA is recognized as a factor that can relate to creativity, including the CQ. This finding is consistent with a previous study from Poland that reported a positive relationship among 1,106 students between academic achievement, GPA, and creativity (Gajda, 2016). Furthermore, a positive relationship between higher-order thinking skills, including creative and critical thinking skills, and the students' GPA was reported in Indonesia (Tanujaya et al., 2017). Likewise, a study of 63 students from Jordan also reported a strong relationship between the GPA and the level of creativity abilities (Awamleh et al., 2012).

(v) Gender. The results revealed a significant difference in the CQ scores among the participants of different genders. Female CQ scores were higher than those of males. This study's results are similar to Awamleh et al. (2012), who examined the creativity of students aged 6, 7, and 8 years using the TFTFB. Awamleh et al. found that the fluency and flexibility of female students were higher than in males. In this study, although the students were all older and at a higher education level, the result was similar. Besides, this result is supported by the study of Lucas et al. (2013), who revealed a significant relationship between the CQ score and gender. Overall, there is a strong relationship between gender and creativity.

(vi) Age. However, in contrast to the above characteristics, in this study, there was no significant difference between the student's age and CQ scores, which is different from the result of Lucas et al. (2013). In contrast, consistent with the results of Palmiero et al. (2014), there was no difference between age and verbal creativity, especially in the 19–22 age range. The absence of an age dependency seen in this study is consistent with the study of Krumm et al. (2015). Krumm et al. revealed that the development of the creative process in this age range was decreased. It may have been influenced by the prevailing attitudes and interests, such as looking for a career path, working, seeking jobs, and paying attention to studying.

Conclusion and recommendations

This study focused on describing and comparing the CQ among undergraduate students in Thailand. The results revealed that the CQ values of undergraduate students differ according to their higher educational contexts. This difference may reflect the effectiveness of educational reform and educational management of creative thinking promotion in higher education within Thailand. The results of this study are critical basic knowledge for educators, academic administrators, and educational policymakers when searching for strategies and guidelines to promote students to have a high CQ. Higher CQ will lead to developing a high level of competency, leadership, and creative characteristics among students, and so is necessary for developing innovation in Thailand. It is an important challenge in educational reform to obtain excellence and competitiveness and to be consistent with the mission of advocating economic, social, and environmental development.

For further research suggestions, the CQ should be studied in other groups at different education levels, such as primary, secondary, and graduate schools, to gain more educational informatics. A longitudinal approach should also be considered to search for issues and trends in future CQ scores. The CQ can be a significant indicator of creative potential or successful

thinking. Finally, factors related to the CQ should be explored in university students in order to determine an effective intervention for creative thinking promotion.

Ethical consideration

This study has been ethically approved by the Office of the Research Ethics Review Committee for Research Involving Human Subjects: The Second Allied Academic Group in Social Sciences, Humanities, and Fine and Applied Arts. The research project number is No. 089/62.

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