

# The association of creativity, creative components of personality, and innovation among nursing students in Taiwan

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## Research article

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## Abstract

**Background:**Recent attention has focused on creativity and the ability to develop innovative products (innovation), and the relationship between creativity, personality traits associated with creativity, and innovation. However, the link between creativity, aspects of personality associated with creativity, and innovation are unclear, especially with regards to nurses and nursing education. **Methods:**This cross-sectional, descriptive, cor-relational design explored levels of creativity, components of creativity, and innovation among nursing students, and examined the association of creativity, aspects of personality, and innovation. Participants were 98 senior-year nursing students enrolled in a capstone course for developing patentable healthcare-related products at a university in Northern Taiwan. Creativity was measured using the verbal and figural Torrance Tests of Creative Thinking (TTCT-V and TTCT-F, respectively); creative personality was evaluated with a self-report instrument, the Affective Components of Creativity Scale (ACCS). Innovation was expressed as the mean product creativity score for healthcare products students developed during the capstone course. Four independent judges scored the products for novelty and uniqueness. Correlations were examined with Pearson's test followed by Bonferroni's post-hoc adjustment. **Results:**Nursing students had moderately high scores for innovation (mean = 91.37, SD = 2.83; range = 83-96). Mean scores on the TTCT-F and TTCT-V were 40.05 (SD = 21.21) and 18.08 (SD = 13.94), respectively. The mean total score on the TTCT was 58.13 (SD = 30.47), indicating a moderate level of creativity for nursing students. The highest mean score of the four components of creative personality was for imagination (4.75, SD = 0.71); challenge and adventure were similar (2.71, SD = 0.31 and 2.53, SD = 0.25, respectively); the lowest score was for curiosity (1.76, SD = 0.23). Mean total score for the ACCS was 2.79 (SD = 0.27). Pearson's correlations showed innovation was correlated with curiosity ( $p < .001$ ). There was no significant association between figural or verbal creativity and components of creative personality. **Conclusions:**The positive relationship between scores for innovation and curiosity suggest teaching faculty might want to consider strategies for improving nursing students' abilities to create innovative products by concurrently focusing on methods of increasing curiosity and innovation.

## Background

In nursing, innovation has been shown to require a combination of creativity and innovation [1]. Innovation in nursing not only improves health care quality and reduces health care costs [2-3] but also creates an organizational atmosphere that eases health care professionals' stress and reduces burnout [4]. Therefore, nursing professionals worldwide have been fostering nurses' creativity and innovation to improve patient and health care outcomes [1].

In 2003, the Advisory Office of the Ministry of Education declared the Taiwanese government must foster creativity for students at all education levels [5]. As a result, since 2006 technical institutes, vocational schools, and universities in Taiwan have integrated capstone courses into their curricula in order to stimulate creativity, innovation, and entrepreneurship [6]. Incorporating this type of 'design thinking' has also been encouraged for nursing programs in the US to help nurses develop problem-solving skills for the improvement of nursing care quality [7]. Five nursing schools in Taiwan have incorporated capstone courses into their curricula to improve nursing students' creativity and innovation; the goal is to help students generate innovative patentable healthcare products to solve real-world healthcare problems [2, 8]. However, there is a gap in the literature as to whether there is a relationship between creativity and innovation.

## Literature Review

### Creativity and innovation

Creativity has been shown to play an important role in models of job performance [9, 10]. Studies suggest both idea generation and implementation of the ideas are important [11]. Idea generation can be viewed as creativity and idea implementation can be viewed as innovation. Creativity has been described as a component of a person's personality [11], a process of psychological engagement in an activity [12], and something that is novel and useful [13-14]. Creativity is also one of the building blocks of innovation [15]. Innovation, defined as a combination of idea generation and implementation has been suggested to be a predictor of creativity in a work environment [16].

Creativity and innovation should also be important considerations for educators. Kamplyis and Berki (2014) have stressed the importance of creative thinking and innovation in education. They state, "Creative thinking enables students to apply their imagination to generating ideas, questions and hypotheses, experimenting with alternatives and to evaluating their own and their peers' ideas, final products and processes" [17]. Although creativity and innovation are considered important core competencies for nursing students in Taiwan [8], few studies have examined the interaction of creativity and innovation for nursing students, as it relates to education courses designed to increase nursing students' creativity and innovation to improve healthcare.

### **Measuring creativity**

Measures of nursing students' creativity require valid assessment tools. Creativity can be measured with the Torrance Tests of Creative Thinking (TTCT) [18], which are a result of Guilford's hypothesis that an individual's creativity results from the ability to use divergent thinking [19]. The Torrance tests measure both verbal (TTCT-V) and figural (TTCT-F) creativity and are correlated with divergent thinking; they have been shown to be a valid assessment of creativity [20, 21] and have been translated into more than 35 languages [22, 23]. Guilford suggested divergent thinking was comprised of fluency, flexibility, originality, and elaboration [19]. Fluency is the ability to generate diverse ideas about a problem quickly, flexibility is the ability to generate diverse ideas to solve many problems, originality is the ability to generate novel ideas, and elaboration is the ability to expand on an idea [18, 21, 24]. Scores on the TTCT can be used to indicate nursing students' abilities to use **strategies and processes to connect ideas and organize creative thoughts**. Therefore, we used scores on the TTCT to measure nursing students' creativity.

### **Measuring creative personality traits**

Numerous studies have examined the correlation between personality and creativity [25-28]; one's openness to experience is a trait consistently and positively associated with creativity in students [26, 27]. Silvia et al. (2009) suggested that a close relationship exists between openness to experience and creativity-related variables, such as the divergent thinking skills of fluency and creativity [28]. Studies have also suggested a relationship between creativity and components of a creative personality [19, 24]. Williams (1980) suggested individuals considered to be creative have high levels of curiosity, imagination, adventure, and challenge [29]. One means of examining the relationship between an individual's creative personality traits and creativity is the

Creativity Assessment Packet (CAP) developed by Williams [29]. Studies using the CAP shown creative personality traits directly influence creativity [30-35]. One study compared students who received a creativity training intervention with a control group, and found the students in the intervention group had higher levels of curiosity, creativity, and sensitivity than controls [33]. A study by Xia (2009) used the Affective Components of Creativity Scale (ACCS), developed for use in Taiwan, to measure college students creative personality traits; students had high levels of imagination and adventure; male students perceived themselves as more curious than female students [31]. In this study, we used the ACCS in order to measure the Taiwanese nursing students' perceived levels of creative personality traits. This instrument has also been used to evaluate perceived levels of creative personality traits for nursing faculty in Taiwan [8].

## **Innovation**

Creativity is purported to be positively related to innovation [17, 34] however most studies showing a positive correlation between creativity and innovation have been conducted with employees in industrial work environments or with college students [32-36]. However, although creative people are often innovators, not all creative people are necessarily innovative [37]. Several studies have reported a positive relationship of an individual's personality traits and innovation [38, 39], however how innovation is measured is often subjective. One way of assessing innovation is to quantify the originality of a created product using the Consensual Assessment technique [40]. This technique assumes the combined assessment from a diverse panel of experts in a field is the best way to evaluate something a person has created. The Consensual Assessment Technique is a valid and reliable tool for use in higher education settings [41]. We used the Consensual Assessment Technique as one component for evaluating innovation.

## **Purpose**

There is a lack of research regarding the relationship of creativity, creative components of personality and innovation in healthcare schools. Understanding these relationships could improve an educator's ability to create learning atmospheres that stimulate students' thinking skills. To fill this gap in the literature, the current study analyzed measures of creativity, creative components of personality and innovation among nursing students in Taiwan enrolled in a capstone course designed to help improve creativity and innovation. Guided by our literature review, we generated the following research question regarding creativity, creative components of personality, and innovation in nursing students: Is there a correlation between creativity, components of a creative personality and innovation? The possible relationships and interactions are shown in Figure 1.

[Figure 1 here]

## **Methods**

### *Design*

Our study used a cross-sectional, descriptive, correlational design.

### *Participants*

Nursing students enrolled in a capstone course in developing healthcare-related products participated in this study; all students were from one university of technology in northern Taiwan. The first author described the study design and purpose to all students, and invited them to participate the last week of the course. Packets containing a description of the study design and purpose, survey questionnaires and a consent form were distributed to all enrolled students ( $n = 120$ ). The first author explained that students who wanted to be participants would need to sign the consent form enclosed in the packet, fill out the questionnaires, and return the packets. In order to maintain the anonymity of the participants, a coding number was assigned to each packet. A total of 98 packets were returned after the conclusion of the course, for a response rate of 81.6%. All 98 packets contained signed consent forms. The average age of the participants was 21.3 years (standard deviation (SD) = .47; almost all (98%) were female. G\*Power 3.1.9.2 software [42] was used to determine sample size required for observing the same effect of the instruments over time with an alpha-type error  $< .05$  and power beta of 85%. The minimum sample size was determined to be 95.

### *Capstone Course*

The capstone course was designed to help nursing students develop patentable healthcare-related products that can be applied to clinical care. The format of the 18-week course included lectures from seven nursing faculty and small group discussions with teams of 7-8 students. Material covered included patent searching, healthcare product development and needs assessment. Students also received instruction in the use of creative thinking tools, such as brain storming to stimulate divergent and convergent thinking skills. Students were required to develop an innovative product, give a mid-term presentation, and present the final product at the end of the semester to the seven nursing faculty and their student-team.

## **Measurements**

### *Creativity*

The Torrance Tests of Creative Thinking (TTCT) [18] determined nursing students' levels of creativity. The TTCT measures two areas of creativity: verbal (TTCT-V) and figural (TTCT-F). We used a Chinese version of the TTCT to evaluate creativity [32]. The TTCT-V contains six activities; each activity begins with a picture and the student responds with a written description of the picture. Three subscales are used for scoring: fluency, which is the number of ideas related to the picture, originality, which is the uniqueness of the response, and flexibility, which is the variety of different ideas [21]. The range for the subscales scores of fluency, flexibility, and originality are 0-50, 0-26, and 0-100, respectively; total score ranges from 0-176.

The TTCT-F is comprised of three activities: picture construction, picture completion, and repeated figures of lines and circles. Four subscales score each activity on the TTCT-F: fluency, originality, and flexibility, as describe for the TTCT-V, and elaboration, which involves rich imagery and abstraction [21]. The range for the subscale scores of fluency, flexibility, originality, and elaboration are 0-57, 0-35, 0-114, and 0-171, respectively; total score ranges from 0-377.

In this study, the Cronbach's alpha coefficients for the subscales of the TTCT-F were between 0.79 and 0.98. In addition, we also measured total scores for TTCT-F and TTCT-V, as suggested by Okuda, Runco, and Berger [43]. In this study, the Cronbach's alpha coefficients for total scores for the TTCT-F and TTCT-V and were 0.83 and 0.90, respectively.

### *Creative personality traits*

The Affective Components of Creativity Scale (ACCS) assessed components of participants' personalities considered to be associated with creativity [29]. The ACCS is a self-assessment instrument derived from the New Creative Affective Scale developed by Xia [31]; the scale measures personality traits of affective creativity: imagination, curiosity, adventure, and challenge. Statements are rated on a 4-point Likert scale; 1 = completely disagree to 4 = completely agree. Some questions are reverse scored. Higher scores indicate higher perceived levels of creativity. The reliability estimate for the ACCS is .92, and satisfactory validity was confirmed through factor analyses. In this study, Cronbach's alpha coefficient was .78 for the total score and ranged from .70 to .85 for all subscales, indicating satisfactory reliability. Table 1 shows examples of statements for each subscale of the ACCS.

### *Innovation*

Innovation was determined by the mean final grade for the 98 students at the end of the capstone course. The seven faculty who taught the capstone graded the students on attendance and participation (30 points), a mid-term report (30 points), a team evaluation (10 points). Students also received a score for their final project, which included a presentation of their project to faculty and team members (10 points) and a project creativity score (20 points), which is described below. Therefore, the maximum score for innovation was 100 points; 20% was their product creativity score.

Product creativity was determined using the Consensual Assessment Technique, which assumes the combined assessment from a diverse panel of experts is the best way to determine the creativity of a product [41]. In this study, the panel was comprised of four judges: a dean of nursing, a practicing RN, an expert in industrial design, and an expert in patent design. The judges scored each product independently for novelty and usefulness. Novelty was determined by originality and uniqueness of the product, as compared to other similar products on the market. Usefulness was determined by appropriateness, which was a measure of how likely the product would be used, and esthetics, which measured visual appeal. Each of the four items was scored low (1 point) to high (5 points); range = 4-20 points; consistency, as measured by Cronbach's alpha coefficient, was

.72 and .85 for novelty and usefulness, respectively. Inter-rater reliability was acceptable ( $ICC_{\text{novelty}} = .91$ ,  $ICC_{\text{usefulness}} = .87$ ). Scores from the four judges were averaged to determine the project creativity score for each developed product.

### **Data collection and analysis**

Data were collected after nursing students completed the 18-week capstone course, in the fall of the 2016. Anonymous survey data were collected from paper-and-pencil questionnaires, which included information regarding the students' age, gender, and their final grade in the capstone course. Data from the questionnaires were analyzed using SPSS version 20.0. Descriptive statistics, such as the mean (M) and standard deviation (SD) were used to describe participants' characteristics, and scores for innovation, creativity, and creative personality traits. Analysis using Pearson's correlation coefficient was used to identify correlations between innovation, creativity, and creative personality traits. To reduce the likelihood of bias in testing 12 variables, we applied a Bonferroni correction ( $\alpha = .05/12$ ), resulting in a required significance  $p .004$ .

### **Ethical Considerations**

Approval was obtained from Institutional Review Board of the hospital ethics committees prior to data collection. When the coded packets were returned, the director of the healthcare program checked for the presence of a signed consent form and removed it from the packet to ensure confidentiality of the students' information. The consent form explained the purpose of the study, assurance that confidentiality and anonymity of the student would be maintained, and that failure to participate would not affect their status as a nursing student.

## **Results**

### **Nursing students' levels of creativity, creative personality traits, and innovation**

Table 2 shows participants mean scores for creativity (TTCT), creative personality traits (ACCS), and innovation following completion of the capstone course. The mean total score for the TTCT was 58.13; mean total scores for the TTCT-V and TTCT-F were 18.08 and 40.05, respectively. The construct with the highest mean score on the TTCT-V was for fluency ( $M = 8.06$ ;  $SD = 6.16$ ); the lowest was flexibility ( $M = 4.91$ ;  $SD = 2.43$ ). The construct with the highest mean score on the TTCT-F was fluency ( $M = 17.17$ ;  $SD = 8.63$ ); the lowest was elaboration ( $M = 1.71$ ;  $SD = 2.09$ ). All scores for creativity were below the mid-point of the ranges, suggesting low levels of creativity. The mean total score for creative personality traits was 2.79 ( $SD = 0.27$ ), suggesting students perceived themselves as moderately creative. Of the traits considered components of a creative personality, the mean score for imagination was highest ( $M = 4.75$ ,  $SD = 0.71$ ); curiosity was lowest ( $M = 1.76$ ,  $SD = .23$ ). The mean scores for innovation ranged between 83 and 96 out of a possible 100, indicating a medium-high level of innovation. A total of 48 students had scores greater than 91, indicating a high level of innovation.

[Table 2 here]

### **Correlations and associations of innovation, creativity, and creative personality traits**

Analysis with Pearson's product-moment correlation examined the correlations between a high level of innovation, creativity, and creative personality traits (Table 3). There was a positive low to moderate correlation between innovation and the creative personality trait of curiosity ( $r = .32, p < .001$ ). Innovation was not correlated with any other personality traits or any figural or verbal constructs of the TTCT.

[Table 3 here]

## **Discussion**

We determined the levels of creativity, creative personality traits, and innovation for Taiwanese nursing students following completion of a capstone course in developing creative healthcare products. These measures were then used to determine if there was an association between innovation and measures of creativity and creative personality traits. Scores from the TTCT and ACCS were used to measure nursing students' creativity, and perceptions of creative personality traits, respectively. Students' grades, 20% of which included a comprehensive assessment score of product creativity, were used as a measure of innovation. Student's scores for creativity, including the figural and verbal scores were low. The highest score for components of creative personality was imagination; the lowest was curiosity. When we examined if there were any correlations with innovation, there was a significant correlation with the creative personality trait of curiosity. Levels of innovation were not correlated with any other personality traits or any figural or verbal constructs of the TTCT.

One explanation for the absence of an effect of creativity on innovation might be explained by the nursing students' scores on the Torrance tests. All scores for creativity were below the mid-point of the ranges, suggesting low levels of creativity in our participants, which included the total score of the TTCT ( $M = 58.13, SD = 30.47$ ), considered the creativity index [21]. A study by Karpova et al. (2011), conducted at a midwestern university in the US, reported the creativity index for college students ranged from a mean of 100.13 ( $SD = 12.87$ ) to 113.73 ( $SD = 13.58$ ) [44]. A study at Washburn University in the US also reported mean scores for the creativity index of 117.02 ( $SD = 15.04$ ) for 164 college students, 83% of whom were female; 93 of the students were in nursing programs [45]. Nursing students in the Washburn University study also had higher mean scores on the TTCT-F and TTCT-V ( $M = 108.9 (SD = 11.0)$  and  $M = 105.9 (SD = 17.4, respectively)$ ). Our students' scores were almost 50% lower for the TTCT and TTCT-F, and approximately 80% lower on the TTCT-V. These significantly lower scores for our participants could explain the lack of correlation with innovation as well as with creative personality traits.

Nursing faculty can improve student creativity by incorporating teaching methods sensitive to the needs of students [46]. However, teaching creativity is often seen as secondary, or optional, relative to other areas of

education and some teaching faculty are reluctant to be viewed as “creative” [47]. This is especially true in Chinese cultures such as Taiwan, where the focus of education is on memorization of facts in order to pass national exams. Chinese society is a collectivist, hierarchical culture; students are more likely to be followers and are strongly influenced by what teaching faculties believe to be important [48-49]. Therefore, in Taiwan, students taught by faculty who do not value the role of creativity in education may be less likely to exhibit creativity than students in Western cultures. Conversely, faculty who value creativity might be more likely to increase nursing students’ motivation and creativity. We suggest studies be conducted that examine relationships between faculty creativity and student creativity in Taiwan.

Although the highest component of creative personality was imagination, the only creative personality trait associated with innovation was curiosity. Wu [39] reported imagination was positively correlated with innovation, which is contrast to our findings. However, the difference in findings may be explained by the environments of the participants; the study by Wu was conducted in the workplace. However, the authors are puzzled by our finding because the creative component of curiosity was the lowest subscale score on the ACCS. One explanation may be that all nursing students in our study were female (98%); two studies have reported female college students in Taiwan score lower for the component of curiosity than males [31, 50]. The ACCS is a self-assessment instrument, and the nursing students may have underestimated their creative personality traits, including curiosity. However, low scores for curiosity in our participants may also be a result of the role gender plays in Chinese culture; males are encouraged to seek new information when faced with a challenge, whereas females are not. Future studies should include a larger sample of male nursing students.

Although curiosity is a key factor in enhancing creativity [51], our study results do not explain how this impacts innovation. There is no standard measure of innovation. Hence, one explanation for our failure to demonstrate a correlation between creativity and innovation could be due to our use of the students’ capstone grades to measure of innovation. The Consensual Assessment Technique, used to evaluate the student projects, is gaining more acceptances in higher education, and it has been demonstrated to be gender-neutral, unlike many achievement or aptitude tests [41]. However, the project creativity score represented only 20% of the students’ capstone grade, which suggests our measure of innovation, which was the entire grade from the capstone course, may have been flawed. A more sensitive assessment of innovation might be achieved by relying solely on scores for project creativity.

A second problem with our study may rest on the format of the capstone course itself. Although, the course included instruction in creative thinking techniques that have been shown to improve innovation [52], there were no formal assessments of how well the understanding or application of these concepts. It is possible students in the capstone course may not have learned how to apply creative thinking. The focus of these capstone courses in Taiwan is to improve students’ creativity in all areas of education, not just healthcare. Therefore, we suggest educators in Taiwan quantitatively assess the effectiveness of providing instruction in creative thinking skills prior to evaluating the relationship of creativity and innovation.

## Limitations

This study had some limitations. First, we used a cross-sectional design, which may make it difficult to determine causal relationships for creativity, creative personality traits, and innovation. Second, only students from one university in northern Taiwan participated in the study, which may limit the applicability of our findings to the nursing student population of Taiwan. However, the university in this study has the largest nursing student enrollment in Taiwan. Finally, almost all students in our study (98%) were female, which could limit generalization of our findings.

## Conclusions

This study adds to the existing work on creativity, creative personality traits, and innovation for nursing students in Taiwan. There was a low correlation between innovation and the creative personality trait of curiosity. There was a significant positive association with high levels of innovation and curiosity. This study provided more questions than answers regarding our three research questions. It is not clear why there was no significant positive correlation between creativity and innovation or why innovation was only correlated with curiosity. Design thinking in higher education has become more important as the impact of technology on healthcare increases [7]. Therefore understanding how educators can improve and enhance students' creativity and innovation is critical. A recent study showed a multidisciplinary program improved creativity and problem-solving skills for pre-professional healthcare students using Interprofessional Education (IPE), which involves faculty mentoring and collaborative learning [48]. The course had many similarities to the capstone course used in this study, however it was a year-long course, and included a weekly 3-hour lab. We suggest nursing educators who teach capstone courses with the intention of fostering creativity and innovation consider additional refinements the capstone course to achieve improvements in students' creativity and innovation.

## Abbreviations

TTCT: Torrance Tests of Creative Thinking; ACCS: Affective Components of Creativity Scale

## Declarations

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### Availability of data and material

Datasets from this study will be publicly available at the end of the study analyses in compliance with the funder's requirement.

## Authors' contributions

HYL and SYC conducted the conceptual framework and research design, and wrote the draft of the manuscript. CCC collected the data through surveys. ITW also contributed to literature review and analyzed the data. All authors participated in interpretation of data, as well as writing, editing and approval of the final manuscript.

## Ethics approval and consent to participate

This study has approved the hospital ethics committees. Study participants completed an informed consent before beginning the survey. Confidentiality was assured in the consent forms and the participants remained the right to withdraw their participations at any phase of the research process.

## Consent for publication

All the authors have approved this publication.

## Competing interests

The authors declare that they have no competing interests.

## References

1. Weng RH, Huang CY, Lin TE: **Exploring the cross-level impact of market orientation on nursing innovation in hospitals.** *Health Care Management Review* 2013, **38**(2):125-136.
2. Liao SC, Chang WC, Li CP: **The effectiveness of modified restraint glove in critical ill patients.** *Journal of health and architecture* 2015, **2**(1):65-73.
3. Tsou YC, Chi MM, Liao CY, Chen YC: **The effectiveness of nursing innovation system in a medical center.** *Veterans General Nursing* 2008, **25**(1):44-52.
4. Kung YS, Chen HC, Hsu CC: **Is creativity needed for helping profession? The influence of creativity on the relationship between burnout and stress among helping professionals.** *Creation journal* 2011, **2**(2):113-136.
5. Taiwan, Ministry, of, Education: **White Paper on Creative Education. Establishing a Republic of Creativity for Taiwan.** 2003.
6. Liu HY, Kuo CL, Shen MH, Lee PY, Lee PY, Ku YL: **Evaluating faculties and students satisfaction of a nursing practicum project workshop in Northern Taiwan.** *Journal of Nursing Research and Practice* 2018, **2**(2):16-19.
7. Beard G, Geist M, Lewis E J: **Design thinking: Opportunities for application in nursing education.** . *Nurse Education Today* 2018, **64**:115-118.
8. Liu HY, Wang IT, Hang HM, Hang DH, Hsu DY: **Self-efficacy of teaching for creativity for nursing faculty in Taiwan: A Preliminary Study.** *Nursing Education Perspectives (in press)* 2019.
9. Pace VL, Brannick MT: **Improving prediction of work performance through frame-of-reference consistency: Empirical evidence using openness to experience.** *International Journal of Selection and Assessment* 2010, **18**(2):230-235.

10. Zhang X, Bartol KM: **The influence of creative process engagement on employee creative performance and overall job performance: A curvilinear assessment.** *Journal of Applied Psychology* 2010, **95**(5):862-873.
11. Janssen O: **Job demands, perceptions of effort-reward fairness and innovative work behaviour.** *Journal of Occupational and Organizational Psychology* 2000, **73**(3):287-302.
12. Sternberg RJ, Lubart TI: **The concept of creativity: Prospects and paradigms.** In: *Handbook of creativity.* edn. New York, NY, US: Cambridge University Press; 1999: 3-15.
13. Drazin R, Glynn MA, Kazanjian RK: **Multilevel Theorizing about Creativity in Organizations: A Sensemaking Perspective.** *The Academy of Management Review* 1999, **24**(2):286-307.
14. TM. A: **A model of creativity and innovation in organizations.** In B. M. Staw, & L. L. Cummings (Eds.). *Research in organizational behavior* 1998,, **10**:123-167.
15. Dewett T, Gruys ML: **Advancing the case for creativity through graduate business education.** *Thinking Skills and Creativity* 2007, **2**(2):85-95.
16. Hülshager UR AN, Salgado JF. : **Team-level predictors of innovation at work: a comprehensive meta-analysis spanning three decades of research.** . *Journal of Applied psychology* 2009, **94**((5)):1128.
17. Kamylylis P BE: **Nurturing creative thinking.** *International Academy of Education* 2014.
18. JJ. W, FY. C, JX. G, WW. L, SH. L, Chen YH: **The directions manual of the Torrance Tests of Creative Thinking.** *Taiwan Taipei* 1999.
19. Michael JJ, Michael WB: **Book Reviews : J. P. Guilford. Intelligence, Creativity, and Their Educational Implications.** **San Diego, Cal.: Robert R. Knapp, Publisher, 1968. Pp. viii + 229. \$7.95.** *Educational and Psychological Measurement* 1969, **29**(4):1013-1015.
20. KIM KH: **Meta-Analyses of the Relationship of Creative Achievement to Both IQ and Divergent Thinking Test Scores.** *The Journal of Creative Behavior* 2008, **42**(2):106-130.
21. Kim KH: **The Torrance Tests of Creative Thinking - Figural or Verbal: Which One Should We Use?** 2017, **4**(2):302.
22. Millar GW: **The Torrance kids at mid-life: Selected case studies of creative behavior.** Westport, CT, US: Ablex Publishing; 2002.
23. Runco MA, Acar S: **Divergent Thinking as an Indicator of Creative Potential.** *Creativity Research Journal* 2012, **24**(1):66-75.
24. Kim KH: **The Creativity Crisis: The Decrease in Creative Thinking Scores on the Torrance Tests of Creative Thinking.** *Creativity Research Journal* 2011, **23**(4):285-295.
25. Dollinger SJ, Burke PA, Gump NW: **Creativity and Values.** *Creativity Research Journal* 2007, **19**(2-3):91-103.
26. Hoseinifar J, Mohammad Siedkalan M, Rasoul Zirak S, Nowrozi M, Shaker A, Meamar E, Ghaderi E: **An Investigation of The Relation Between Creativity and Five Factors of Personality In Students,** vol. 30; 2011.
27. Lee IR, Kemple K: **Preservice Teachers' Personality Traits and Engagement in Creative Activities as Predictors of Their Support for Children's Creativity,** vol. 26; 2014.

28. Silvia PJ, Kaufman JC, Pretz JE: **Is creativity domain-specific? Latent class models of creative accomplishments and creative self-descriptions.** *Psychology of Aesthetics, Creativity, and the Arts* 2009, **3**(3):139-148.
29. Williams FE: **Creativity assessment packet : (CAP).** East Aurora, N.Y.: D.O.K. Publishers; 1980.
30. Wang A-C, Cheng B-S: **When does benevolent leadership lead to creativity? The moderating role of creative role identity and job autonomy.** *Journal of Organizational Behavior* 2010, **31**(1):106-121.
31. Xia WH: **The research of attachment style and creativity among college students (Unpublished master's thesis).** *National Chengchi University* 2009.
32. Hsiao CC, Tu CH: **The Inventory of Teachers' Teaching for Creativity.** *Curriculum & Instruction Quarterly* 2012, **15**(2):87-118.
33. Wu MH: **The effect of Williams creative teaching method on the elementary school students' creative cognition, sensitivity, and science academic performance. (Unpublished master's thesis).** *National Taipei University of Education* 2002.
34. Simonton DK: **Creativity: Cognitive, personal, developmental, and social aspects.** *American Psychologist* 2000, **55**(1):151-158.
35. Prajogo DI, Ahmed PK: **Relationships between innovation stimulus, innovation capacity, and innovation performance.** *R&D Management* 2006, **36**(5):499-515.
36. Wu CT, Wang PC, Huang WH: **A Study on the Relationship among Creative Personality and Creative Behavior - Evidence from A University of Science and Technology.** *Management Information Computing* 2016, **5**(2):47-57.
37. Fadaee A, Alzahrh HOA: **Explaining the relationship between creativity, innovation and entrepreneurship.** *International Journal of Management, Economics and Social Sciences* 2014, **3**(12):1-4.
38. Hsieh TH, Lin YY, Chung RG, Yang WH, Chen YJ: **The Impact of Creativity Personality Trait on Innovation Behavior: The Test of Mediating Effect of Well-being.** *Hsiuping Journal* 2013, **27**:61-77.
39. Wu TY: **The Influence of Creative personality, Imagination and Innovation Performance The Moderating of Voice Behavior.** *National Chung Hsing University* 2015.
40. Amabile TM: **The social psychology of creativity.** New York: Springer-Verlag; 1983.
41. John Baer, Sharon S. McKool: **Assessing Creativity Using the Consensual Assessment Technique;** 2009.
42. Faul F, Erdfelder E, Lang A-G, Buchner A: **G\*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences.** *Behavior Research Methods* 2007, **39**(2):175-191.
43. Okuda SM, Runco MA, DE. B: **Creativity and the finding and solving of real-world problems.** *Journal of Psychoeducational assessment* 1991, **9**(1):45-53.
44. Karpova E, Marcketti SB, Barker J: **The Efficacy of Teaching Creativity: Assessment of Student Creative Thinking Before and After Exercises.** *Clothing and Textiles Research Journal* 2011, **29**(1):52-66.
45. University W: **Strategic Analysis and Reporting Torrance Test of Creative Thinking Results** In.; 2014.
46. Duhamel KV: **Bringing us back to our creative senses: Fostering creativity in graduate-level nursing education: A literary review.** *Nurse Education Today* 2016, **45**:51-54.

47. Henriksen D, Richardson C, R. M: **Design thinking: A creative approach to educational problems of practice.** *Thinking Skills and Creativity* 2017, **26**:140-153.

48. Saad G, Cleveland M, Ho L: **Individualism–collectivism and the quantity versus quality dimensions of individual and group creative performance.** *Journal of Business Research* \$V 68 2015(3):578-586.

49. Tsai CY, Horng JS, Liu CH, Hu DC, YC. C: **Awakening student creativity: Empirical evidence in a learning environment context.** *Journal of Hospitality, Leisure, Sport & Tourism Education* 2015, **17**:28-38.

50. Sarasota DT: **Book Reviews: TORRANCE, E. P. (1995) Why Fly? A philosophy of creativity.** Norwood, NJ: Ablex, hardcover \$59.50, 391 pp., ISBN 1-56750-172-9. *Gifted Child Quarterly* 1997, **41**(1):54-55.

51. Puccio GJ, Burnett C, Acar S, Yudess JA, Holinger M, Cabra JF: **Creative Problem Solving in Small Groups: The Effects of Creativity Training on Idea Generation, Solution Creativity, and Leadership Effectiveness.** *The Journal of Creative Behavior* 2018, **0**(0).

52. Ludwig PM, Nagel JK, Lewis EJ: **Student learning outcomes from a pilot medical innovations course with nursing, engineering, and biology undergraduate students.** *International Journal Of STEM Education* 2017, **4**(1):33-33..

## Tables

**Table 1**

Examples of statements used to generate subscale scores for the Affective Components of Creativity Scale (ACCS)

Subscale	Example statement (each statement is scored from 1 to 4)
Curiosity (CU)	<ul style="list-style-type: none"> <li>· In school, I like to try to guess the answer, even if the answer is not correct.</li> <li>· When I see a picture of a stranger, I like to try to guess what kind of person he/she is.</li> </ul>
Imagination (IM)	<ul style="list-style-type: none"> <li>· I will often guess first. Then check the answer and see if I am correct.</li> <li>· When working in a group, I like to do things the way they have been done in the past; I do not like to try alternate approaches.<sup>R</sup></li> <li>· If I have enough time, I believe I can answer all the questions on an exam.</li> <li>· When I do my work, I like to gather a variety of information to improve my understanding of the topic.<sup>R</sup></li> </ul>
Adventure (AD)	<ul style="list-style-type: none"> <li>· When faced with a difficult problem, I approach the solution one step at a time.<sup>R</sup></li> <li>· If my supervisor at work asks me to do something, I do not speculate about the reasons behind the request.</li> </ul>
Challenge (CH)	<ul style="list-style-type: none"> <li>· When I do something incorrectly at work, I voluntarily admit my mistake.<sup>R</sup></li> <li>· I think each question has only one possible answer.<sup>R</sup></li> <li>· In my part-time job, I don't want to try doing an assignment which no one else is capable of doing.<sup>R</sup></li> <li>· I do not like to do tasks that I do not do well or have not done before.<sup>R</sup></li> </ul>

R indicates the statement is reverse scored.

**Table 2** Scores for nursing students (N = 98) for measures of creativity, creative personality traits, and innovation following completion of the capstone course

Variable	Mean	SD	Range
TTCT total score (creativity)	58.13	30.47	12-160
TTCT-V			
Total score	18.08	13.94	2-75
Fluency	8.06	6.16	1-36
Flexibility	4.91	2.43	1-12
Originality	5.11	6.19	0-35
TTCT-F			
Total score	40.05	21.21	6-92
Fluency	17.17	8.63	3-42
Flexibility	9.74	3.90	2-18
Originality	11.42	8.83	0-38
Elaboration	1.71	2.09	0-11
ACCS (Creative personality traits)			
Total score	3.15	0.33	2.09-4.31
Traits			
Curiosity	1.76	0.23	1.17-2.25
Imagination	4.75	0.71	2.75-8.25
Adventure	2.53	0.25	1.73-3.18
Challenge	2.71	0.31	1.18-3.88
Innovation	91.37	2.83	83-96

Abbreviations: TTCT-F, Torrance Tests of Creative Thinking-Figural; TTCT-V, Torrance Tests of Creative Thinking-Verbal; ACCS, Affective Components of Creativity Scale; Innovation, determined by the mean grade following completion of the capstone course.

**Table 3** Pearson's correlation for scores of innovation, constructs of figural creativity (TTCT-F), verbal creativity (TTCT-V), and creative personality traits (ACCS) for nursing students (N =98)

Variable	Innovation	TTCT-F				TTCT-V			ACCS			
		FLU	FLE	ORI	ELA	FLU	FLE	ORI	CU	IM	AD	CH
Innovation	1.00											
TTCT-F												
Fluency (FLU)	-.03	1.00										
Flexibility (FLE)	-.01	.77	1.00									
Originality (ORI)	-.04	.86	.90	1.00								
Elaboration (ELA)	.12	.42	.47	.43	1.00							
TTCT-V												
Fluency (FLU)	-.03	.40	.36	.47	.09	1.00						
Flexibility (FLE)	.04	.45	.45	.53	.19	.84	1.00					
Originality (ORI)	-.02	.40	.40	.46	.13	.86	.72	1.00				
ACCS												
Curiosity (CU)	.32***	-.00	-.03	-.07	-.09	-.08	-.13	-.12	1.00			
Imagination (IM)	.10	.01	.06	.01	.00	-.14	-.07	-.18	.58	1.00		
Adventure (AD)	.23	-.10	-.16	-.19	-.15	-.14	-.17	-.21	.74	.60	1.00	
Challenge (CH)	.29	.17	.16	.13	.04	-.10	-.05	-.08	.72	.57	.73	1.00

Abbreviations: Innovation, defined as the final score at the conclusion of the capstone course. TTCT-F, Torrance Tests of Creative Thinking-Figural; TTCT-V, Torrance Tests of Creative Thinking-Verbal; ACCS, Affective Components of Creativity Scale; Significance of  $p = .004$  determined by applying a Bonferroni correction.

\*\*\* $p < .001$

## Figures

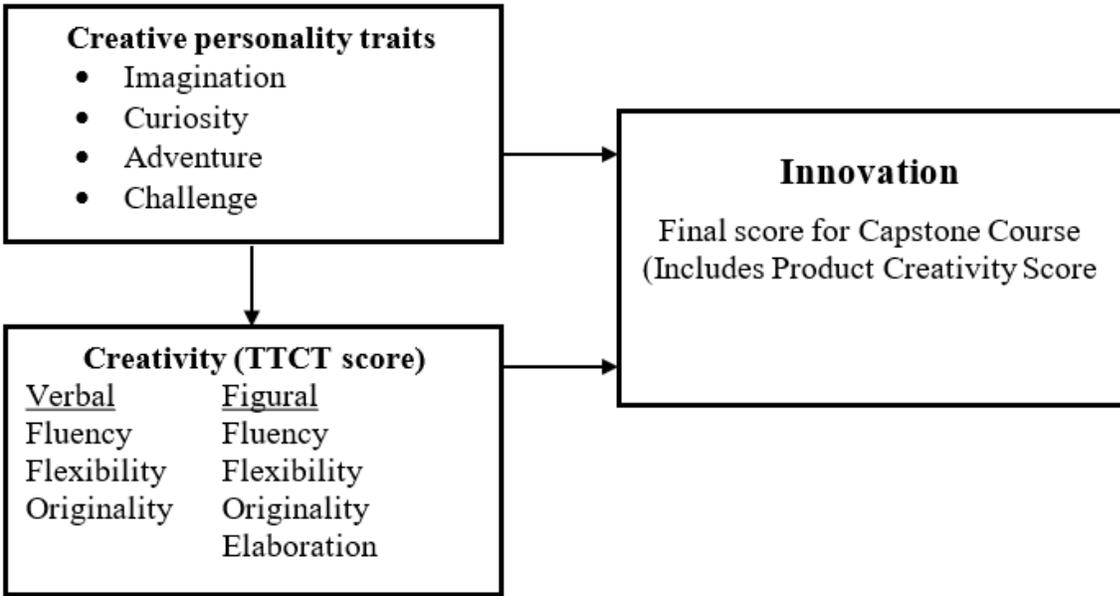


Figure 1

Possible relationships and interactions between creativity, creative personality traits, and innovation