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Revising the Imaginative Capability and Creative Capability Scales: Testing the Relationship between Imagination and Creativity among Agriculture Students

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Abstract. We conducted three studies to revise the imaginative capability scale and creative capability scale, and to examine the relationship between imagination and creativity among college students majoring in agriculture. First, Study 1 was conducted to determine the most appropriate scale structure by performing an exploratory factor analysisof a sample comprising 390 students. A three-factor solution was used to identify the dimensions of imaginative capability (initiating, conceiving, and transforming imagination), and a two-factor solution was used to identify the dimensions of creative capability (originality and usefulness). Next, Study 2 was conducted to confirm the structures established in Study 1 by performing a confirmatory factor analysis of a sample comprising 520 college students. In addition, we tested the degree of measurement invariance of the scales across genders. Finally, Study 3 was conducted to further examine the relationship between imagination and creativity among 430 college students majoring in agriculture. The results show that originality is influenced primarily by conceiving and initiating imagination. In addition, transforming imagination has a slightly negative influence on originality. Finally, usefulness is influenced primarily by conceiving imagination, and it was slightly influenced by initiating imagination.

Keywords: agriculture students; creative capability; imaginative capability; measurement invariance; scale development.

Introduction

Although engaging the imagination of students and fostering their creativity are crucial in modern society, Egan (2010) argued that typical classroom environments are not conducive to stimulating the imagination and creativity of

students. Swirski (2010) asserted that the manner in which society envisions, creates, and contributes to its educational, social, and cultural environments is limited only by human imagination. An imaginative approach to designing a learning environment frameseducational activities and facilitates innovative assessments that encourage students to explore, question, resolve, and understand the diversity and complexity of their environment. Although this research field is crucial for understanding the human ability to consider the future and promote human creativity, few studies addressed this field during the 21st century (Morosini, 2010, p. 43).

Previous studies have examined human imagination based on various approaches, such as visual imagery (Gordon, 1949; Richardson, 1969), philosophical inquiry (Emig, 1983; Warnock, 1976), spatial conceptualization (Thurstone & Thurstone, 1965), mental imagery (Marks, 1973, 1995), and imagery companions (Taylor, 1999; Taylor, Hulette, & Dishion, 2010); however, few studies have empirically examined both imaginative and creative capabilities, and few evaluation tools exist for assessing these capabilities. Liang and Chia (2014) conducted three studies to test the reliability, validity, and factor structure of the imaginative capability scale (ICS). The three-factor model of the ICS was confirmed by surveying college students studying in various domains. In addition, Lin, Hsu, and Liang (2014) developed the creative capability scale (CCS), and they examined the effect of creativity and imagination on the academic performance of design students.

Humanity is adversely affected by global trends, including unprecedented climate change, over-consumption, social inequity, and inter tribaland interreligious conflicts (Ellyard, 2011). Compared with other academic fields, agricultural education is influenced the most by these trends. The research, curricula, and teaching practices used in this field have undergone substantial changes during the past 20 years. Moreover, the number of students enrolling in agricultural colleges and universities in industrialized countries is declining, and these institutions must evaluate alternative structures and functions carefully to ensure a sustainable food supply (Lieblein, Francis, & King, 2000). Numerous scholars have stressed the need to cultivate student imagination and creativity to address the dynamic challenges associated with developing and maintaining a globally sustainable society (Ellyard, 2011; Intarachaimas, 2012).

In this research, we conducted three studies to revise both the ICS and CCSto examine the relationship between imagination and creativity among college students majoring in agriculture. Study 1 was conducted to determine the most appropriate scale structure by performing an exploratory factor analysis with a sample comprising 390 college students. To confirm the validity of these structures, Study 2was conducted by performing a confirmatory factor analysis (CFA) with a sample comprising 520 college students. In addition, we tested the degree of measurement invariance of the scales across genders based on the sample data from Studies 1 and 2. Finally, Study 3 was conducted to further examine the relationship between imagination and creativity among 430 college students majoring in agriculture.

Imagination and creativity

Imagination is defined as "a power of the mind" (Perdue, 2003) that enables people to transcend experience and construct alternative possibilities to organize fragmented situations into meaningful and complete concepts (Passmore, 1985). Liu and Noppe-Brandon (2009) claimed that imagination is the ability to conceive something that either does not exist, or may exist yet cannot be perceived (p. 19). Many contemporary psychologists have described imagination as one of the "higher mental functions" that "involve the synthetic combining of aspects of memories or experiences into a mental construction that differs from past or present perceived reality and many anticipate future reality" (Morosini, 2010, p. 42). Furthermore, Liu and Noppe-Brandon (2009) and Liang and Chia (2014) have indicated that imaginative capability comprises three dimensions; initiating, conceiving, and transforming imagination.

Barron and Harrington (1981) noted that numerous studies have applied the following two definitions of creativity: (1) an ability manifested byperformance in critical trials (Guilford, 1975; Torrance, 1998); and (2) a socially recognized achievement that is supported through the development of novel products (Baer, Kaufman, & Gentile, 2004; Hennessey & Amabile, 2010). Regardless of which categories are applied, the concepts of originality and usefulness are considered core dimensions of creative capability (Runco & Jaeger, 2012). Many researchers have perceived originality as newness, novelty, surprise, and uncommonness (Barron, 1955; Sternberg, 1999). Similarly, usefulness has been perceived as adaptation, appropriateness, effectiveness, flexibility, practicality, utility, or value (Barron, 1988; Stein, 1953). Recently, Lin et al. (2014) empirically examined student creativity and confirmed that creative capability comprises two dimensions: originality and usefulness.

Regarding the relationship between imagination and creativity, Gaut (2005) explained that imagination can be considered a vehicle of active creativity. Gaut purported that creative people imagine various propositions and believe that subsequent developments could yield the most appropriate solution. Thus, this "possibility thinking" can be considered a basis for cultivating creative thinking and driving innovation (Craft, Chappell, & Twining, 2008). Morosini (2010) analogized imagination as a conduit through which the unconscious self is expressed through creative mental imagery that can drive deliberate actions.

In this study, imagination refers to the capability of students to initiate, conceive, and transform their ideas intoschoolwork and/or perform related actions. In addition, creativity refers to the capability of students to do schoolwork that satisfies the criteria of originality and usefulness. In this study, the distinction between imagination and creativity is based on whether students engage in deliberate action. In other words, imagination involves conceptualizing something that does not exist, whereas creativity involves creating something derived from an imagined concept. In general, a person's creativity is inspired by his or her imagination.

The need for imagination and creativity in agricultural education

Wilson and Morren (1990) reported that society demands ecological, ethical, and social dimensions to be considered in discussions on the future of agriculture and use of rural landscapes. However, the transition from focusing on agricultural productionto focusing on rural development presents difficult choices for traditional agricultural education systems. In addition to continually introducing professional knowledge and novel techniques, numerous studies have stressed the need to cultivate student imagination and creativity to address the dynamic challenges associated with developing and maintaining a globally sustainable society (Herrmann, 2011; Marshall, 2009). In particular, Marshall (2009) indicated that collective imagination is crucial to addressing widely held beliefs regarding climate change. Herrmann (2011) argued that harnessing student creativity and imagination to facilitate effective engagement in sustainable education would lead to deeper learning.

Lieblein et al. (2000) stated that the gap between knowledge and action in agricultural education must be bridged to facilitate major conceptual and structural changes that contribute constructively to a future complex and multifunctional agriculture sector, as well as to domestic food systems. Lieblein et al. (2000) hypothesized that agricultural colleges require imaginative planning and creative action to progress from being a narrowly oriented private food production sector to become a broad societal activity involving the management of natural resources and social concerns. Considerable changes are necessary regarding the management of human capital in the agriculture sector. Henry (2001) argued that creativity and innovation add more value to business than land, labor, or capital do.

Ellyard (2011) explained that a sustainable future cannot be created if it is not first imagined, and few imaginative efforts have been made to establish clear goals and objectives. Hope is the ideal quality for overcoming fear, and it is through imagination and vision that people can inspire hope; hence, an affirmative action approach to leadership thinking is necessary. Intarachaimas (2012) argued that practitioners of agricultural systems must be constantly changing, innovating, and reinventing themselves to remain competitive in an environment characterized by technological change, international competition, fluctuating consumer demand, and the pursuit for a globally sustainable society. Herrmann (2011) claimed that adopting assignments or curricular activities to harness student imagination and creativity is critical, particularly in the context of sustainable education.

Study 1: Exploratory factor analysis

Method: The ICS (Liang & Chia, 2014) was derived from 10 indicators of imaginative capability (Liang et al., 2013). However, the ICS items are unbalanced. Moreover, the CCS resulted in similar problems. Therefore, we revised both the ICS and CCS. The revised ICS (27 items) and CCS (16 items) were measured using a 6-point Likert-type scale ranging from 1 (strongly disagree) to 6 (strongly agree). The research participants were instructed to report the level at which they agreed with each imaginative and creative item.

The 390 participants in Study 1 were students enrolled in various programs at three Taiwanese universities. The students were recruited as a calibration sample to test the number of factors in the data by performing an exploratory factor analysis (EFA). Most participants were women (53.8%); 25.9% were freshmen, 31.3% were sophomores, 25.1% were juniors, and 17.7% were seniors. An identical investigation process was employed at each university. The surveys were conducted by graduate assistants who were accompanied by the class instructor. Participation was voluntary, confidential, and anonymous. Furthermore, the participants were allowed to review their response results.

Results

The data were analysed using SPSS version 17.0. An item analysis was performed to organize the measured items based on the formal survey data. The mean ICS scores ranged from 3.59 to 4.65, with standard deviations ranging from 0.70 to 0.99.The skewness and kurtosis values of the formal survey data ranged from −0.709 to 0.221and −0.821 to 0.928, respectively. In addition, the mean CCS scores ranged from 3.46 to 4.45, with standard deviations ranging from 0.78 to 0.99.The skewness and kurtosis of the data ranged from −0.476 to 0.228and −0.475 to 1.097, respectively. The analysis results of both scales indicated that the measured items were appropriate for further analysis.

The Kaiser–Meyer–Olkin measure of sampling adequacy was performed for the ICS (0.928) and CCS (0.917) items. In addition, the Bartlett's test of sphericity was performed, and the results were statistically significant for both the ICS (χ^2 = 55767.056, *df* = 351, $p < .005$) and CCS (χ^2 = 3615.313, *df* = 120, $p < .005$) items. Thus, the sample data were considered appropriate for factor analysis. Principal axis factoring (PAF) analysis with promax rotation was conducted to determine the dimensionality of both scales.

Based on the proven criteria (Tabachnick & Fidell, 2001), three-factor solutions (eigen values greater than one) explaining 45.56% of variance were considered the optimal factor structure for the ICS. Factor 1(i.e., conceiving imagination) included items related to sensibility, concentration, effectiveness, dialectics, and intuition; Factor 2(i.e., initiating imagination) included items related to novelty andproductivity, and Factor 3 (i.e., transforming imagination) included items related to exploration, crystallization, and transformation. The correlation coefficients among the factors ranged from 0.483 to 0.850, and the Cronbach's α values of Factors 1–3 were 0.837, 0.891, and 0.893, respectively.

In addition, two-factor solutions explaining49.82% of variance was considered the optimal factor structure for the CCS.The correlation coefficients among the factors ranged from 0.449 to 0.848. The Cronbach's α value of Factor 1 (i.e., originality) is 0.918, and that of Factor 2(i.e., usefulness) is 0.817.The high level of internal consistency indicates that the revised scalesobtained appropriate reliability estimates.Tables 1 and 2 respectively show the ICS and CCS analysis results (mean, standard deviation, and PAF) obtained in Study 1.

Table 1: Imaginative capability scale results

Factor／item	Loading	*M*	*SD*
Conceiving Imagination			
I become excited when I expect to be successful.	.305	4.65	.96
I am emotionally stable because I expect to overcome difficulties.	.316	4.21	.98
I can concentrate while thinking without being distracted.	.614	3.79	.96
I can continually focus on a school project until ideas are formed.	.690	3.59	.99
I can formulate an approach to meet the teacher's requirements.	.674	4.49	.83
I can formulate a needs-satisfaction approach under constraints.	.657	4.40	.70
I frequently set goals in accordance with my abilities.	.632	4.33	.89
I can deliberate on the contradictions of a problem to generate definite thoughts.	.538	4.30	.85
I can connect seemingly unrelated concepts.	.496	4.27	.80
I can absorb and integrate diverse perspectives.	.495	4.62	.78
I can formulate possible approaches quickly in accordance with an assigned project.	.317	4.27	.82
I can understand the implications of a concept by organizing fragmented information.	.377	4.19	.84
Initiating Imagination			
I formulate unique ideas more frequently than other people do.	.915	4.11	.99
I frequently develop ideas by examining unconventional perspectives.	.813	4.11	.99
I frequently generate new ideas by combining previous experiences.	.581	4.26	.92
I frequently have a rich diversity of ideas.	.835	4.15	.96
I can consistently formulate numerous approaches to complete a project.	.699	3.95	.99
I am proficient at adapting valuable elements into existing concepts.	.499	4.17	.91
Transforming Imagination			
I frequently perceive the world through various sensorial perceptions.	.462	4.47	.88
I enjoy deepening my understanding of concepts through personal experiences.	.579	4.65	.95
I enjoy testing products to learn how they function.	.621	4.43	.97
I can express abstract concepts by using examples from daily life.	.877	4.58	.97
I can explain unfamiliar concepts and provide examples relevant to a target audience.	.862	4.54	.91
I frequently use concrete images to explain difficult concepts.	.854	4.50	.93
I frequently apply my experiences to resolve new problems.	.748	4.65	.83
I can apply similar concepts to different school assignments.	.522	4.53	.85
I can resolve daily life problems by applying what I have learned.	.495	4.46	.82

Table 2: Creative capability scale results

Factor／item	Loading	*M*	*SD*
Originality			
Teachers and classmates consider that my approach to school projects is inspirational.	.743	3.84	.78
Teachers and classmates consider that my approach to completing school projects is ingenuous.	.783	3.95	.78
I can generate various outcomes for a school project within a short period.	.555	3.71	.94
Teachers and classmates consider that my work expresses my personal style.	.721	3.98	.89
Teachers and classmates consider that I can produce work that did not exist previously.	.870	3.46	.88
Teachers and classmates consider that I can produce unique work.	.878	3.63	.96
Teachers and classmates consider that my work conveys multiple meanings.	.642	3.75	.81
Teachers and classmates consider that my work can stimulate diverse ideas.	.808	3.67	.88
Usefulness			
I can identify order in chaos.	.743	4.26	.83
I can identify problems with a school project quickly.	.566	4.06	.86
I can flexibly adjust approaches according to emerging changes.	.569	4.33	.82
I can practically adapt alternatives based on specific needs.	.706	4.35	.81
I can distinguish between the results of various practices.	.753	4.32	.81
I can adapt current work to fit various situations.	.815	4.25	.85
Typically, my work is completed after several revisions.	.646	4.29	.99
I can accept criticism of my work from other people.	.378	4.45	.94

Study 2: Confirmatory factor analysis and measurement invariance

Method

The 520 participants in Study 2 were enrolled in various programs at five Taiwanese universities. These students were recruited as a validation sample to confirm the established factor structures by performing a CFA. Most students were men (57.1%); 36.9% were freshmen, 26% were sophomores, 27.9% were juniors, and 9.2% were seniors. In addition, we combined the sample data from Studies 1 and 2, and then selected 400 men and women to test the level of measurement invariance of the scales across genders (Vandenberg & Lance, 2000).The investigation followed the process used in Study 1.Participation was voluntary, and anonymity was guaranteed.

Results

This study tested the factorial validity of the factor structures by using LISREL version 8.80 to perform CFA with maximal likelihood estimation. Wead opted indicators recommended by Hu and Bentler (1999) and Tabachnick and Fidell (2001) to assess the goodness of fit of the model. Regarding the ICS, the three-factor solution yielded a good fit (χ^2 = 1288.36, *df* = 321, p< .005, RMSEA = .077, SRMR = .060, CFI = .96, NFI = .95, TLI = .96).Table 3 shows the factor loadings and composite reliability result.

Table 3: CFA results of the ICS and CCS

Variable	ICS			CCS	
Item／Factor	Conceiving imagination	Initiating imagination	Transforming imagination	Originality	Usefulness
1	0.52	0.78	0.59	0.73	0.71
2	0.51	0.72	0.68	0.72	0.74
3	0.70	0.73	0.67	0.70	0.78
4	0.73	0.77	0.68	0.71	0.73
5	0.60	0.78	0.73	0.81	0.73
6	0.73	0.74	0.67	0.78	0.71
7	0.67		0.71	0.78	0.64
8	0.74		0.67	0.83	0.48
9	0.75		0.65		
10	0.63				
11	0.67				
12	0.66				
Composite reliability	0.897	0.888	0.882	0.916	0.882

In this study, construct validity was determinedbased on convergent and discriminant validity. The convergent validity of each factor was tested by assessing the standardized factor loadings. Factor loadings should be equal to or higher than .50 to achieve convergent validity (Hair, Black, Babin, & Anderson, 2010). Discriminant validity wasassessed by calculating the confidence intervals of the interfactor correlation estimates, denoted asφ (Bagozzi & Phillips, 1982). Where the confidence intervals do not equal 1, discriminant validity is achieved. The results show that the φ values between Factors 1 and 2 range from 0.63 to 0.75, those between Factors 1 and 3 range from 0.67 to 0.79, and those between Factors 2 and 3 range from 0.72 to 0.80, thereby achieving discriminant validity.

Regarding the CCS, the two-factor solution yielded a good fit (χ^2 = 528.87, *df* = 103, *p*< .005, RMSEA = .079, SRMR = .042, CFI = .97, NFI = .96, TLI = .96). Table 3 shows the factor loadings and composite reliability results. Based on the criteria reported by Hair et al. (2010), each factor achieved convergent validity. The discriminant validity results show that the φ values between Factors 1 and 2 range from 0.72 to 0.80, thereby assuring discriminant validity.

We further tested the degree of measurement invariance of both scales across genders in accordance with Steenkamp and Baumgartner (1998). As shown in Table 4, configural invariance issupported. Subsequently, we examined whether various degrees of measurement were invariant across genders, including factor loadings (metric invariance), response tendency (scalar invariance), factor covariance, factor variance, and error variance.Except forχ^2 and $\Delta\chi^2$, which are sensitive to large samples, other goodness of fit indices—including ΔCFI, which was proposed to test the measurement invariance—indicated that all models were acceptable under the assumption of various degrees of invariance (Cheung & Rensvold, 2002). Both the ICS and CCS exhibited a high degree of measurement invariance across genders. Furthermore, the relationship among the three covariates with three ICS factors was invariant (structural invariance). The structural invariance of the CCS was also confirmed.

Table 4: Measurement invariance tests results of the ICS and CCS

Problem	χ^2	$\Delta\chi^2$	*df*	*RMSEA*	*NNFI*	*CFI*	Δ*CFI*
ICS							
Configural Invariance	819.9692		206	0.08620	0.9634	0.9686	
Metric Invariance	831.0189	11.0497	220	0.08321	0.9659	0.9688	0.0002
Scalar Invariance	861.7500	30.7311	234	0.08167	0.9671	0.9679	-0.0009
Factor Covariance Invariance	867.4689	5.7189	235	0.08178	0.9670	0.9677	-0.0002
Factor Variance Invariance	867.9413	0.4724	237	0.08130	0.9673	0.9677	0.0000
Error Variance Invariance	927.7345	59.7932	253	0.08060	0.9673	0.9655	-0.0022
Structural Invariance	930.1504	2.4159	255	0.08027	0.9575	0.9655	0.0000
CCS							
Configural Invariance	2489.2106		642	0.08682	0.9470	0.9515	
Metric Invariance	2547.7527	58.5421	666	0.08605	0.9481	0.9508	-0.0007
Scalar Invariance	2728.6642	180.9115	690	0.08736	0.9458	0.9467	-0.0031
Factor Covariance Invariance	2733.3754	4.7112	693	0.08713	0.9460	0.9467	0.0000
Factor Variance Invariance	2740.0651	6.6897	696	0.08735	0.9461	0.9466	-0.0001
Error Variance Invariance	2861.4761	121.411	723	0.08800	0.9455	0.9439	-0.0027
Structural Invariance	2892.6420	31.1659	726	0.08812	0.9452	0.9434	-0.0005

Study 3: Relationship between imagination and creativity among college students majoring in agriculture

Method

The 430 participants in Study 3 were students enrolled in an agricultural college in northern Taiwan. Most students were women (52.5%); 26.9% were freshmen, 28% were sophomores, 25.1% were juniors, and 20% were seniors. The investigation followed the process used in Study 1.Participation was also voluntary, and anonymity was guaranteed.

Results

This study tested the relationship between imagination and creativity by using LISREL version 8.80 to perform structural equation modeling (SEM) with maximal likelihood estimation. The results showed that the model fit was acceptable(χ^2 = 4645.71, *df* = 851, p < .005, RMSEA = .078, SRMR = .063, CFI = .92, NFI = .92, TLI = .93). The SEM results accounted for a substantial level variance for the dimensions of originality (R^2 = .55) and usefulness (R^2 = .72). Figure 1 shows the structural model.In the figure, the solid line indicates that the effect was statistically significant, whereas the dotted line indicates that the effect is not significant.

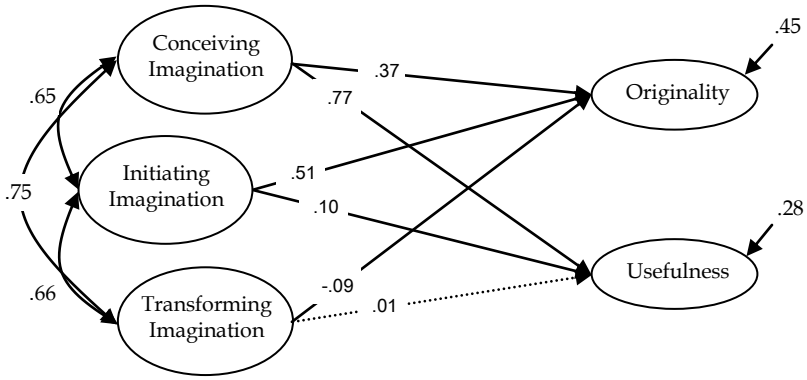

Figure 1: Structural model of the imagination and creativity of college students majoring in agriculture (*n* = 430)

Discussion

This study was conducted to address the problems of unbalanced items and cross-loading in the original ICS and CCS. The results of the revised ICS show that (1) the 12 items for measuring sensibility, concentration, effectiveness, dialectics, and intuition were combined into the capability of conceiving imagination; (2) the six items for measuring novelty and productivity were grouped into the capability of initiating imagination; and (3) the remaining nine items for measuring exploration, crystallization,and transformation were combined into the capability of transforming imagination. Although the problem of unbalanced items remained, the cross-loading problem was resolved. However, the revised CCS results indicated that 16 items were equally structured into two dimensions (i.e., originality and usefulness), thereby indicating that both of the aforementioned problems were resolved.

Based on the results, conceiving imagination can be defined as (1) the capability to mentally grasp the core of a phenomenon by applying intuition and sensibility; and (2) the capability to formulate effective ideas for achieving a goal through concentration and logical dialectics; in summary, it is the capability to form mental images. Next, initiating imagination can be defined as the capability to productively generate original ideas; in other words, it is the capability to initiate new ideas. Finally, transforming imagination can be defined as the capability to explore unknown concepts, crystallize abstract ideas, and recreate

mental images based on various domains and situations; in other words, it is the capability to apply previous experience.

Although the definitions of the aforementioned imaginative capability differed slightly different from the results reported by Liang and Chia (2014), the definitions of creativity capability supported the results reported by Lin et al. (2014). Originality can be defined as the capability to generate thoughts, perform behaviors, or create works that are considered original, novel, or unique within a particular sociocultural and temporal context. In addition, usefulness can be defined as the capability to generate thoughts, perform behaviors, or create works that are considered appropriate, effective, or valuable within a specific sociocultural context, or useful to human society as a whole.

Based on the assertion that imagination functions as a vehicle of creativity, the results of this study provide a basis for empirically testing the relationship between imagination and creativity. Shin (1994) indicated that professionals in various domains may require varying levels of imagination engagement. Therefore, we considered the following three questions: (1) which imaginative capabilities trigger which creative capabilities? (2) which imaginative capabilities may be required in various domains? and (3) what are the implications of these differentiations? The answers to these questions may provide insight into student selection processes and educational strategies employed by universities, as well as the employee recruitment and incentive policies applied in creative industries.

The results of Study 3 show that both conceiving and initiating imagination exert a significant influence on originality and usefulness, whereas transforming imagination has a negative influence on originality. The results can also be interpreted from the perspective of creativity. Originality is influenced primarily by conceiving and initiating imagination. Usefulness is influenced mainly by conceiving imagination, and it is influenced slightly by initiating imagination.

The results indicate that agriculture students who are competent at initiating new ideas and forming mental images are ideal candidates for initiating school projects, and they could play a crucial role in the ideation stage. By contrast, agriculture students who are proficient at forming mental images may be ideal candidates for executing school projects, and they could play a critical role in project implementation. Furthermore, students who excel in applying their previous experiences could hinder the initiation of novel ideas or actions, potentially because most agricultural projects are inherently complex, and they have become subject to greater uncertainty because of global climate change. The findings of this study warrant further research. Furthermore, they provide insights for domains and/or settings where imaginative talent and creative performance are crucial.

Limitations and conclusion

Before discussing the broader implications of this study, certain limitations should be clarified. First, we used self-reported scales rather than expert

evaluations or behavioral measures. However, the decision to use self-reporting was justified by the preliminary nature of this study. The questionnaire items used in this study were not considered personally sensitive, which can result in social desirability bias. Because this study analyzed relatively large samples, the findings are generalizable to larger populations (Chan, 2009). The consistency between the EFA and CFA results, as well as the measurement invariance results, indicate that the factor structures of the measures are stable across the sample groups, and no indications of self-reporting bias were observed.

Second, no attempt was made to examine the opinions of instructors. All participants were college students in Taiwan. Out of respect for Confucian culture, the potential influence of instructors on student imagination and creativity was not examined, which may have resulted in the limited variance observed in the sample. Future research should consider extending this study by including the perspective of instructors, as well as the influence of other contextual variables.

Despite these limitations, the results of this study provide numerous directions for future research. Lieblein et al. (2000) asserted that agricultural research and education based on narrow details invariably fails to address broad problems that determine the long-term sustainability of food systems, the environment, and rural society. The tendency to focus on researching and teaching narrow details in agricultural industries has resulted in the establishment of specialized departments and disciplines in universities (Orr, 1994). Most agricultural scientists understand neither how the components of the food system are organized, nor the long-term effect that their work has on society. Numerous scholars have stressed the need for reform in agricultural education (Corbett, 2013; Enshayan, 1992; Lacy, 1993; Lieblein et al., 2000). Accordingly, this study was conducted to build on this foundation.

We revised the ICS and CCS to provide a framework for assessing the imagination and creativity of college students majoring in agriculture. We tested the predictive relationship between imagination and creativity to facilitate an ongoing discussion on innovative reforms in agricultural education. The findings of this study support assertions made by Lieblein et al. (2000); specifically, agricultural colleges must embrace a novel rural paradigm by acknowledging that agriculture and food systems cannot be developed without referring to the intelligence, imagination, creativity, and competence of students, farmers, and consumers. Our findings also support statements made by Intarachaimas (2012); specifically, the future prosperity of human society will depend increasingly more on their capacity to develop innovative ideas to create novel agricultural products, services, technologies, and production methods, and to introduce these products and services to new markets.

Preliminary studies such as this invariably identify numerous problem and research questions. Thus, further research must be conducted in this area.

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