# Enhancing Comprehensive Ability through Subject Competitions: Model Development and Testing

***Xiaoxia Chen***
School of Translation Studies, Qufu Normal University, China

Doi: 10.19044/ejes.v5no1a3 URL:http://dx.doi.org/10.19044/ejes.v5no1a3

**Abstract**

An empirical study of innovation education model with a related survey of subject competitions in Chinese colleges and universities was carried out, and the results of which was presented in this paper. Under the paradigm of the agility theory, a dynamic and cross-level 'enhancing comprehensive ability through subject competitions' innovation education theoretical model was constructed and examined by using structural equation modeling. A total of 350 English majors and 50 social personnel participated in this study by using the method of multi-layer random sampling and cluster sampling. 382 valid questionnaires were used for the data analysis. Data collected were analyzed by internal consistency reliability analysis, exploratory factor analysis, and confirmatory factor analysis. The empirical results suggest that under the guidance of the agility theory, the six links have significant positive impact on the innovation education and ultimately enhance students' comprehensive ability through subject competitions.

**Keywords:** Comprehensive ability, subject competitions, innovation education, agility, model.

## 1. Introduction

In order to meet present and future needs in a transformed world, maintain excellence and ensure equity, innovation in education is critically important and is imperative for success (Roberts et al., 2012). Innovation education is a kind of education mode that is based on the cultivation of innovation spirit and innovation ability. Due to its specificity, comprehensiveness, openness, democracy, and other characteristics, it has attracted great attention and created a worldwide wave of innovation education development and reform. In the practice of constructing a variety of innovation education models and cultivating innovative ability, undoubtedly, the subject competitions in colleges and universities are an effective carrier. The agility is the strategic capability of the enterprise to survive, develop, and maintain its

competitive advantage in the rapidly changing competition. It builds durable and efficient supply chains that power businesses and drive trade, thereby creating access to new opportunities (Chen et al., 2014). Agile organizations can be more flexible in their products, development strategy, etc. They can respond quickly to rapidly changing and high-quality requirements. In agile development era, it is required to understand what agile development means, how to create agile teams, and how agile teams collaborate, cooperate, and function in various situations, particularly in geographically and culturally diverse environments (Crowder et al., 2015). Therefore, constructing the innovation education model based on the agility theory provides a new perspective for the study of innovative education, which has important research significance. Under the paradigm of the agility theory, this paper constructs a dynamic 'enhancing comprehensive ability through competitions' innovation education mode. Therefore, it combines with the subject competitions in colleges and universities. In selecting English majors in colleges and universities as the sample, the empirical study on the theoretical model is carried out by using practical data. This is with the hope of promoting the development of innovation education in colleges and universities, and providing a useful reference for the establishment of competitive advantage of colleges and universities.

## 2. The Theoretical Model of Innovation Education

### 2.1 Theoretical Background

Education should promote the young to develop their talents, their intellect and capabilities to their fullest potential, regardless of any disadvantage in their background (Maclellan, 2016). Essentially, innovation is 'the creation and implementation of new processes, products, services and methods of delivery, which result in significant improvements in the efficiency, effectiveness or quality of outcomes' (Australian National Audit Office, 2009:1). There is no doubt that 'innovation is important for education to equip the young to thrive, to fulfill aspirations for excellence and equity, and to provide students with opportunities to learn in ways that are consistent with learning sciences knowledge' (Roberts et al., 2012: 21). As a response to traditional forms of instruction, innovation education is a systematic project, aiming at cultivating creative talents. Innovation education has been identified as a key contributor to enhancing the innovative behavior of individuals and organizations. Finding its antecedents in constructivism theory, such as the work of Dewey among others, innovation education lays stress on the cultivation of innovation spirit and ability, and the realization of comprehensive development of the educated. Based upon a successful international innovation management program, Herstatt et al. (2014) constructed a conceptual innovation education framework, which provides a

thematic appreciation of the multi-dimensional relationships between components. Besides theoretical researches, innovation education has made significant practical achievements in foreign countries. Thus, a series of successful innovative education models have been formed, such as MIT model, model of Tokyo University, Timberlake's model and Taylor's plural ability development model, which contribute a lot to the education now and in the future.

Originating from the agile manufacturing in the United States in the late 20th century, the concept of agility has become a new strategic thinking to guide the development of enterprises, enterprise services, and knowledge management (Dubey et al., 2015). It is the strategic capability of the enterprise to survive, develop, and maintain its competitive advantage in contemporary business environments. Later, the term is applied to a broad range, from the initial production areas to knowledge management, information systems, education and other fields. From different perspectives and levels, scholars at home and abroad have carried on the thorough study on agility and have gradually shifted the focus to the framework analysis and empirical research. Colleges and universities play an important role in the construction of national innovation system, shouldering the responsibility of cultivating innovative talents. The subject of competition in colleges and universities is an effective carrier for cultivating innovative talents. Yet, very little study exists on the combination of subject competition and the innovation education. This is particularly so in the higher education. Based on the agility theory, this paper deeply analyzes the process and mechanism of the construction of innovation education model, in order to enhance students' comprehensive ability through subject competitions.

## 2.2 The Theoretical Model

As an ability to facilitate rapid reaction and development, the agility plays a very important role in promoting the construction of 'enhancing comprehensive ability through subject competitions' innovation education model. Combined with subject competitions in colleges and universities, this study tries to construct the 'enhancing comprehensive ability through subject competitions' innovation education theoretical model from the perspective of the agility theory, in order to explain the basic characteristics and evolution mechanism of agility in promoting the construction of the model. As shown in Figure 1, the model is dynamic and cross-level which includes three levels (individual, team, and society) and six links (desire and needs, information gaining, resource integration, innovation practice, acting and reflecting, and institutionalizing). Starting from the link of individual's desire and needs and information gaining, it comes to the stage of the team's resource integration and innovation practice, then to the acting and reflecting, and institutionalizing

of the team and society. The accumulated feedback and information provides an effective source of knowledge and institutional guarantee for a new round of innovation education, realizing the dynamic and agile cycle of innovation education. In this model, the three levels interact through the agility, and the six links of different levels circulate, achieving recycle development and agile innovation of 'enhancing comprehensive ability through subject competitions' innovation education.

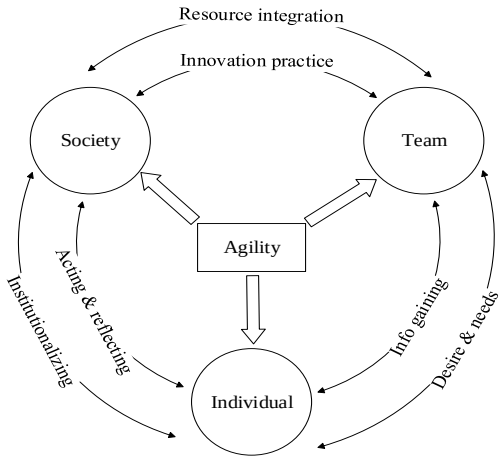


**Figure 1. Theoretical model of innovation education**

Based on the relationship between the above six links and the 'enhancing comprehensive ability through subject competitions' innovation education, this study proposes the following research hypothesis model (Figure 2) and six research hypotheses.

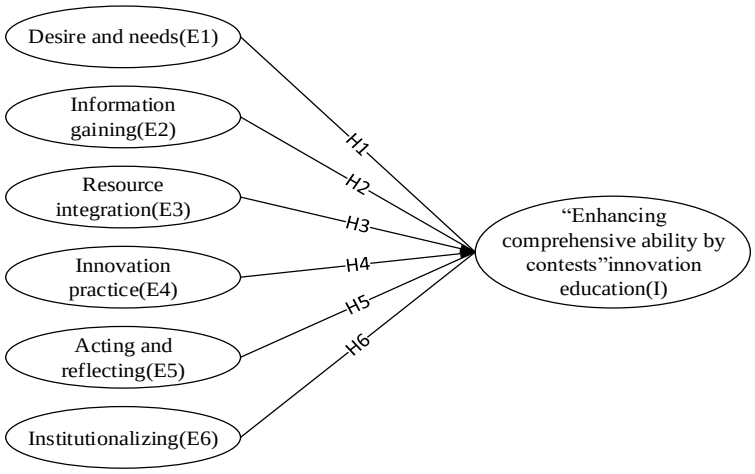


**Figure 2. Research hypothesis model**

H1: the desire and needs has significant positive impact on the 'enhancing comprehensive ability through subject competitions' innovation education.
H2: the information gaining has significant positive impact on the 'enhancing comprehensive ability through subject competitions' innovation education.
H3: the resource integration has significant positive impact on the 'enhancing comprehensive ability through subject competitions' innovation education.
H4: the innovation practice has significant positive impact on the 'enhancing comprehensive ability through subject competitions' innovation education.
H5: the acting and reflecting has significant positive impact on the 'enhancing comprehensive ability through subject competitions' innovation education.
H6: the institutionalizing has significant positive impact on the 'enhancing comprehensive ability through subject competitions' innovation education.

## 3. The Empirical Study on the Theoretical Model of Innovation Education

### 3.1 Sample Selection and Pre-survey

By using focus group, this study selects 20 teachers, students and social personnel to optimize the model elements, aiming to make the model more practical and reasonable. Therefore, the 'enhancing comprehensive ability through subject competitions' innovation education model scale (Table 1) is constructed, which consists of 6 primary elements and 12 secondary elements.

**Table 1. The 'enhancing comprehensive ability through subject competitions' innovation education model scale**

| Primary element | Secondary element | Description of secondary element |
|---|---|---|
| **Desire and needs** | Desire needs | V1 : be willing to devote time and energy<br>V2 : broaden horizons and improve skills<br>V3: enhance employment competitiveness |
| **Information gaining** | Way content | V4 : learn practical experience<br>V5 : get information about competitors<br>V6 : collect content information |

| | | |
|---|---|---|
| **Resource integration** | Reality network | V7：entity resource integration<br>V8：learn and share<br>V9：interaction among team members<br>V10：network resource integration |
| **Innovation practice** | Group individual | V11：communication among teams<br>V12：simulation practice<br>V13：targeted and personalized guidance<br>V14：comments of experts and the public |
| **Acting and reflecting** | Reflection feedback | V15：team reflection<br>V16：personal introspection<br>V17：social feedback |
| **Institutionalizing** | Existing innovative | V18：follow current standards<br>V19：learn from the advanced system<br>V20：perfection of relevant systems |

Based on literature research and the interview information of the sample group, an innovation education questionnaire was designed, which composes of 20 elements. Before large-scale questionnaire survey, 50 questionnaires were randomly distributed to conduct a pre-survey in order to ensure the rationality and feasibility of the questionnaire. According to the results of the pre-survey, the Likert four-scale questionnaire consisting of 20 items was revised. The questionnaire has six dimensions: desire and needs, information gaining, resource integration, innovation practice, acting and reflecting, and institutionalizing. The dimension of the desire and needs has 3 items, the dimension of information gaining has 3 items, the dimension of resource integration has 4 items, the dimension of innovation practice has 4 items, the dimension of acting and reflecting has 3 items, and the dimension of institutionalizing has 3 items.

### 3.2 Data Collection

A network questionnaire survey and an on-site questionnaire survey were conducted among 350 English majors of some universities and 50 persons in Rizhao City. This, however, was done by using the method of multi-

layer random sampling and cluster sampling. The questionnaire survey was conducted from April to June in 2016, lasting for 3 months. The network questionnaire survey was conducted through professional survey platform, and English majors were investigated in the on-site questionnaire survey. 400 questionnaires were given out and 382 valid questionnaires were collected back, with the effective response rate of 90%.

### 3.3 Data Statistics and Analysis

#### 3.3.1 Internal Consistency Reliability Analysis

Internal consistency is typically a measure based on the correlations between different items on the same test (Green et al., 2015). It measures whether several items that propose to measure the same general construct produce similar scores. Internal consistency is measured with Cronbach's alpha. As shown in Table 2, the overall reliability was 0.960, and Cronbach's values of each item were higher than 0.7. Therefore, this means the questionnaire had good reliability and validity.

**Table 2. Internal consistency reliability analysis results**

| Items | Desire & needs | Information gaining | Resource integration | Innovation practice | Acting & reflecting | Institutionalizing | Overall |
|---|---|---|---|---|---|---|---|
| Crombach' α | 0.840 | 0.835 | 0.824 | 0.869 | 0.782 | 0.778 | 0.960 |

#### 3.3.2 Exploratory Factor Analysis

'In order to decrease the dimension of variables effectively and uncover the underlying structure of a relatively large set of variables' (Cudeck, 2012: 270), exploratory factor analysis was used in this study. The number of variables in this study was 20, and 359 effective samples were obtained through the questionnaire, which met the premise condition of exploratory factor analysis. It shows that the collected sample data is suitable for exploratory factor analysis.

To examine the construct validity of the questionnaire, KMO and Bartlett sphericity test for 20 variables were conducted firstly. Results showed that KMO value was 0.837, the chi square value of Bartlett sphericity test was 6072.701, and the level of significance was less than 0.05. The result indicates that exploratory factor analysis can be conducted. Under the standard of eigenvalue$>$1 and factor loading value$>$0.4, the principal component analysis of the 20 items in the questionnaire were conducted. By making varimax rotation, 6 factors were extracted, which could explain 67.578% of the total variance. Further analysis showed that the common degree of V1 in factor1 (desire and needs) and V7 in factor3 (resource integration) was less than 0.4; therefore, V1 and V7 were deleted. Further exploratory factor

analysis and varimax rotation of the left 18 variables showed that it was appropriate to extract 6 factors. The eigenvalue, variance contribution rate, and cumulative variance contribution rate of each factor are shown in Table 3.

**Table 3. Exploratory factor analysis results**

| Component | Initial eigenvalue | | | Extraction sums of squared loadings | | | Rotation sums of squared loadings | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | % of variance | cumulative% | Total | % of variance | cumulative% | Total | % of variance | cumulative% |
| **1** | 1.992 | 7.826 | 42.516 | 1.992 | 7.826 | 42.516 | 2.943 | 32.467 | 32.467 |
| **2** | 1.771 | 7.013 | 43.255 | 1.771 | 7.013 | 43.255 | 2.510 | 29.537 | 34.156 |
| **3** | 1.464 | 6.099 | 48.253 | 1.464 | 6.099 | 48.253 | 2.205 | 23.412 | 41.798 |
| **4** | 1.321 | 5.478 | 53.721 | 1.321 | 5.478 | 53.721 | 2.073 | 20.375 | 53.241 |
| **5** | 1.215 | 5.022 | 58.778 | 1.215 | 5.022 | 58.778 | 1.964 | 19.117 | 61.746 |
| **6** | 1.124 | 4.685 | 67.578 | 1.124 | 4.685 | 67.578 | 1.873 | 18.451 | 67.578 |
| **7** | .991 | 4.130 | 69.231 | | | | | | |
| **8** | .921 | 3.821 | 71.423 | | | | | | |
| **9** | .863 | 3.598 | 75.115 | | | | | | |
| **10** | .787 | 3.470 | 76.235 | | | | | | |
| **11** | .740 | 3.269 | 77.134 | | | | | | |
| **12** | .721 | 2.976 | 79.269 | | | | | | |
| **13** | .679 | 2.743 | 80.136 | | | | | | |
| **14** | .674 | 2.357 | 81.435 | | | | | | |
| **15** | .610 | 2.276 | 82.234 | | | | | | |
| **16** | .594 | 2.142 | 84.156 | | | | | | |
| **17** | .563 | 2.047 | 86.732 | | | | | | |
| **18** | .542 | 1.832 | 89.049 | | | | | | |

Exploratory factor analysis showed that 6 factors can be concluded in the questionnaire which was designed according to the innovation education theoretical model. According to the content of the items of each factor, 6 factors were renamed in this study: ‘desire and needs’, ‘information gaining’, ‘resource integration’, ‘innovation practice’, ‘acting and reflecting’, and ‘institutionalizing’.

By exploratory factor analysis, ‘enhancing comprehensive ability through subject competitions’ innovation education theoretical model is improved further. There are 6 primary elements (desire and needs, information gaining, resource integration, innovation practice, acting and reflecting, and institutionalizing) and 18 secondary elements. The result is consistent with the hypothesis model basically.

### 3.3.3 Confirmatory Factor Analysis

In order to verify the relationships among the latent variables, the confirmatory factor analysis of sample data was conducted by using Amos 22 software. In addition, the theoretical model and research hypothesis model were tested by using the structural equation. If the constraints the researcher has imposed on the model are consistent with the sample data, then the results of statistical tests of model fit will indicate a good fit, and the model will be not rejected (Hoyle, 2012). Using CMIN/DF, NFI, GFI, CFI and RMSEA as the evaluation index, the structural equation model (Figure 3) and its fitting index data (Table 4) were obtained in the study. Thus, it can be concluded that 'enhancing comprehensive ability through subject competitions' innovation education theoretical model has good fitting degree. Furthermore, it has been proven that the hypothesized model is reasonable.

**Table 4.The fitting index data of the structural equation model**

| Fitting index | CMIN/DF | NFI | CFI | GFI | RMSEA |
|---|---|---|---|---|---|
| **Standard value** | ≤2.00 | ≥0.90 | ≥0.90 | ≥0.90 | ＜0.05 |
| **Measured value** | 1.95 | 0.921 | 0.910 | 0.920 | 0.047 |

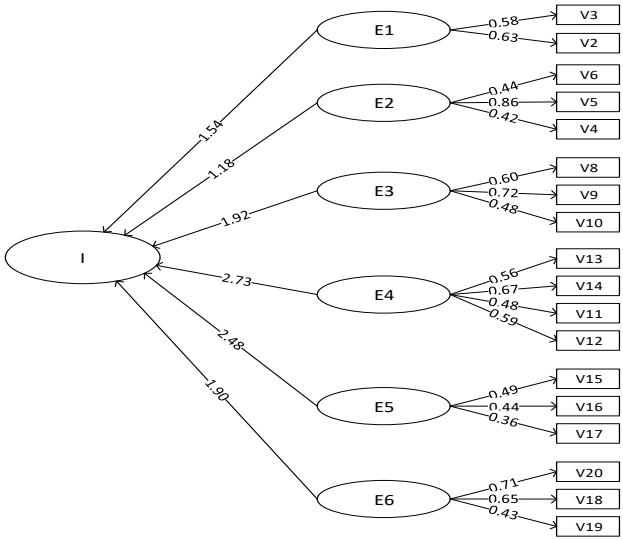


**Figure 3. The structural equation model of innovation education**

## 4. Findings and Discussion

As shown in Figure 3, the regression coefficient of E1 (desire and needs) to I ('enhancing comprehensive ability through subject competitions' innovation education) was 1.54, which arrived at significance level (＜0.001).

It indicated that E1 had a significantly positive effect on I, and the research hypothesis 1 was correct. E1 (desire and needs) consists of two items (V2 and V3). Therefore, this shows that strong personal attitude and intention is the first step in the process of agile learning and it has a positive influence on the innovation education. Desire is a sense of longing or hoping for a person, object, or outcome and is the fundamental motivation of all human action. When a person desires something, their sense of longing is excited by the enjoyment or the thought of the item, and they want to take actions to achieve their goal (Guzman et al., 2014). Subject competition in colleges and universities is an effective platform for cultivating innovative talents, providing the students with the opportunity to show their ability and creativity. In order to give full play to its positive role in promoting the growth of young talents, deepening the quality-oriented education and promoting social development, colleges and universities should fully mobilize students'enthusiasm to take part in the subject competitions.

E2 (information gaining) had a significantly positive effect on I ('enhancing comprehensive ability through subject competitions' innovation education). As shown in Figure 3, the regression coefficient of E2 to I was 1.18, which arrived at significance level ($<0.001$). It proved that the research hypothesis 2 was correct. E2 (information gaining) consists of three items (V4, V5, and V6). To get relevant information quickly under the guidance of the agility theory is very important for the construction of 'enhancing comprehensive ability through competition' innovation education model. Learning from other institutions and taking the initiative to obtain relevant information will help to promote the agility and feasibility of 'enhancing comprehensive ability through competition' innovation education. Aiming at information gaining and agile learning, it is an effective way to collect information about the subject competitions and competitors in time, and to understand the level and needs of the participants.

As shown in Figure 3, the regression coefficient of E3 (resource integration) to I ('enhancing comprehensive ability through subject competitions' innovation education) was 1.92, which arrived at significance level ($<0.001$). It indicated that E3 had a significantly positive effect on I, and the research hypothesis 3 was correct. E3 consists of three items (V8, V9, and V10). With the enhancement of the behaviors of different levels, such as information exchange, resource integration and interactive contact, the effectiveness of 'enhancing comprehensive ability through subject competitions' innovation education is improved accordingly. It creates a dynamic process of resource recycling. It also proves that the close relationship among and within the teams can bring great advantages to innovation. Strong ties promote the acquisition, absorption and construction of knowledge, and the evolution of cooperation in dynamic networks

(Melamed et al., 2016). Therefore, the rapid and effective integration of resources can promote the construction of innovation education model.

E4 (innovation practice) had a significantly positive effect on I ('enhancing comprehensive ability through subject competitions' innovation education). As shown in Figure 3, the regression coefficient of E4 to I was 2.73, which arrived at significance level ($<0.001$). It proved that the research hypothesis 4 was correct. E4 (innovation practice) consists of four items (V11, V12, V13, and V14). Putting theory into practice positively will effectively improve the effectiveness of the 'enhancing comprehensive ability through subject competitions' innovation education. Practice is the only criterion to test new knowledge and methods.

As shown in Figure 3, the regression coefficient of E5 (acting and reflecting) to I ('enhancing comprehensive ability through subject competitions' innovation education) was 2.48, which arrived at significance level ($<0.001$). It indicated that E5 had a significantly positive effect on I, and the research hypothesis 5 was correct. E5 consists of three items (V15, V16, and V17). Thus it can be concluded that constant acting and reflecting can put the original experience in constant process of being examined, modified, and strengthened. Constant acting and reflecting refines practical experience effectively and makes it a rational, open force.

E6 (institutionalizing) had a significantly positive effect on I ('enhancing comprehensive ability through subject competitions' innovation education). As shown in Figure 3, the regression coefficient of E6 to I was 1.90, which arrived at significance level ($<0.001$). It proved that the research hypothesis 6 was correct. E6 consists of three items (V18, V19, and V20). It indicates that fixed procedure and process as well as the system and norms are of vital importance to the construction of 'enhancing comprehensive ability through subject competitions' innovation education model. In the process of practice, the learning outcomes of the individual and team are integrated into the system guarantee through the process or norms. In the future innovation practice, the members will have rules to follow and search for useful information, learn useful experiences, and predict development trends quickly, thereby achieving the real dynamic cycle of innovation education.

## 5. Suggestions and Research Prospect

'Enhancing comprehensive ability through subject competitions' innovation education model contains three levels (individual, team, and society) and six links (desire and needs, information gaining, resource integration, innovation practice, acting and reflecting, and institutionalizing). The desire and needs refers to the individual's attitude and intention of participating in subject competitions. The information gaining refers to

information gaining methods and information contents. The resource integration refers to information exchange and interactive integration from different levels and different sources. The innovation practice refers to practice methods and contents of the individual, team, and society. The acting and reflecting refers to the fact that individuals and teams reflect in practice, and they change their behaviors with new ideas and knowledge. The institutionalizing refers to the fact that the team and the society integrate the practice results into the system guarantee to ensure the future innovation practice have rules to follow.

For 'enhancing comprehensive ability through subject competitions' innovation education model, the above six links have significantly positive relationships, forming a dynamic process of reciprocating cycle and collaborative development. Therefore, in the construction of agile innovation education, we should first pay attention to students' needs. Personalized publicity and training should be provided according to the needs of students from different majors in order to improve the effectiveness of innovation education. Secondly, cooperation and exchanges should be strengthened, and mutual development be sought. Exchange and cooperation at different levels can effectively promote the effectiveness and social recognition of innovation education. Thirdly, the institutional construction of innovation education should be strengthened, and the existing practice results be institutionalized. Continuous testing and optimization in the future should be improved in order to ensure the agility and effectiveness of innovation education.

Based on the combination of theoretical analysis and empirical study, a new model of innovation education was constructed in this study, straightening up the development trend of 'enhancing comprehensive ability through subject competitions' innovation education. Although the model can provide theoretical and empirical basis for the follow-up study, there are still some deficiencies in this study owning to the limited data sources and complex research process. In the following research, the scope and level of sample selection should be expanded to enhance the universality of the 'enhancing comprehensive ability through subject competitions' innovation education model. In addition, the research results can be combined with the specific subject teaching to explore more practical basis for the model. It is also the content of further study to investigate the agility of different stages of innovation education by other research methods.

**Acknowledgment**

This study was supported by the Social Science Research Project of Shandong Higher Education Institutions under Grant [No. J17RA044]; Philosophy and Social Science Research Program of Qufu Normal University under Grant [No. XSK201618].

**References**

Australian National Audit Office. (2009). Innovation in the public sector: Enabling better performance, driving new directions. Canberra: Commonwealth of Australia.

Chen, Y., Wang, Y., Nevo, S., Jin, J., Wang, L., & Chow, W. S. (2014). It capability and organizational performance: the roles of business process agility and environmental factors. *European Journal of Information Systems*, 23(3), 1-17.

Crowder, J. A., & Friess, S. (2015). Agile Project Management: Managing for Success. Springer International Publishing.

Cudeck, R. (2012). Exploratory factor analysis. Handbook of Applied Multivariate Statistics & Mathematical Modeling, 17(3), 265-296.

Dubey, R., & Gunasekaran, A. (2015). Agile manufacturing: framework and its empirical validation. The International Journal of Advanced Manufacturing Technology, 76(9), 2147-2157.

Green, S. B., & Yang, Y. (2015). Evaluation of dimensionality in the assessment of internal consistency reliability: coefficient alpha and omega coefficients. Educational Measurement: Issues and Practice, 34(4), n/a-n/a.

Guzman, M. O., & Quiroz, J. (2014). Desire. Encyclopedia of Critical Psychology, 394-397.

Herstatt, C., Waal, A. D., Maritz, A., Maclachlan, R., Lassen, A., & Buse, S. (2014). Innovation education programs: toward a conceptual framework. European Journal of Innovation Management, 17(2), 166 - 182.

Hoyle, R. H. (2012). Confirmatory factor analysis. Beverly Hills Calif, 29(4), 29-89.

Melamed, D., & Simpson, B. (2016). Strong ties promote the evolution of cooperation in dynamic networks. Social Networks, 45, 32-44.

Maclellan, E. (2015). Updating understandings of 'teaching': taking account of learners' and teachers' beliefs. Teaching in Higher Education, 20(2), 171-182.

Roberts, K., & Owen, S. (2012). Innovative education: a review of the literature. American Journal of Industrial Medicine, 8(3), 207–217.