EURASIA Journal of Mathematics, Science and Technology Education
ISSN: 1305-8223 (online) 1305-8215 (print)
OPEN ACCESS 2017 13(12):8313-8321 DOI: 10.12973/ejmste/80791

Identification and Evaluation for Key Factors of Innovative Education in Universities Based on Grey Relational Model

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Received 27 June 2017 ▪ Revised 24 October 2017 ▪ Accepted 12 November 2017

ABSTRACT

The development of innovative education in universities is influenced by many factors inside and outside the system. It is important to identify the key factors of innovative education in universities, and it is helpful to promote the practice of innovative education and the development of entrepreneurship education. This paper takes Jiangsu Province as an example to study innovative education in universities. Based on research ideas of data envelopment analysis, fifteen factors from two angles of input and output are designed. According to the relevant statistics of Jiangsu Province from 2006 to 2015, the grey relational model is used to analyze the factors that affect the development level of the innovative education in universities, and the key factors are identified and evaluated. Based on quantitative results, countermeasures are put forward from the aspects of educational concept, management system, teaching practice and so on.

Keywords: innovative education, key factors, grey relational degree, identification

INTRODUCTION

As a modern educational concept, innovative education is essentially to reform and discard the traditional ideas of education, so as to cultivate the students' innovative spirit and practical ability. Innovative education is the basic value orientation to cultivate innovative ability and innovative spirit, not only reform the educational methods, but also redefine the educational function. It is a systematic and structural reform in education. Innovative education mainly includes the following four aspects: to arouse students' critical awareness; to encourage students to participate in innovative activities; to train students' creative thinking; to cultivate students' creative practical ability.

As a strong province of education, Jiangsu attaches great importance to the education of innovation and entrepreneurship in universities, and has issued a series of reform programs, and achieved good policy results. However, innovative education is characterized by openness, transcendence and specificity, innovative education is facing some bottlenecks in the implementation of Jiangsu Province: innovative education effect is difficult to measure; teachers' innovation awareness is not high; innovative education output has uncertainty and hysteresis; lack of innovative practice of extra-curricular activities.

Through literature review found that although a lot of research on the innovative education of domestic and foreign scholars, but the research mostly focused on innovative education concept definition (Cook et al, 2014; Hsiao et al., 2017), innovative education development predicament (Roberts and Owen, 2012), innovative education improvement strategy (Yueh et al, 2012; Chou, 2017) and so on. The related research lacks the study of key influencing factors based on the data analysis. For instance, Francis et al (2011) studied innovative education in the field of agricultural ecology and emphasized that teachers should combine theory teaching with practice teaching to develop their potential. Vorontsov (2015) analyzed the development trend of Russian higher education, and emphasized that innovative education is not only a new mode of education, but also includes innovation objectives and educational programs. Aithal (2016) proposed an ideal educational system model, and explored the possibility of implementing the system model through online education. In view of this, according to the statistical data of the

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Contribution of this paper to the literature

- This paper determines the evaluation index from the perspectives of input and output, which comprehensively reflects the current situation of innovative education in Jiangsu province. This research provides a theoretical reference for subsequent research.
- Grey relational model is often used to measure the degree of association between factors. Our study contributes to current research by introducing grey relational model into the identification of key factors. It expands the scope of quantitative analysis of innovative education.
- Based on the result analysis, this study puts forward some countermeasures from the aspects of education concept, management system and practice teaching, which has strong pertinence and operability, and can provide theoretical reference for government decision-making.

development of innovative education in universities in Jiangsu Province from 2006 to 2015, grey relational analysis is used in this paper to determine the key influencing factors.

FACTORS OF INNOVATIVE EDUCATION

The development of innovative education in universities is a complex systematic project, which is affected by both internal and external factors (Bedford, 2015). Using the basic idea of data envelopment analysis (DEA), this paper analyzes the influencing factors of innovative education in universities from two perspectives of input and output (Tsou, 2010). In the selection of specific factors, on the one hand, referring to the latest research results in the field of innovative education, we can select the factors that reflect the development level of innovative education in universities; On the other hand, referring to the index selection of Jiangsu Statistical Yearbook, the paper sets specific influence factors from six aspects, such as human resources, material resources, financial resources, personnel training level and so on. The specific content is shown in **Table 1**.

Table 1. The influencing factors of innovative education in universities

Research perspective	Criteria layer	Factor layer	Identifier
Input	Human resources	The ratio of students to teachers of colleges (%)	α1
		Number of persons for science and technology activities (person)	α2
		Number of persons for R&D (person)	α3
		Number of postgraduates in school (10000 person)	α4
	Material resources	Number of institutions for R&D (unit)	α5
	Financial resources	Funds income on R&D (million yuan	α6
		Education industry cost for students (yuan)	α7
		Public education funds for students (yuan)	α8
Output	Talent training level	Number of graduate students (10000 person)	α9
	Scientific research level	Number of R&D projects (item)	α10
		Scientific and technological books published (type)	α11
		Scientific and technological treatise published (paper)	α12
		Transfer of scientific and technological achievements (item)	α13
		Number of award achievements (item)	α14
	Social service level	Number of patents applications granted (piece)	α15

METHODS AND KEY FACTORS

Methods

Gray relational analysis is used to quantitatively describe and compare the development trend of the system. The method measures the degree of correlation between the factors according to the similarity or dissimilarity of the development trends among the factors (Ho, 2006). Its basic idea is to analyze and determine the degree of influence among factors or the contribution measure of the characteristic sequence of the system according to the similarity degree of the geometric shapes of the sequence curves (Wang et al, 2013). Gray relational analysis includes gray absolute relational degree, gray relative relational degree and gray comprehensive relational degree. General steps for gray relational analysis as follows.

Step one: Determine the system characteristic sequence and correlative factor sequence. The system characteristic sequence is a comparison of the reference system, denote by X_0, $X_0 = \{X_0(t), t = 1,2,\dots,n\}$, t is the time series. The correlative factor sequence is a collection of various factors related to the system characteristic

sequence. Assuming that there are $m(i = 1,2,\ldots,m)$ factors, the factor i is recorded as $X_i = \{X_i(t), t = 1,2,\ldots,n\}$ (Samvedi et al, 2012).

Step two: Gray absolute relational degree. Let X_0 and X_i have the same sequence length and belong to the 1-AGO sequence, the difference sequences of the system characteristic sequence and the correlative factor sequence are X_0^0 andX_i^0, $X_0^0 = x_0(t) - x_0(1)$, $X_i^0 = x_i(t) - x_i(1)$.

$$|s_0| = \left|\sum_{t=2}^{n-1} x_0^0(t) + \frac{1}{2}x_\mathrm{o}^0(n)\right| \tag{1}$$

$$|s_i| = \left|\sum_{t=2}^{n-1} x_i^0(t) + \frac{1}{2}x_i^0(n)\right| \tag{2}$$

$$|s_i - s_0| = \left|\sum_{t=2}^{n-1}\left(x_i^0(t) - x_0^0(t)\right) + \frac{1}{2}\left(x_i^0(n) - x_\mathrm{o}^0(n)\right)\right| \tag{3}$$

Gray absolute relational degree between X_0 and X_i as follows.

$$\varepsilon_{0i} = \frac{1 + |s_0| + |s_i|}{1 + |s_0| + |s_i| + |s_i - s_0|} \tag{4}$$

Step three: Gray relative relational degree. $X_0{}'$ and $X_\mathrm{i}{}'$ are the initial values of X_0 and X_i respectively, the grey absolute relational degree of $X_0{}'$ is the grey relative relational degree of X_0, and the grey absolute relational degree of $X_\mathrm{i}{}'$ is the grey relative relational degree of X_i, denote by r_{0i}.

$X_0{}'(t) = \frac{x_0(t)}{x_0(1)'}$, $X_i{}'(t) = \frac{x_i(t)}{x_i(1)'}$, calculate the sequence difference between $X_0{}'$ and $X_\mathrm{i}{}'$, then the grey absolute relational degree is obtained, that is, the grey relative relational degree between X_0 and X_i as follows.

$$\varepsilon_{0i} = \frac{1 + |s_0| + |s_i|}{1 + |s_0| + |s_i| + |s_i - s_0|} \tag{5}$$

Step four: Gray comprehensive relational degree. The grey comprehensive relational degree between X_0 and X_i is ρ_{0i}, and the formula as follows.

$$\rho_{0i} = \theta\varepsilon_{0i} + (1 - \theta)r_{0i} \tag{6}$$

Among them, $\theta = 0.5$. The gray relational degree reflects the degree of similarity of curves X_0 and X_i, reflecting the degree of proximity of the rate of change relative to the starting point. It is a quantitative index that comprehensively describes the degree of closeness between sequences (Malekpoor et al, 2017).

Step five: Comparison of relational degree and calculation results. According to the relative degree, the results are compared and analyzed.

Data Collection and Processing

According to the results above, refer to *Jiangsu Statistical Yearbook, China Statistical Yearbook, National Education Development Statistics Bulletin* and other statistical information, we can get the statistical data of the influencing factors of innovative education in universities in Jiangsu province from 2006 to 2015. The results are summarized in **Table 2**.

Table 2. The statistical data of the factors of innovative education in Jiangsu Province from 2006 to 2015 and the results of grey relational grade

Factors	Years										P_{oi}
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
α1	14.87	15.12	15.32	15.53	15.88	15.65	15.45	15.48	16.24	16.54	0.5070
α2	41657	44952	46138	49188	51374	52776	61939	65116	68815	73204	0.5267
α3	25989	27145	28625	32085	33672	34898	42185	44799	46645	48423	0.5324
α4	8.91	9.65	10.47	11.39	12.6	13.44	13.95	14.59	15.07	15.56	0.5285
α5	335	294	319	365	390	447	521	557	606	635	0.6507
α6	4341	5014	6373	7091	9358	10446	12114	13394	14178	14499	0.5825
α7	5315	6135	8156	8352	10089	12042	14836	14836	15728	17764	0.5747
α8	2227	2274	4108	4173	5213	7196	7891	8501	6941	8324	0.6035
α9	1.93	2.40	2.60	2.96	3.00	3.34	3.84	4.03	4.17	4.28	0.5399
α10	14682	15409	17511	19069	21760	31158	33489	37596	40765	42988	0.5566
α11	169	173	194	248	239	216	212	275	267	370	0.5829
α12	46383	48465	53857	62636	68563	75298	77244	79321	81844	86525	0.5310
α13	651	808	1321	993	1231	1977	1573	1703	1666	1432	0.6626
α14	346	405	374	437	427	436	480	539	547	394	0.6086
α15	1367	1568	2133	3228	6038	8373	11234	12116	13003	19209	0.7429

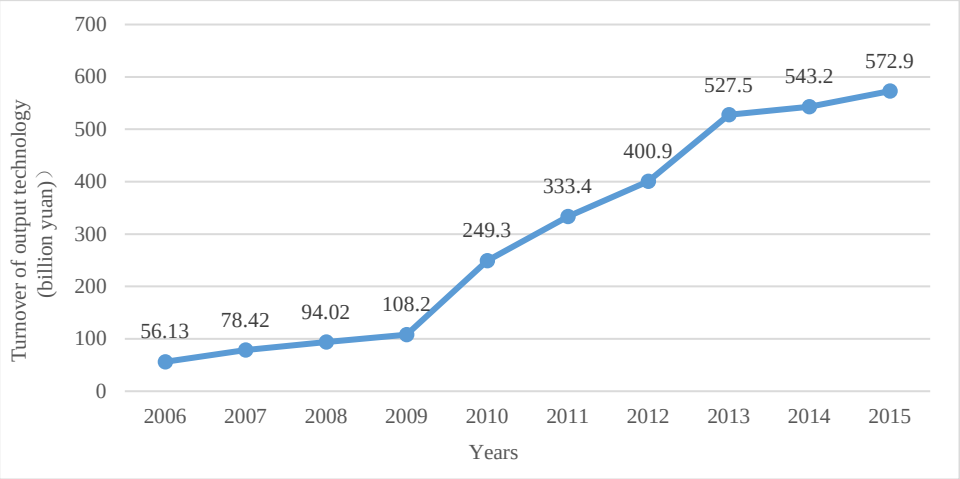

Figure 1. Turnover of output technology of technology market in Jiangsu from 2006 to 2015

According to the basic idea of gray relational analysis, it is necessary to determine the systematic characteristic sequence of innovative education in universities in Jiangsu Province as a comparative reference system. Due to the lack of research on the key influencing factors of innovative education in universities, it is determined that the system characteristic sequence lacks academic basis. In this paper, the influencing factors of logistics development are used for reference, and turnover of output technology of Jiangsu technology market is selected as the system characteristic sequence. The reason is as follows. First, turnover of output technology represents the level of innovative education development in universities, and the operation is simple and convenient, covering the social effects of innovation achievements in universities and enterprises. Second, the economic profits reflect the ultimate goal of the development of innovative education in universities, and echo the basic thinking of selecting the influencing factors from the two angles of input and output. Therefore, this paper takes turnover of output technology of technology market in Jiangsu from 2006 to 2015 (as shown in **Figure 1**) as the systematic characteristic sequence of grey comprehensive correlation analysis.

Identification and Evaluation of Key Factors

Based on the statistical data of **Table 2**, according to the calculation procedure of grey comprehensive relational degree, the gray comprehensive relational degree (P_{oi}) of the system characteristic sequence and correlative factor sequence of the innovative education in Jiangsu province is calculated. In terms of the length of the article, the concrete calculation procedure of the grey comprehensive relational degree is omitted, and the results are shown in the last column of **Table 2**.

The results show that the factors of innovative education in universities in Jiangsu Province are as follows: number of patents applications granted, transfer of scientific and technological achievements, number of institutions for R&D, number of award achievements, public education funds for students, scientific and technological books published, funds income on R&D, education industry cost for students, number of R&D projects, number of graduate students, number of persons for R&D, scientific and technological treatise published and so on.

RESULTS AND COUNTERMEASURES

Results

From the results of gray comprehensive relational degree, number of patents applications granted and transfer of scientific and technological achievements are a very important factor in the development of innovative education in universities in Jiangsu Province, ranking first and second respectively among the various factors. They reflect the market acceptance of innovative results, indicating the long-term positive impact of innovative education.

The number of institutions for R&D play an important role in the development of innovative education in universities. The ultimate goal of innovative education is to rely on innovative talents to produce innovative results, resulting in social and economic benefits. R&D institutions are the carrier of innovative talents engaged in innovative activities, the number of R&D institutions shows the results of innovative education, and counterproductive to innovative education.

Funds income on R&D, public education funds for students, education industry cost for students and other factors become more and more important. The development of higher education cannot be separated from the financial support of the government, and it is necessary to provide adequate financial support for the cultivation of innovative talents. On the one hand, sufficient financial resources provide conditions for innovative education in universities; On the other hand, the improvement of public budget is conducive to solving the worries of researchers, and the purpose and direction of innovative education in universities are clearly defined.

The number of R&D projects has great influence on the development of innovative education in universities in Jiangsu province. It reflects the market demand for scientific and technological innovation, reverse the promotion of universities to improve the quality of personnel training, and strengthen the output of innovative talents to have the ability to undertake research and development issues. Through the analysis, it is proved that the results obtained by gray comprehensive correlation analysis are in good agreement with the actual situation of innovative education development in universities in Jiangsu province.

Analysis of influencing factors of input level

The number of institutions for R&D, funds income on R&D, education industry cost for students and public education funds for students are the main factor influencing the development of innovative education in universities in Jiangsu Province, and influence of the ratio of students to teachers of colleges, number of persons for science and technology activities, number of persons for R&D and number of postgraduates in school are relatively weak. This shows that public financial funds are the main driving force for the development of innovative education in universities, and they provide material resources and financial resources for innovative education in universities. Therefore, the government must strengthen the education support, continue to tilt the public budget to the education field, and then strengthen the teaching staff and infrastructure construction, promote foreign exchange, update the concept of education, and change the teaching model (Kaufman et al, 2016). The correlation between the influencing factors of human resources and the development of innovative education in universities is small, which does not mean that teachers, researchers and graduate students have low contribution to creative education, but in the short term, these factors tend to be stable in quantity, and the improvement in quality is reflected in the influencing factors of output level (Brenna, 2016; Hamada and Hassan, 2017).

Analysis of influencing factors of output level

On the whole, the grey relational degree between the influencing factors of output level and the development of innovative education in universities is higher. The transfer of scientific and technological achievements, number of award achievements, number of patents applications granted and number of R&D projects have a greater impact on the development of innovative education in universities in Jiangsu province, influence of scientific and technological treatise published, number of graduate students are relatively weak. Therefore, the focus of the development of innovative education is to increase the number of scientific and technological achievements transferred and the amount of patents applications granted, and to obtain as much R&D projects as possible so as to enhance the level of scientific research and social service in universities. Among the factors that reflect the level

of scientific research, the importance of scientific and technological treatise published is low. The reason is that academic research has not been further translated into innovative results due to lack of practice. Therefore, in order to speed up the development of innovative education in universities, Jiangsu should speed up the output of innovative achievements under the guidance of innovative educational goals and innovative educational programs (Klement, 2017). Meanwhile, Jiangsu must optimize the process of innovative education, pay attention to the quality of graduate education, adhere to both theoretical innovation and practice innovation, enhance the concentration of academic atmosphere, promote academic output (Heinis et al, 2016).

Countermeasures

In order to promote the sustainable development of innovative education in universities in Jiangsu province, it is necessary to make suggestions on educational ideas, academic environment and innovative practice on the basis of grasping the key influential factors.

Change educational concept

The implementation of innovative education needs to change the traditional way of education, create an active and innovative cultural environment, and enhance students' awareness of innovation. Under the shackles of traditional educational ideas, higher education in Jiangsu has continued the inculcation education model. The dependence of modern education on authority leads to the difficulty of innovative education in universities, and innovative education becomes a mere formality. On the one hand, college students should break the shackles of the inherent ideas, consciously cultivate awareness of innovation, discuss and exchange academic frontiers with their teachers, and offer independent opinions on academic issues (Du et al, 2014; Lee, 2017). On the other hand, teachers should strengthen the inculcation of students' innovative spirit, help students realize the difficulties of innovative activities, and strengthen professional knowledge accumulation.

Perfect the educational management system

Jiangsu Province, the overall level of education ranks the forefront of China, innovative education has made certain achievements, but the relevant management system is to be perfected. First, universities in Jiangsu should modify regulations to give students greater freedom, encourage students to participate actively in innovative activities, and adjust their learning plans according to their own needs (Kim et al, 2012). Second, universities in Jiangsu should adjust the existing degree evaluation system, and put innovative practice and innovative ability evaluation into students' quality assessment, and pay attention to the innovative performance of students during their studies. Third, according to the principle of fairness, universities should establish innovative rewards and punishments mechanism, reward students with innovative ability, and give appropriate punishment to students who do not actively participate in the school's innovative activities (Castro, 2015).

Create a free and active academic atmosphere

Constructing innovative culture atmosphere is helpful to train creative talents (Clothey, 2011). First of all, universities should organize cultural activities to promote student communication. Universities in Jiangsu should take mass organizations and student associations as the carrier, organize cultural activities actively, set up cross disciplinary communication platform, promote the learning of each subject, and guide the students to form an innovative thinking mode. Secondly, universities should optimize the curriculum system, encourage students to participate in practical activities, enhance the proportion of innovative courses, pay attention to the content of practical courses, and consciously enhance the practical ability of college students (Ferreras-Méndez et al, 2016). Finally, Jiangsu should optimize the teaching methods, use heuristic teaching methods, try to carry out open teaching, stimulate students' creative inspiration, and enhance students' divergent thinking ability.

Strengthen the practice of innovative teaching

Practical teaching can test the mastery of students' knowledge, test students' ability of problem analysis and knowledge use, and discover the deficiencies of curriculum system and teaching methods in time. On the one hand, Jiangsu Province should make full use of social resources, and exchanges and cooperation with enterprises to build innovative educational practice platform, encourage students to enter the enterprise practice, transform the scientific research achievements into the social productive forces, and expand the ways to cultivate students' creative ability in universities (Cheng et al, 2016). On the other hand, the practice teaching takes the enterprise as the platform, and the teaching process and the teaching quality are lack of controllability. Therefore, we must strengthen the supervision and management of practice teaching. In order to ensure the controllability and

feasibility of practical teaching, Jiangsu should comprehensively review the operation mechanism of practical teaching and evaluate the quality of teaching with multi index comprehensive evaluation method.

Improve the educational quality evaluation methods

Firstly, the traditional evaluation method, which takes the final examination as the main part, cannot effectively check the students' innovative ability. It is easy for students to pay more attention to examination results, but neglect the cultivation of innovative consciousness (Chhokar, 2010). Jiangsu should build up a quality evaluation mechanism with equal emphasis on academic performance and practical ability, and treat different types of students differently so as to ensure their respective lengths. Secondly, universities should often go to the top universities in foreign countries to learn from their useful experience in management, teaching and other aspects, and establish a quality evaluation system which is conducive to the cultivation of students' innovative ability. Finally, universities in Jiangsu province should revise the assessment standards and build an evaluation mechanism with teachers, employers and educational institutions as the evaluation subjects (Hofman et al, 2013). The quality evaluation of innovative education should gradually highlight the employing requirements of employers, and objectively evaluate students through innovative achievements, practical reports, evaluation of employers and research reports.

Building an innovative teacher team

The teacher's creative consciousness has an enlightening effect on students. Jiangsu should build an innovative teacher team through training, visits and exchanges. On the one hand, Jiangsu Province should adjust the standard of talent introduction, change the talent selection mechanism which is too concerned with academic ability, pay attention to cultivate the innovation consciousness and personality charm of teachers, establish a good teacher image and guide students to establish good learning concept (Nazarov et al, 2013). On the other hand, universities should often organize teachers to participate in exchange activities, invite well-known scholars held academic lectures to improve the academic sensitivity of teachers. Meanwhile, teachers should get rid of the traditional knowledge-based teaching model, adopt the teaching method of guiding supervision and establish equal teacher-student relationship.

DISCUSSION AND CONCLUSION

Innovative education in universities is the basic value orientation in cultivating innovative ability and innovative spirit. According to the relevant statistics of Jiangsu Province from 2006 to 2015, the grey relational analysis is used to analyze the factors that affect the development level of the innovative education in universities, and the key influencing factors are determined.

Similar to most empirical studies, we must note several limitations. On the one hand, the empirical research based on a single province is not enough to fully explain the key factors of innovation education. There are obvious regional differences in China's education. The key factors of higher education in different regions are slightly different, and cross regional comparative research is more convincing. Based on an analysis of ten institutional cases from five European countries, a comprehensive description and classification of barriers and drivers of innovation are provided by Lašáková et al (2017). On the other hand, the data in this study are not rich enough. The statistical data of 10 years can not fully reflect the changing course of higher education in Jiangsu Province. Due to the change of statistical data caliber, this paper is limited by the set of evaluation indexes, and the data of the longer span have incommensurability. Furthermore, our study contributes to current research by introducing grey relational analysis into the identification of key factors. Grey relational model is often used to measure the degree of association between factors. This paper uses it to determine the key factors, and extends the model of factor identification.

In conclusion, this paper demonstrates that in our sample, the improvement of innovative education in universities in Jiangsu has benefited from the increase in the number of R&D institutions, the number of scientific and technological achievements transferred and the amount of patents applications granted. An important insight we can draw is that the government financial input has an important impact on the development of innovative education in universities, the continuing increase in R&D funds income provides impetus for innovative activities. Finally, the importance of human resources to the development of innovative education in universities is self-evident, but the correlation between human resources and innovative education in universities is relatively low.

ACKNOWLEDGEMENTS

This research was financially supported by National Social Science Foundation (Grant No. 16BJY042).

REFERENCES

Aithal, P. S., & Aithal, S. (2016). An innovative education model to realize ideal education system. *International Journal of Scientific Research and Management, 3*(3), 2464-2469.

Bedford, D. S. (2015). Management control systems across different modes of innovation: Implications for firm performance. *Management Accounting Research, 28*, 12-30.

Brenna, B. (2016). Book review: Inspiration and innovation in teaching and teacher education. *Journal of the Canadian Association for Curriculum Studies, 13*(2), 82-85.

Castro, G. M. (2015). Knowledge management and innovation in knowledge-based and high-tech industrial markets: The role of openness and absorptive capacity. *Industrial Marketing Management, 47*, 143-146.

Cheng, C. C., Yang, C., & Sheu, C. (2016). Effects of open innovation and knowledge-based dynamic capabilities on radical innovation: An empirical study. *Journal of Engineering & Technology Management, 41*, 79-91.

Chhokar, K. B. (2010). Higher education and curriculum innovation for sustainable development in India. *International Journal of Sustainability in Higher Education, 11*(2), 141-152.

Chou, C., (2017). An Analysis of the 3D Video and Interactive Response Approach Effects on the Science Remedial Teaching for Fourth Grade Underachieving Students. *Eurasia Journal of Mathematics Science and Technology Education, 13*(4), 1059-1073.

Clothey, R. A. (2011). Educating global citizens in colleges and universities: challenges and opportunities (review). *Review of Higher Education, 34*(3), 508-510.

Cook, J. A., Edwards, S. V., Lacey, E. A., & Guralnick, R. P. (2014). Natural history collections as emerging resources for innovative education. *Bioscience, 64*(8), 725-734.

Du, J., Leten, B., & Vanhaverbeke, W. (2014). Managing open innovation projects with science-based and market-based partners. *Research Policy, 43*(5), 828-840.

Ferreras-Méndez, J. L., Fernández-Mesa, A., & Alegre, J. (2016). The relationship between knowledge search strategies and absorptive capacity: A deeper look. *Technovation, 54*, 48-61.

Francis, C. A., Jordan, N., Porter, P., & Breland, T. A. (2011). Innovative education in agroecology: experiential learning for a sustainable agriculture. *Critical Reviews in Plant Sciences, 30*(1-2), 226-237.

Hamada, M., & Hassan, M. (2017). An Interactive Learning Environment for Information and Communication Theory. *Eurasia Journal of Mathematics Science and Technology Education, 13*(1), 35-59.

Heinis, T. B., Goller, I., & Meboldt, M. (2016). Multilevel design education for innovation competencies. *ScienceDirect, 50*, 759-764.

Ho, C. T. (2006). Measuring bank operations performance: an approach based on Grey Relation Analysis. *Journal of the Operational Research Society, 57*(4), 337-349.

Hofman, R. H., Boom, J. De., Meeuwisse, M., & Hofman, W. H. A. (2013). Educational innovation, quality, and effects: An exploration of innovations and their effects in secondary education. *Educational Policy, 27*(6), 843-866.

Hsiao, S., Lin, H., & Ko, Y. (2017). Application of Grey Relational Analysis to Decision-Making during Product Development. *Eurasia Journal of Mathematics Science and Technology Education, 13*(6), 2581-2600.

Kaufman, N. J., & Scott, C. (2016). Innovation in higher education: lessons learned from creating a faculty fellowship program. *Journal of Law Medicine & Ethics, 44*, 97-106.

Kim, D. Y., Kumar, V., & Kumar, U. (2012). Relationship between quality management practices and innovation. *Journal of Operations Management, 30*(4), 295-315.

Klement, M. (2017). Models of integration of virtualization in education: Virtualization technology and possibilities of its use in education. *Computers & Education, 105*, 31-43.

Lašáková, A., Bajzíková, L., & Dedze, I. (2017). Barriers and drivers of innovation in higher education: Case study-based evidence across ten European universities. *International Journal of Educational Development, 55*, 69-79.

Lee, C. I. (2017). An Appropriate Prompts System Based on the Polya Method for Mathematical Problem-Solving. *Eurasia Journal of Mathematics Science and Technology Education, 13*(3), 893-910.

Malekpoor, H., Chalvatzis, K., Mishra, N., & Mehlawat, M. K. (2017). Integrated grey relational analysis and multi objective grey linear programming for sustainable electricity generation planning. *Annals of Operations Research, 6*(8), 1-29.

Nazarov, Z., & Akhmedjonov, A. (2013). Education, on-the-job training, and innovation in transition economies. *Eastern European Economics, 50*(6), 28-56.

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

Samvedi, A., Jain, V., & Chan, F. T. (2012). An integrated approach for machine tool selection using fuzzy analytical hierarchy process and grey relational analysis. *International Journal of Production Research, 50*(12), 3211-3221.

Tsou, M. H. (2010). Multidisciplinary cooperation in GIS education: a case study of US colleges and universities. *Journal of Geography in Higher Education, 34*(4), 493-509.

Vorontsov, A., & Vorontsova, E. (2015). Innovative education in Russia: the basic tendencies analysis. *Procedia-Social and Behavioral Sciences, 214*(12), 1147-1155.

Wang, P., Meng, P., Zhai, J. Y., & Zhu, Z. Q. (2013). A hybrid method using experiment design and grey relational analysis for multiple criteria decision making problems. *Knowledge-Based Systems, 53*(9), 100-107.

Yueh, H. P., Chen, T. L., Chiu, L. A., Lee, S. L., & Wang, A. B. (2012). Student evaluation of teaching effectiveness of a nationwide innovative education program on image display technology. *IEEE Transactions on Education, 55*(3), 365–369.