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Research Article

Education Model of Industry-University-Research Cooperation in Training Application-oriented innovative Talents*

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Abstract

In view of the fact that the research method of innovative talent education model is too single, this paper studies the education model of industry-university-research (IUR) cooperation in training application-oriented innovative talents from the two aspects of qualitative analysis and quantitative analysis. Firstly, this paper analyses the education status of IUR cooperation in training application-oriented innovative talents. Then, based on the previous studies, it conducts qualitative analysis on the education model of IUR cooperation to cultivate applied innovative talents. Finally, it proposes a quantitative analysis method for the application-oriented innovative talent education model based on IUR cooperation. The quantitative analysis method proposed in this paper is applied to the research of application-oriented innovative talent education model for the first time, which has made a useful attempt to introduce quantitative analysis in this field. The research results, from qualitative analysis and quantitative analysis, show the evaluation method of the education model for application-oriented innovative talent based on IUR cooperation, which provides a theoretical reference for the development of innovative talent education in various fields, and also has important practical significance for promoting the transformation of talent training ideas in higher education.

Keywords

Industry-University-Research (IUR) Cooperation • Application-Oriented Innovative Talents • Educational Model

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In order to solve the problem that the research method of innovative talent education mode is too single, this paper proposes a new research method from two dimensions of qualitative analysis and quantitative analysis.

The concept of the IUR cooperative education model has been a hot topic of researchers since its introduction. In particular, the IUR cooperation is very suitable for the cultivation of application-oriented innovative talents, so researchers have paid special attention to this. In the existing research, some researchers focus their research on macro-policy, giving reasonable advice for existing problems (Bramwell & Wolfe, 2008); some researchers, taking students in specific majors as the research object, puts forward a highly targeted education strategy based on IUR cooperation (Lacetera, 2009; Fraser *et al*., 2011); some propose new evaluation method for education effectiveness under the background of IUR cooperation (Singh & Singh, 2005); some other present the status quo and useful exploration of application-oriented innovative talents based on facts and feedback from all parties (Luthi, 2013). The predecessors have done a lot of useful research work, but the research methods basically used the traditional qualitative analysis.

For further consolidating the research foundation of IUR cooperative education, this paper introduces the quantitative analysis method based on qualitative analysis method. From the two dimensions of qualitative analysis and quantitative analysis, the author conducts an in-depth study on the education model of IUR cooperation to cultivate application-oriented innovative talents. The research results shall provide more solid theoretical support for the all parties involved to actively cooperate and deeply conduct the cultivation of the application-oriented innovative talents.

In this paper, Chapter 1 makes introduction; Chapter 2 presents the IUR cooperation-based education status of the application-oriented innovative talents; Chapter 3 conducts a qualitative analysis for IUR cooperation-based education model of the application-oriented innovative talents; Chapter 4 adopts the quantitative analysis for this education model; and Chapter 5 draws the conclusions.

Education status of IUR cooperation in training the application-oriented innovative talents

The effectiveness of IUR cooperative education

One hundred years ago, American researchers first proposed the concept of IUR cooperative education model. The concept emphasizes quality education oriented to the actual society, promotes the teaching behaviour of the university-enterprise cooperation, and focuses on the training goal of application-oriented innovative talents (Jasny *et al*., 2017). In the past 100 years, the talent training model of IUR cooperation has been polished and gradually matured. A series of studies and practices for the past few years have shown that IUR cooperative education is an effective way to cultivate innovative talents, especially application-oriented innovative talents. Along with the rapid development of modern society and the upgrading of various industries, modern higher education must keep pace with them and continuously provide various innovative talents to

advance social progress. The IUR cooperative education model has solved this problem well, and mobilized all parties to actively participate in the teaching process through mutual benefit and common growth.

Deficiency with IUR cooperative education

Although the IUR cooperative education has achieved remarkable results in cultivating application-oriented innovative talents, there are still some deficiencies in this educational model. First, there is a conflict between this cooperative education model and some concepts in higher education that overemphasize basic education, which confines the promotion of the IUR cooperative education model within a certain scope. Second, due to some restrictions on the systems such as teaching examination and evaluation in the existing education system, these systems cannot adapt well to the IUR cooperative education model, to spoil the enthusiasm of teaching objects to participate in the IUR cooperation to a certain extent. Third, certain industrial enterprises have insufficient understanding for the importance of IUR cooperation, so that they cannot guarantee the continuous investment of the education model funds, or can only provide less funding, resulting in the ineffective implementation of IUR cooperation. Thus, the final teaching effect cannot be ensured (Saille, 2013). Aimed at the three problems above, this study was carried out. Through the quantitative analysis of the existing data, it provides theoretical support for the promoting the concept of IUR cooperative education model, and data support for the reform of the existing education system. Besides, the industry enterprises have more confidence in the prospects of IUR cooperative education.

Qualitative Analysis for the IUR cooperation-based education model of application-oriented innovative talents

The role of IUR cooperation in promoting the basic education of innovative talents

Studies have shown that the education model based on IUR cooperation doesn't weaken basic education, but can promote the importance of basic education for all parties, so as to cultivate the innovative talents with more solid basic theory (Clackson, 2006). Specifically, for colleges and universities, the IUR cooperation firstly can make them acquire more accurate and real social needs, and then quickly adjust the teaching content in a targeted manner; second, through the real industrial environment, the teaching effect can be verified in the social practice of teaching objects; thirdly, it can broaden the source of project funding, increase the amount of project funding support, laying a material foundation for providing better quality teaching resources; at last, the stability of teacher literacy can be maintained, making their knowledge reserve along with social development.

The role of IUR cooperation in promoting the practice of innovative talents

Practice has proved that the education model based on IUR cooperation can enable the teaching object to track the actual situation of the industry and familiarize with the work content, so that they can be quickly integrated into the working environment, master the work process, and create economic value after officially

employed (Guillot, Paulmani, Kumar & Fraser, 2017). Specifically, for the employer, the IUR cooperation firstly can accurately convey the true demand for teaching content and staff quality to higher education institutions and their teaching objects; second, it can help the employer to understand the overall situation and personality information in the participating process of talent education, to facilitate the recruitment and training of talents in the future; thirdly, the scientific research breakthroughs of higher education institutions can be simultaneously understood, and the transformation of scientific research results be carried out at first time, which accelerates the benign interaction of scientific research and technology transformation; Fourth, the mature educational resources in higher education institutions can be used to complete the on-the-job training of the staff, and maintain the high level of existing productivity.

The role of IUR cooperation in promoting independent learning of innovative talents

The survey shows that the education model based on IUR cooperation is highly recognized by the teaching objects, since it provides closed-loop iterations of education and practice for the teaching objects, and offers a broad space for independent learning (Crespo & Dridi, 2007). Specifically, for the teaching objects, the IUR cooperation firstly can help them understand the true level of industrial development, and the problems that need to be solved at this stage, which prompts them to think actively, change the teaching process from passive acceptance to active participation, and thus effectively improve the final teaching effect; secondly, it can help them rethink their career development, that is, combined with their own interests and knowledge ability structure, they should determine their career and effort direction as soon as possible according to the characteristics of each segmentation in the industry; thirdly, it can improve the teaching objects' own practice level, and through early intervention in production, they can seamlessly complete role transformation and carry on independent work after employed officially; at last, their ability to work with others can be trained, and early intervention in production is conductive to improving their communication level, and clearly specifying their own positioning and role division.

Quantitative analysis for the IUR cooperation-based education model of application-oriented innovative talents

Influence of IUR cooperation on the economic benefits of employers

Taking 10 enterprises in the fields of software information, machinery manufacturing and material processing etc. as the research objects, this paper studies the influence of IUR cooperation on the application of innovative talent education model on the talent structure, patent quantity and profit amount. Table 1 shows the basic information of 10 enterprises in the period from 2012 to 2014 before the introduction of IUR cooperation, and Table 2 shows that from 2015 to 2017 after the introduction of IUR cooperation.

By comparing Tables 1 with 2, it can be seen that after the introduction of IUR cooperation, the proportion of highly educated employees, the number of patents, and the amount of profits of the 10 enterprises have increased to varying degrees, e.g., in enterprise 8, the proportion of highly educated employees has changed

from 46% to 75%, increasing by 30%, which indicates that enterprises have begun to attach importance to talent intelligence factors or enterprises have begun to transform and upgrade. Under these circumstances, corporate profitability will be gradually reflected in the current or later period. Also, in enterprise 3 and 4, the number of patents has achieved zero breakthrough, indicating that the enterprises' patent protection awareness has been strengthened or the technology research and development capabilities have improved, thus, the market competitiveness of enterprises has been further strengthened. In addition to the vertical comparison of each enterprise on the timeline, the enterprise 9 was also selected in this paper, to conduct horizontal comparison among its various departments. The comparison results are shown in Table 3.

Table 1
Basic Information of 10 Companies before the Introduction of Industry-University-Research Cooperation (2012-2014)

Company number	Proportion of highly educated employees	Number of patents	Profit amount (Million U.S. dollars)
Company 1	54%	18	4.1
Company 2	68%	25	4.5
Company 3	19%	0	0.2
Company 4	28%	0	0.2
Company 5	62%	19	3.9
Company 6	43%	14	2.6
Company 7	58%	6	2.8
Company 8	46%	13	3.3
Company 9	71%	37	5.1
Company 10	38%	2	2.4

Table 2
Basic Information of 10 Companies after the Introduction of Industry-University-Research Cooperation (2015-2017)

Company number	Proportion of highly educated employees	Number of patents	Profit amount (Million U.S. dollars)
Company 1	60%	24	5.9
Company 2	69%	31	5.7
Company 3	34%	5	1.3
Company 4	41%	6	1.0
Company 5	70%	28	4.4
Company 6	59%	25	3.8
Company 7	66%	16	4.2
Company 8	75%	27	8.1
Company 9	80%	53	7.2
Company 10	45%	7	3.5

Table 3
Comparison between Various Departments within Company 9 (2015～2017)

Department name	Participate in industry-university-research cooperation?	Number of patents	Profit amount (Million U.S. dollars)
Department A	No	9	1.2
Department B	No	9	1.1
Department C	Yes	17	2.4
Department D	Yes	18	2.5

Before the introduction of IUR cooperation, the number of patents and the amount of profit in departments A-D are almost the same. However, it can be seen from Table 3, between 2015 and 2017, the departments C and D participating in the IUR cooperation are significantly higher in terms of the number of patents and the amount of profit than those in department A and B without participating in the IUR cooperation.

Influence of IUR Cooperation on teaching and research in colleges and universities

Table 4
Comparison of 5 Universities before and after the Introduction of Industry-University-Research Cooperation

University number	Phase	Student Competency Assessment (Percentile)	Number of research projects	Amount of Funds (Thousand dollars)	Employment rate
University 1	Before the cooperation	61	12	512	85%
	After the cooperation	78	25	1240	92%
University 2	Before the cooperation	70	8	462	73%
	After the cooperation	85	19	1050	87%
University 3	Before the cooperation	69	10	380	80%
	After the cooperation	81	17	865	89%
University 4	Before the cooperation	82	5	150	78%
	After the cooperation	89	11	326	86%
University 5	Before the cooperation	73	32	680	91%
	After the cooperation	90	55	1420	97%

Taking 5 colleges and universities as the research objects, this paper studies the influence of IUR cooperation-based education model of application-oriented innovative talents on the students' ability improvement, the number of scientific research tasks from enterprises, the amount of funds supported by enterprises, and the employment rate of students in colleges and universities. Table 4 lists the basic information of the five colleges before and after the introduction of IUR cooperation.

Table 4 indicates that after the introduction of IUR cooperation, the five colleges and universities have significantly improved their indicators in terms of teaching effects, scientific research volume, and student employment etc.

Influence of IUR cooperation on students' ability improvement

Taking the college students majoring in software engineering, mechanical manufacturing, and polymer materials etc. as the research objects, this paper studies the influence of IUR cooperative education model of

application-oriented innovative talents on the students' application and innovation ability, teaching satisfaction and employment satisfaction. The questionnaires were adopted to conduct surveys of the employers about the students' application innovation ability, and also survey of the students about the teaching satisfaction and employment satisfaction. In this survey, 300 questionnaires were distributed to the student groups both participating and not participating in the IUR cooperation, and the valid questionnaires were 283 and 265, respectively; 127 questionnaires were distributed to the employers, and 121 valid questionnaires were collected. After statistical analysis, the basic information of different student groups is obtained. Table 5 shows the comparison list of information.

Table 5
Comparison of Basic Information of Different Student Groups

Major	Student group type	Application Innovation ability (percentile)	Teaching satisfaction	Employment satisfaction
Software Engineering	Student group participating in cooperation	98	85%	92%
	Student group not involved in cooperation	71	63%	77%
Mechanical manufacturing	Student group participating in cooperation	94	83%	87%
	Student group not involved in cooperation	82	67%	63%
Polymer Materials	Student group participating in cooperation	97	88%	86%
	Student group not involved in cooperation	75	74%	61%

It can be seen from Table 5 that under different professional backgrounds, the student groups participating in the IUR cooperation are higher in the indicators such as application innovation ability, teaching satisfaction, and employment satisfaction than the student group participating in the IUR cooperation. Esp. in the employer's evaluation of students' application and innovation ability, the student groups majoring in three different departments respectively and participating in the IUR cooperation obtained high scores of 98, 94, and 97. This fully shows that the role of IUR cooperation in improving students' ability has been highly recognized by employers.

Conclusions

This paper studies the education model of IUR cooperation in training application-oriented innovative talents. Firstly, from the perspectives of the effectiveness and deficiency with the IUR cooperation, this paper introduces the education status of IUR cooperation in training application-oriented innovative talents. Then, it conducts a qualitative analysis for the IUR cooperation-based education model in the three aspects of basic education, industrial practice and independent learning. Finally, based on the three main entities of employers, universities and students, this education model was quantitatively analysed. This paper not only conducts a detailed qualitative analysis of the IUR cooperative education model, but also proposes a quantitative analysis method for this model for the first time. The research results provide a theoretical reference for all parties to

actively participate in the IUR cooperation, and have important practical significance for accelerating the cultivation of application-oriented innovative talents.

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