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A Comparative Study of Undergraduates' Understanding of Scientific Virtue

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Abstract: It is of great significance to explore virtue as the internal driving force of subject moral practice. This study investigates the situation of Undergraduates in the four dimensions through the questionnaire method, including scientific virtue content, scientific virtue judgment, scientific virtue motivation and scientific virtue decision-making. The results show that the overall level of Undergraduates' understanding of scientific virtue is above medium, there are significant differences between grades and disciplines in the four dimensions.

1. Introduction

Undergraduates are the "potential scientists" of the future. Their moral attitude towards scientific research and their understanding of scientific morality are related to future scientific and technological achievements.

This study agrees that the science and technology ethics based on normative ethics exceeds its own theoretical load, and emphasizes that the behavior of scientific people shows obvious lag through system guidance and restraint, and cannot intervene and regulate the possible ethical problems. The ethical education and scientific moral education based on it also have deficiencies. At present, the academic circles constantly call for the transformation of scientific and technological ethics from normative ethics to virtue ethics to make up for its theoretical limitations. This study explores the understanding of Undergraduates' scientific virtue, in order to provide ideas and experience for scientific virtue education.

2. Literature and Hypotheses

From the existing literature, people are used to taking the scientific ethics as the main content of discussing the problems of scientific ethics education, and emphasize restricting the subject's behavior by means of law and system. There are few relevant studies from the perspective of virtue ethics. College students' scientific and moral education also focuses on cultivating scientific and technological ethics and moral consciousness from the perspective of normative ethics.In view of

the frequent academic misconduct, the academic circles began to reflect on the effect of scientific moral education from the perspective of normative ethics, and the voice of scientific virtue education from the perspective of virtue ethics became stronger and stronger.

2.1. Research on Scientific Moral Education

In recent years, researchers have realized that morality is not governed by strict rules. Recognizing the limitations, they began to shift their focus to virtue ethics.Based on Aristotle's understanding of virtue, Daniel Nyberg reflected on the traditional way of restricting the subject's behavior by rules.[1] It is believed that the morality in daily activities is not a right, but a good thing to do. Only the behavior voluntarily and consciously can be moral, and the morality in daily activities is emphasized.

Compared with the current scientific and moral education curriculum in China, the teaching forms of RCR training curriculum are more flexible and diverse. However, it is undeniable that the course still takes teaching principles as the core purpose, ignoring the cultivation of students' virtue consciousness and research quality. Kovac believes that external mandatory norms can only provide behavior reference and limit the general scope of their behavior, nonetheless, it cannot really stimulate the subject's moral consciousness from the inside.[2] In view of the limitations of RCR training courses, Pennock also pointed out that this kind of training is an externally imposed rule, requiring attention to the interior of the subject, and proposed a "three center" scientific virtue method including Theory-Centered SV approach, Example-Centered SV approach, Concept-Centered SV approach, trying to develop a new way of scientific ethics training based on scientific virtue. [3] Noticing the limitations of traditional ethics education, some researchers try to develop an alternative course for training scientists in responsible research behavior (RCR), by emphasizing the internal value and the beauty of scientific subjects rather than the externally imposed rules.[4] On the other hand, Pennock advocated a course in the form of dialogue by virtue theory,and describes the guided-dialogue structure of the workshops, the nature of the discussion prompts, the pilot assessments carried out.[5]

2.2. Hypotheses

Based on the above framework, the hypothesis were proposed as follows:

Hypothesis 1: there are significant differences in the dimensions of undergraduate scientific virtue cognition in grade

Hypothesis 2: there are significant differences in the dimensions of undergraduate scientific virtue cognition in discipline

Hypothesis 3: there are significant differences in the dimensions of undergraduate scientific virtue cognition in the types of colleges and universities

3. Methods

3.1. Subjects and Data

In order to ensure the rationality and effectiveness of the questionnaire scenario setting, some items were adjusted after consulting the opinions of some undergraduates and experts, and the collected 700 questionnaire data were tested first.

This study collected sample data through online questionnaires. In order to ensure the validity, this study collected statistic from various universities, including double first-class university, universities directly under the Ministry of Education, universities are built by Ministry and province

jointly and provincial universities, ranging from Freshman to the senior and the fifth grade.

The alternative answers of all questions in the questionnaire are expressed in a Likert scale of 1-5(1=agree strongly, 5 = disagree completely). 5 points for "agree strongly", 4 points for "basically agree", 3 points for "uncertain", 2 points for "disagree" and 1 point for "disagree completely". Summarize the scores of the items in the same link to indicate the attitude and tendency of the tested group in this link. A total of 1900 questionnaires were collected in this survey, and 1832 valid questionnaires were obtained after screening the invalid questionnaires. The effective rate of the questionnaire was 96.42%.

3.2. Measures

Based on the four-stage process of Rest, this paper divides undergraduates' understanding of scientific virtue into four dimensions, including scientific virtue content, scientific virtue judgment, scientific virtue motivation and scientific virtue decision-making. The kmo value obtained by the sub questionnaire of each dimension is between 0.723-0.946, the total questionnaire is 0.929, p=0.000***< 0.01. Therefore, the sub questionnaire items of this questionnaire have good correlation, are suitable for factor analysis, and have good structural validity.

3.2.1. Scientific virtue content

Dimension 1 is the content of scientific virtue. The topics mainly investigate the sensitivity of Undergraduates' scientific virtue situation and whether they have the consciousness and ability to explain the scientific virtue situation, including the connotation of scientific virtue, the value of scientific virtue, the difference between scientific virtue and scientific morality, and specific items of scientific virtue, with a total of 12 questions. The Cronbach coefficient is 0.877.

3.2.2. Scientific virtue judgment

The second dimension is the judgment of scientific virtue, which mainly investigates whether undergraduates can make a correct value evaluation when facing contradictions, conflicts or interest choices in scientific research and academic activities, including the recognition of the value of scientific virtue, the attitude towards scientific research, and the evaluation of the specific behavior of others, with a total of 9 questions. The Cronbach coefficient is 0.726.

3.2.3. Scientific virtue motivation

Dimension 3 is the motivation of scientific virtue, which mainly investigates the starting point of undergraduates engaged in scientific research activities, including the pursuit of truth, the attention to social value, the pursuit of economic interests and the pursuit of personal reputation. There are 7 questions in total, and the Cronbach coefficient is 0.721.

3.2.4. Scientific virtue decision-making

Dimension 4 is scientific virtue decision-making, which mainly investigates what kind of choices undergraduates will make when specific moral conflicts occur on themselves, and whether they can implement the recognized values into specific behaviors to achieve the unity of knowledge and practice, including choices in courage, kindness, justice and moderation. It involves the specific conflicts that undergraduates may face in college life, with a total of 8 questions, and the Cronbach coefficient is 0.764.

3.3. Analysis

We used statistic software SPSS 26.0 to perform descriptive statistics, one-way ANOVA, reliability and validity analysis. Through descriptive statistics of the proportion of Undergraduates in each dimension, in order to understand the overall level of Undergraduates' understanding of scientific virtue; Taking discipline, grade and college type as variables, this paper uses one-way ANOVA to understand the differences of Undergraduates' understanding of scientific virtue.

4. Results

Table 1: The general situation of Undergraduates' understanding of scientific virtue.

Items	M	SD
Content	4.462	0.474
Judgement	3.869	0.636
Motivation	3.489	0.699
Decision-making	3.356	0.499
Total questionnaire	3.794	0.443

Table 2: A test of the differences of grades in the dimensions of Undergraduates' understanding of scientific virtue.

Items	Grade	M	SD	F	*p*
Content	Freshman	4.587	0.448	12.200	.000***
	Sophomore year	4.497	0.454		
	Junior	4.361	0.543		
	Senior	4.439	0.389		
	The fifth grade	4.350	0.653		
Judgement	Freshman	4.004	0.675	6.320	.000***
	Sophomore year	3.888	0.667		
	Junior	3.765	0.617		
	Senior	3.833	0.565		
	The fifth grade	3.855	0.636		
Motivation	Freshman	3.751	0.720	14.729	.000***
	Sophomore year	3.482	0.735		
	Junior	3.375	0.624		
	Senior	3.438	0.645		
	The fifth grade	3.396	0.746		
Decision-making	Freshman	3.488	0.546	20.237	.000***
	Sophomore year	3.442	0.476		
	Junior	3.231	0.482		
	Senior	3.265	0.473		
	The fifth grade	3.344	0.493		
Understanding	Freshman	3.958	0.474	19.578	.000***
	Sophomore year	3.827	0.451		
	Junior	3.683	0.421		
	Senior	3.746	0.386		
	The fifth grade	3.736	0.485		

Note: (1) To determine the difference among the grades, the ANOVA was run for five grades. (2)*Marginally significant at .05 level, **significant at .01 level,and ***significant at .00 level

Table 1 presents the descriptive statistics of the survey data of Undergraduates in Chinese Mainland on the understanding of scientific virtue and the four dimensions. The results show that the average score of the overall level of scientific virtue cognition is 3.794, which is above the

medium level, indicating that the overall level of Undergraduates' scientific virtue cognition is good. From the perspective of each dimension, the average score of each dimension is extremely unbalanced. The highest score is the content dimension of scientific virtue, which is 4.462, indicating that undergraduates have a good grasp of the content of scientific virtue and have the ability to identify the characteristics of virtue situation; The second is the judgment dimension of scientific virtue, which is 3.869 points; The third is the motivation dimension of scientific virtue, which is 3.488 points. The lowest score is the decision-making dimension of scientific virtue, which is 3.356 points. Both of them are below the overall understanding level and lower than 3.5 points.

Table 3: A test of the differences of disciplines in the dimensions of Undergraduates' understanding of scientific virtue.

		Content	Judgement	Motivation	Decision-making	Understanding
Philosophy	M	4.480	3.623	3.298	3.290	3.673
	SD	0.451	0.821	0.786	0.349	0.497
Economics	M	4.344	3.672	3.356	3.276	3.662
	SD	0.440	0.666	0.683	0.499	0.432
Law	M	4.204	3.598	3.191	3.105	3.525
	SD	0.726	0.636	0.605	0.494	0.426
Pedagogy	M	4.508	3.946	3.586	3.394	3.859
	SD	0.409	0.620	0.674	0.428	0.416
Literature	M	4.441	3.827	3.566	3.305	3.785
	SD	0.482	0.656	0.663	0.534	0.439
History	M	4.509	4.105	3.865	3.551	4.007
	SD	0.709	0.608	0.678	0.575	0.532
Science	M	4.440	3.851	3.409	3.325	3.756
	SD	0.367	0.584	0.651	0.490	0.401
Engineering	M	4.542	3.939	3.550	3.460	3.873
	SD	0.453	0.661	0.759	0.501	0.460
Agronomy	M	4.024	3.614	3.261	3.217	3.529
	SD	0.870	0.703	0.702	0.475	0.563
Medicine	M	4.589	4.032	3.580	3.345	3.886
	SD	0.309	0.534	0.657	0.504	0.378
Management	M	4.474	3.882	3.492	3.320	3.792
	SD	0.378	0.574	0.647	0.501	0.387
Art	M	4.276	3.689	3.342	3.277	3.646
	SD	0.547	0.542	0.603	0.427	0.407
F		10.918	6.884	5.163	5.931	10.349
p		.000***	.000***	.000***	.000***	.000***

Note: (1) To determine the difference among the disciplines, the ANOVA was run for 11 disciplines. (2)*Marginally significant at .05 level,**significant at .01 level,and ***significant at .00 level

In order to further test the hypotheses in the study, we performed one-way ANOVA on the sample data with grade, discipline and college type as independent variables. Results as shown in Table 2, significant difference was found in grades, and there are significant differences in all dimensions, so Hypothesis 1 was supported.($F=19.578$,$p=0.000$***)Compared with the average value, the average value of freshmen and sophomores is greater than that of junior, senior and fifth students, among which the average value of freshmen is the highest, followed by sophomores, senior and fifth graduates and junior students. After LSD post comparison, freshmen understanding of scientific virtue is significantly better than that of students in other grades in all dimensions. In addition, table 3 shows that undergraduates' understanding of scientific virtue also has significant differences in disciplines, and each dimension has significant differences at the same time, so

hypothesis 2 was supported.(F=10.349,*p*=0.000***)However, hypothesis 3 was only partially supported.As shown in Table 4, there are significant difference in Undergraduates' understanding of scientific virtue as a whole, but from all dimensions, there are only significant differences in the content and judgment of scientific virtue,no significant difference was found in motivation and decision-making.

5. Conclusion and discussion

Generally speaking, the awareness intensity of scientific virtue of Chinese undergraduates is medium to high, and the perception degree of scientific virtue situation and decision-making of undergraduates varies with different educational background factors (grade, discipline and college type).For example, significant differences were found in the four dimensions of scientific virtue cognition between different grades. Among them, freshmen have higher awareness of scientific virtue, scientific virtue situation and decision-making process than students in other grades. The awareness of scientific virtue decreased in sophomore year, and increased in junior and senior year.It can be indicated that the level of Undergraduates' understanding of scientific virtue is not a straight-line rise or decline process, which is affected by the different tasks they face in the research stage.

Taking disciplines as an example, the scope of this study involves 12 disciplines except military science. There are significant differences in the understanding of scientific virtue among different disciplines, which is mainly related to the research contents, research methods and other research characteristics among disciplines. Humanities and Social Sciences depend on long-term accumulation, so it is difficult to make a qualitative breakthrough in a short time; The research of natural disciplines (Science, engineering, agriculture and medicine) sometimes emphasizes the emergence of "inspiration". Even in similar projects, changing different input variables will get different results. Therefore, compared with the pressure of paper output, it may be easier than the research of Humanities and social sciences. However, in the decision-making dimension of scientific virtue, the four natural disciplines, are lower except engineering. Compared with liberal arts research, natural disciplines are more vulnerable to the influence of funds, equipment and research environment in the research process, and researchers are more vulnerable to the restrictions of research conditions. For example, the required research equipment is expensive, and the required funds are huge, which cannot be afforded by themselves; At the same time, it is also vulnerable to the temptation of external projects, whether to "take private jobs" or stick to its own academic work, which have become factors affecting natural science research. Therefore, in the process of carrying out scientific virtue education, in the face of students of different disciplines, we should pay attention to carrying out education according to the characteristics of moral conflicts and psychological contradictions they may face.

6. Impact and Enlightenment

The cultivation of Undergraduates' understanding of scientific virtue needs to rely on the cultivation of scientific virtue education and Practice for a long time.It is hoped that the survey results obtained in this study will help to understand the basic level and differential characteristics of Undergraduates' understanding of scientific virtue, and provide corresponding basis for carrying out scientific virtue education.

First of all, we should build an integrated target system of scientific virtue education. According to the students' cognition and psychological characteristics of each learning stage, it is necessary to set the corresponding educational objectives. We also promote the transformation of undergraduate scientific virtue cognition from fuzzy to clear in content, from perceptual to rational in judgment,

from instrumental rationality in motivation to value rationality and emotional sense of mission. Secondly, we can develop an integrated scientific virtue education curriculum. Students in different disciplines will face different moral dilemmas, teachers should pay attention to students' psychological dynamics timely, excavate and make use of the moral education resources contained in various disciplines, so as to ensure the systematic and three-dimensional penetration of scientific virtue education and build a new pattern of joint education of various disciplines. Finally, we can improve the guarantee system, including pay attention to scientific virtue education, provide a solid system, and organizational guarantee and high-quality teachers.

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