The Impact of the Epidemic on the Learning and Research Output of Graduate Students

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Abstract. Everyone got the impact from the COVID-19 epidemic on lives and studies to some extent. In order to quantitatively analyze the impact of the epidemic on postgraduate students' learning and research achievements, this paper focuses on dimensions including "research communication", "research data acquisition", "publication and cultivation process", "financial support and research topics", "internship and practice", "graduation and job-hunting". Structural equation modeling is used to analyze the data collected from questionnaires. The results show significant correlations between "research communication" and any of the three dimensions of "research data acquisition", "publication and cultivation process", "financial support and research topics". It finds out that "access to research data" has a significant effect on "publication and training process". It also reveals a strong correlation between the following three pairs of dimensions, which are pair of "research data acquisition" and "financial support and research topics", "publication and cultivation process" and "financial support and research topics", as well as "publication and cultivation process" and "practice and job-hunting".

Keywords: COVID-19, graduate students, learn and research, structural equation modeling.

1 Introduction

From the end of 2019 to the end of 2022, the outbreak of COVID-19 epidemic has affected various sectors in the country, especially an unprecedented impact on the education sector. It changed the learning style of students, who had to adapt to online-learning. Graduate students were not exceptions, although they are a bit different from other types of students. Graduate students are usually required to regularly engage in academic discussions with their supervisors, experiments in laboratories, and academic conferences home and abroad. It is of great significance for the mechanism of graduate student training and educational theories to know whether these rapid changes of the learning environment have an impact on graduate students' learning situation and research output and how to quantitatively describe this impact.

Many research results are found regarding the impact from the epidemic to the students. This paragraph summarizes the results from research perspective and student level. Regarding research perspectives, existing researches mainly focus on the changes in the aspects of students' learning attitude, academic performance, learning ability and motivation, and learning stress in the context of online learning. Regarding student level, existing researches focus on the changes of undergraduate students and high-school students. Raviv et al [1] studied the tendency of students to quit in the context of online academic courses offered by schools under the impact of the epidemic. They found that learning in online and online-offline-mixed courses has a significant impact on personal skills and learning abilities, and these factors also affect dropout rates. A survey carried by Rahman et al [2] found that challenges and difficulties of online learning together with its effectiveness, and students' motivation, had a substantial impact on students' attitudes toward online learning. Almomani et al [3] assessed the impact of online learning on students' self-directed learning skills and motivation to learn during the COVID-19 and the results showed that online learning had a positive impact on students' motivation, self-directed learning skills, students' organizational skills, learning management skills, learning resource utilization skills, and self-evaluation skills. Pérez et al [4] investigated the impact of sudden changes in the learning environment on students' performance, and found that the change improved students' academic performance, probably due to more efficient usage of time. A study by Shaiba et al [5] found that students were stressed regardless of the university they attended or their age. Younger students and those from economically disadvantaged families faced more difficulties compared to other students. Miao et al [6] conducted a questionnaire survey on 2350 undergraduate-students in Beijing and Shanghai to investigate the changes in their studies as well as physical-and-mental health during the closed and non-closed periods during the COVID-19. They found that the stress levels of senior and living-in-campus students rose significantly during the closed period. And these stresses were mainly due to academics, finances, and relationships with others.

After reviewing the existing studies, it finds that achievements focusing on the changes of learning and research output of graduate students are relative rare. The reasons to these changes have neither been explored. To fill these gaps, this study uses a questionnaire to quantitatively analyze the impact on graduate students' learning and research output during the epidemic using structural equation modeling (SEM).

2 Methodology

2.1 Questionnaire Design and Data Collection

Graduate students' learning situation, especially the research output, is believed closely related to the factors including communication during the study and research process, the research data obtained, the granted fundings and research topics. And it is reflected through the publication of papers, learning and cultivation process, and internship and job-hunting. During the epidemic, graduate students had restriction for communicating and discussing with their supervisors and classmates, resulting in a worse discussion

efficiency and experience. During the epidemic, most of the offline academic conferences, lectures, and seminars could not be held as scheduled, and students lost the opportunity to exchange knowledge face-to-face, which could not be replaced by online meetings with good results. Students' access to research data through lab experiments, field investigation, and library visiting were also affected. In addition, epidemic also affected the progress of graduate students' application for scholarships, grants fundings for projects by prolonged procedures and processes for approval [7].

Considering the above analysis, this study conducts an online questionnaire focusing on the following six dimensions, including "research communication", "research data acquisition", "publication and cultivation process", "financial support and research topics", "internship and practice", "graduation and job-hunting". Sociodemographic information of the respondents is also part of the question in the questionnaire. The options to the questions regarding these six dimensions were designed to satisfy the requirements from the SEM.

The online questionnaire was distributed to graduate students for master course or doctor course over the whole country of China. Finally, a total of 2586 respondents answered the questionnaires, from which 2552 responded answers were believed as valid samples. There are almost equal valid male-respondents (45.42%) to the valid females (54.58%). 95.53% of the survey respondents were master course students.

2.2   Structural Equation Modeling

SEM is a method for building, estimating, and testing causal models for multivariate statistical data analysis, allowing for the measurement of non-directly observable variables based on multiple observable variables. Non-directly observable variables are also referred to as latent variables in the model. SEM also can do the simultaneous estimation of factor structures and factor relationships at the same time. Therefore, constructing an SEM model is to investigate the relationship between observable variables and latent variables, and the relationship among latent variables [8-10].

Compared with traditional statistical methods, SEM has several advantages. (1) It can consider and handle multiple dependent variables simultaneously. (2) It allows for measurement errors in both the independent and dependent variables. (3) It can estimate the factor structure and factor relationships simultaneously. (4) It can optimize the degree of fit of the entire model.

3   Procedure of Constructing the SEM Structure and Results Analysis

This study uses the reliability and validity test to check the quality of the data to ensure that the data quality meets the analysis standard of SEM, which could bring trusted results. The structure is kept being adjusted until the fitting index meets the requirements. Then the adjusted structure is believed to be suitable to analyze the impacting factors to the learning and research output of graduate students.

3.1   Initial Structure

The six dimensions, including "research communication", "research data acquisition", "publication and cultivation process", "financial support and research topics", "internship and practice", "graduation and job-hunting" are used as latent variables, which cannot be directly measured. Each latent variable is reflected by different observable variables. The expected structure was initially established as shown in Fig. 1.
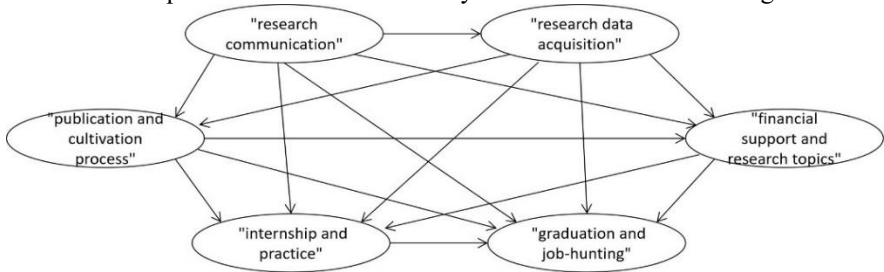

Fig. 1. Initial Structure of the analysis by SEM

3.2   Reliability Test of Data Structure

SEM has high requirements for both measurement and influence relationships. So the tests for reliability and validity should be implemented to ensure the relationships satisfy the standards.

Regarding the reliability test on our survey data, the reliability coefficient value, i.e. Cronbach's α value is greater than 0.8, indicating that the reliability quality of our surveyed data is high. Then the validity analysis was carried out. However, the validity analysis of six dimensions shows a result of failed matching with the expectation. As a result, a series of trials including deleting observable variable (i.e. a question in the questionnaire), and merging any two dimensions of the six ones were done, until the results matching with the expectation. In this case, the observable variable of "How do you feel about your participation in international exchanges and cooperation was affected by the epidemic?" was removed, and the dimensions of "internship and practice" and "graduation and job-hunting" were merged as a new dimension named as "practice and job-hunting". Finally, five dimensions were finally formed, as shown in Fig. 2.

The validity was also verified using KMO and Bartlett's test. The KMO value is 0.921, satisfying the requirement that it should be greater than 0.8, indicating that the surveyed data is very suitable for extracting information for SEM structure construction.
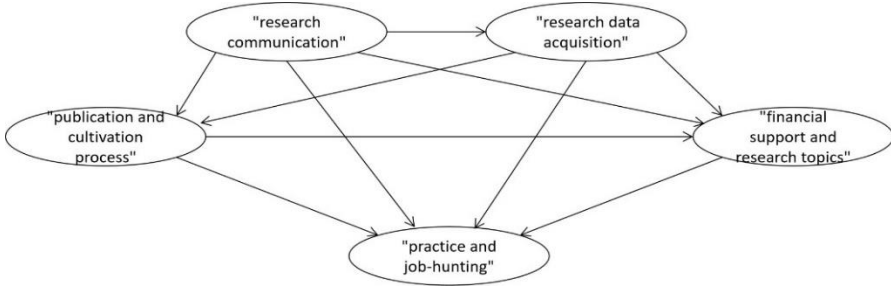
Fig. 2. Adjusted Structure of the analysis by SEM

3.3   Analysis of Fitted Indicators in the Estimated Results

Based on the adjusted structure of SEM, the interrelationships among the variables were further investigated. During the process, the structure of SEM was kept being adjusted until the index of GFI, RMR, CFI, and NNFI satisfied the standards. The final optimized structure with loading coefficients were achieved, as shown in Fig. 3.
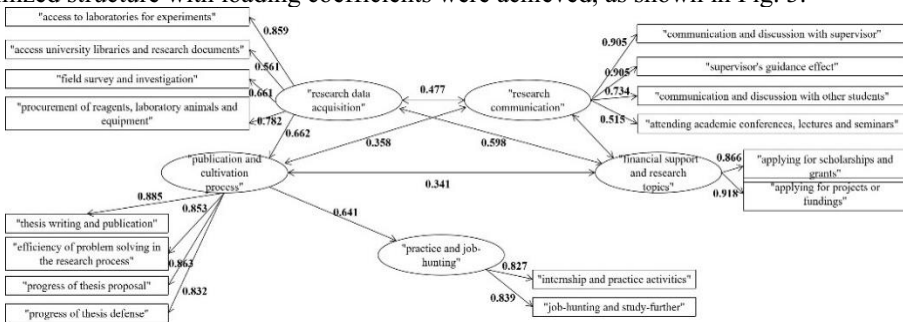

Fig. 3. Estimated results of SEM analysis

In this study, the maximum likelihood method was used to estimate the standardized regression coefficients and the corresponding significance level. The results show significant correlations between "research communication" and any of the three dimensions of "research data acquisition", "publication and cultivation process", "financial support and research topics", whose correlation coefficients are 0.477, 0.358 and 0.517, respectively. And "access to research data" has a significant effect on "publication and training process" and its correlation coefficient is 0.662. The results also show that "research data acquisition" and "financial support and research topics" have a significant relationship, whose correlation coefficient is 0.598. And the correlation coefficient between "publication and cultivation process" and "financial support and research topics" is 0.341, demonstrating a significantly relationship. The correlation coefficient of 0.641 between "publication and cultivation process" and "practice and job-hunting" means a significant relationship between these two dimensions of latent variables.

3.4 Results Analysis and Discussion

This section explains the impacts from the observed variable to the latent variables, which demonstrate how the various factors, i.e. the observed variables, influence the five dimensions due to the epidemic. Then the impacts among the latent variables are also discussed.

Relationships Between Latent and Observed Variables.
Regarding the dimension of "research communication", the correlation coefficients from "communication and discussion with supervisor", "supervisor's guidance effect", "communication and discussion with other students", and "attending academic conferences, lectures and seminars" are 0.905, 0.905, 0.734, and 0.515, respectively. During the epidemic, students and their supervisors are unable to communicate with each other discuss problems face-to-face, resulting ineffective supervision. Students conducted research at home alone, much less communication with other students, causing great impact on the research exchange. However, the impact on research exchange is smaller. It is because that the frequency of participation in academic conferences, lectures, etc. was generally once or twice a month before the epidemic, which was not very frequent in itself, while most of the conferences were changed to online meetings, which means the students can attend these online events with not much influence.

As far as the dimension "research data acquisition" is concerned, the correlation coefficients from "access to laboratories for experiments", "access university libraries and research documents", "field survey and investigation", "procurement of reagents, laboratory animals and equipment" are 0.859, 0.561, 0.661 and 0.782, respectively. During the epidemic, the students were in isolation at home most of the time, unable to enter the laboratory to conduct experiments to obtain the data needed. Neither purchasing the experimental items nor field survey and investigations is possible, resulting a significant influence on the data acquisition. Although the students could not enter the libraries to investigate or check the documents offline, they could do it online instead. As a result, this factor had less impact on research data acquisition compared to other factors.

Regarding the dimension of "publication and cultivation process", the correlation coefficients from "thesis writing and publication", "efficiency of problem solving in the research process", "progress of thesis proposal" and "progress of thesis defense" are 0.885, 0.853, 0.863, and 0.863 respectively. This indicates that when "research communication" and "research data acquisition" were affected, the "publication and cultivation process" cannot be carried out smoothly. Four observable variables impacted by the epidemic had a significant influence on "publication and cultivation process".

For the dimension of "financial support and research projects", the correlation coefficient from "applying for scholarships and grants" and "applying for projects or fundings" are 0.866 and 0.918 respectively. It means that the epidemic has negative influence on the scholarship application, grants, projects and fundings to the graduate students. This influence further made their research and study in a rough way.

Regarding the dimension of "practice and job-hunting", the correlation coefficient from "internship and practice activities" and "job-hunting and study-further" are 0.827

and 0.839 respectively. This indicates that the great impact on the production and operation of many enterprises due to the epidemic, resulted in the unsuccessful internships and practice activities, as well as the subsequent job-hunting and furthered studies.

Influence Relationships Between Latent Variables.

The results show significant correlations between "research communication" and any of the three dimensions of "research data acquisition", "publication and cultivation process", "financial support and research topics", whose correlation coefficients are 0.477, 0.358 and 0.517, respectively. These relationships were due to the research procedure of graduate students. Specifically, communication between students and supervisors is important during the whole process of graduate cultivation, which includes project or funding application, data acquisition, experiments of the research, achievements publication and thesis writing.

In addition, the results also show that "research data acquisition" and "financial support and research topics" have a correlation coefficient is 0.598. And the correlation coefficient between "publication and cultivation process" and "financial support and research topics" is 0.341. It means that scholarship application is influenced by the learning status, which could be further reflected as the experiment progress, paper and thesis progress, paper publication and etc.

Further, "access to research data" has a significant effect on "publication and training process" with a correlation coefficient of 0.662. It demonstrates the significance of data acquisition to the paper publication and thesis completion.

The correlation coefficient of 0.641 between "publication and cultivation process" and "practice and job-hunting" means a significant relationship between these two dimensions of latent variables. It means paper publication is directly influence whether the students can graduate successfully.

4   Conclusions

This paper investigates the impact of the epidemic on China's postgraduate students' learning and scientific research output, with an online questionnaire surveyed more than 2000 students. SEM method was used to construct the relationship among six dimensions of "research communication", "research data acquisition", "publication and cultivation process", "financial support and research topics", and "practice and job-hunting", together with their observable variables. The results show significant correlations among these variables.

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