Analysis of the factors affecting the study of college students and the countermeasures taken during the outbreak of COVID-19

Yingying Zhang
Shandong University of Management (China), Changqing, Jinan, 250300
Email: 14438120170232@sdmu.edu.cn

Abstract. This study was focused on understanding the learning effect and influencing factors affecting students at home during the epidemic, better help the college students in improving their learning efficiency, and achieving the state of "no suspension of classes". At first, we considered the students of science and engineering of Shandong University of management as an example to collect the relevant data through the questionnaire; secondly, with the help of SPSS 23.0 software, factor analysis method is used to obtain three public factors affecting the learning outcomes of students: external interference factor, curriculum factor, and emotional factor. At last, the actual situation of students and the results of the questionnaire have been combined in this paper, which puts forward practical improvement measures from the viewpoint of teachers and students.

1. Background of problem
A novel coronavirus emerged in Wuhan at the beginning of 2020 and spread across the country within a short term. All over the country, doctors have been working together to fight against the virus; businesses and schools have been shut down. This has seriously deteriorated the economic development of the nation. In order to deal wisely with the epidemic, and gradually return to work and school after such a long time-lag, many enterprises have implemented home-office. Schools also conform to the development of the times, and all regions have started implementing "no suspension of classes".

Since the universities gather students from all over the nation, they should be more cautious. The Ministry of education also issued a decision that universities are not allowed to start schools until the epidemic is stable. It has also been found on the internet that few people regard the instruction of resuming universities as a sign that the epidemic has ended. In order to keep that the progress of classes remains unaffected, colleges and universities are actively engaged in online teaching. It is not practical to re-explain the teaching part, which has already been carried out online once the schools begin. Therefore, there is an urgent need to study the teaching approach that students prefer during the epidemic, the factors that affect the 'learning effect' along with the required improvement measures.

There have been many studies carried out on the factors affecting students' performance [1, 2, 3] carried out. However, only a handful of them analyzed the 'learning effect' during the epidemic period. Also, most of the countermeasures proposed in these studies are long-term strategies, which are not suitable for forthright use at the moment [4, 5, 6]. This paper puts forward the corresponding countermeasures against influencing factors in the current predicament, which is time-effective. Also, the previous studies compare most of the influencing factors with the 'determined learning
achievement’, and in this sudden epidemic crisis, students have no definite learning achievements to compare; therefore, this paper only analyzes the influencing factors, which is more in line with the current situation.

2. Sample selection and data source
At present, all freshmen, sophomores, and juniors have adopted the online learning method. Senior students have begun to practice and do not have any actual learning courses. Based on this information, the present paper has selected the freshmen, sophomores, and juniors of Shandong University of management as the research subjects. The class teachers of every class randomly distributed the two-dimensional questionnaire code via the class group, and a total of 330 valid questionnaires were collected at the end.

In combination with the previous communication with students and the review of relevant literature [1, 2, 3, 7], a total of eight scale questions and one single choice question (the teaching mode preferred by students) were set up in the questionnaire. Seven of all the questions enquires the factors that affect students’ learning: mobile phone (check websites, watch videos, etc.), game (the effect of time spent on playing games and its impact on studies), learning atmosphere, epidemic conditions (emotional impact), family (the environment, members), teaching methods (live broadcasts: conducting classes face to face via the internet, recording lessons: the course is recorded in advance, and the lecture is played directly; internet resources), and teachers. Each factor was set at a scale with 1-5 points. The higher the score of the selected influencing factor, the greater was its influence on the ‘learning effect’ according to the students.

3. Research process

3.1. Analysis of learning effect
The questionnaire also addresses the topic of ‘learning effect’, which is calculated as 1-5 points in five stages. Supposing that the learning effect that students can achieve in school is 5, students fill in the questionnaire according to the actual situation (if better than the school learning effect, the students choose 5). The results are interpreted as the higher the score, the better the learning effect at home. A descriptive statistical analysis of the data has been shown in Table 1. Out of all the 330 students, only 34 could achieve or exceed through the school learning effect, which is only 10% of the total number of the questionnaires received. As can be seen from Figure 1, most students could achieve 60% of the school level (learning effect is 3). It can thus be concluded that the overall learning effect at home is far less than that at school.

| Effective | Frequency | Percentage | Effective percentage | Cumulative percentage |
|-----------|-----------|------------|----------------------|-----------------------|
| 1         | 24        | 7.3        | 7.3                  | 7.3                   |
| 2         | 30        | 9.1        | 9.1                  | 16.4                  |
| 3         | 167       | 50.6       | 50.6                 | 67.0                  |
| 4         | 75        | 22.7       | 22.7                 | 89.7                  |
| 5         | 34        | 10.3       | 10.3                 | 100.0                 |
| Total     | 330       | 100.0      | 100.0                |                       |

Table 1. Descriptive statistics of learning effect.
3.2. Feasibility test of questionnaire [8]

3.2.1. Reliability analysis. It is used to measure whether or not the sample answer results in the questionnaire are reliable and further whether there is a real answer or not. The higher the test reliability, the more reliable the results are. Generally, the Cronbach α reliability coefficient is used for reliability analysis. If the α coefficient is higher than 0.8, it means the reliability is high; if the α coefficient lies between 0.7 and 0.8, it means the reliability is good; if the α coefficient falls between 0.6 and 0.7, it means the reliability is acceptable; α coefficient less than 0.6 signifies poor reliability. SPSS 23.0 was used to analyze the reliability of the questionnaire. The results have been depicted in Table 2:

| Cronbach α | Cronbach α based on standardized terms | Item number |
|------------|---------------------------------------|-------------|
| .739       | .741                                  | 7           |

Cronbach α has a reliability coefficient of 0.739, ranging from 0.7 to 0.8, which is a better option for questionnaires with seven elements.

3.2.2. Validity analysis. Analysis of the validity of the questionnaire measurement results, that is, the test of the extent to which the measurement results of the designed questionnaire reflect the objective reality it should reflect is validity analysis. Generally, KMO (Kaiser-Meyer-Olkin) and Bartlett's sphericity test are used to analyze the structural validity of the questionnaire. KMO test statistics are used to compare simple and partial correlation coefficient between variables; Bartlett's sphericity test statistics are obtained according to the determinant of the correlation coefficient matrix. When the corresponding associated probability value is less than the set significance level, the original hypothesis is rejected and the correlation between the original variables is considered. In general, when the KMO test coefficient is more than 0.6 and the significance probability p-value of Bartlett sphere test statistical value is less than 0.05, the questionnaire is said to have structural validity and factor analysis. KMO test and Bartley sphere test of the questionnaire data have been determined using SPSS 23.0 and are as follows:
Table 3. KMO and Bartlett test.

|                          | KMO test coefficient | Bartlett's sphericity test |
|--------------------------|----------------------|----------------------------|
|                          | .753                 | Approximate chisquare      |
|                          |                      | 435.484                    |
|                          |                      | Freedom                    |
|                          |                      | 21                         |
|                          |                      | Significance level         |
|                          |                      | .000                       |

It can be seen from Table 3 that the KMO test coefficient is 0.753 > 0.6, and the significance probability $p$-value of Bartlett sphere test statistical value is less than 0.05, so the data of this questionnaire can be used for factor molecules.

3.3. Basic theory of factor analysis [9, 10, 11]

3.3.1. Basic thought. By studying the internal dependence of the correlation matrix or covariance matrix, multiple variables are integrated into a small number of factors to reproduce the correlation between the original variables and factors.

3.3.2. Orthogonal factor model. Let $X = (x_1, x_2, ..., x_p)'$ be the observable random vector, expectation be $\mu$, variance be $\Sigma$, $F = (F_1, F_2, ..., F_m)'$ ($m < p$) be the unobservable random vector, expectation be 0, variance be $\Sigma_m$, $\varepsilon = (\varepsilon_1, \varepsilon_2, ..., \varepsilon_p)'$ be the variable not related to $F$, expectation be 0, variance be diagonal matrix $D$, then the orthogonal factor model can be represented as:

$$X = \mu + AF + \varepsilon$$

where $F$ is the common factor of $X$, and $\varepsilon$ is the special factor of $X$. The common factor generally affects each component of $X$, while the special factor only influences the corresponding component. $A(a_{ij})_{p \times m}$ is called the factor load matrix, which is the coefficient matrix to be evaluated. $A_{ij}$ is called factor load, which is the load of the $i^{th}$ variable on the $j$ factor.

3.3.3. Parameter estimation. To establish the factor model, the first step is to estimate the factor load $A_{ij}$ and the variance of special factors.

3.3.4. Orthogonal rotation. To clarify the practical meaning of common factors, it is necessary to rotate the factor load matrix so that the square of each element in each column of the factor load matrix can be transformed into two poles of 0 or 1. In this paper, the orthogonal rotation method with the largest variance has been used.

3.4. SPSS software implementation and conclusion analysis of the data [12]

3.4.1. Descriptive statistics. Descriptive statistics have been carried out for the data, and the mean value and variance are shown in Table 4:

Table 4. Descriptive statistics.

|                          | Average value | Standard deviation | Number of analysis cases |
|--------------------------|---------------|--------------------|--------------------------|
| Mobile impact            | 3.01          | 1.244              | 330                      |
| Game impact              | 2.24          | 1.281              | 330                      |
| Impact of learning atmosphere | 3.47      | 1.221              | 330                      |
| Impact of epidemic situation | 2.50      | 1.342              | 330                      |
| Family environmental impact | 2.39      | 1.175              | 330                      |
| Impact of teaching methods | 3.22      | 1.149              | 330                      |
| Influence of Teachers    | 3.00          | 1.308              | 330                      |
It is evident from Table 4 that the difference in the standard deviation of each influencing factor is quite small, indicating that the dispersion degree is small; the factors with larger mean value are in order: learning atmosphere, teaching method, mobile phone, and teacher. However, the correlation analysis among the elements (Table 5) illustrates that the influence of various factors on learning does not subsist independently and that some variables have a certain correlation, thus necessitating the classification and reduction in data measurements.

Table 5. Descriptive statistics.

|                 | Mobile | Game | Learning atmosphere | Epidemic situation | Family environmental | Teaching methods | Teachers |
|-----------------|--------|------|---------------------|-------------------|--------------------|-----------------|----------|
| Mobile          | 1.000  | .346 | .297                | .131              | .267               | .305            | .249     |
| Game            | .346   | 1.000| .289                | .296              | .357               | .184            | .150     |
| Learning atmosphere | .297    | .289 | 1.000               | .215              | .342               | .324            | .290     |
| Epidemic situation | .131    | .296 | .215                | 1.000             | .425               | .270            | .212     |
| Family environmental | .267    | .357 | .342                | .425              | 1.000              | .224            | .296     |
| Teaching methods | .305   | .184 | .324                | .270              | .224               | 1.000           | .490     |
| Teachers        | .249   | .150 | .290                | .212              | .296               | .490            | 1.000    |

3.4.2. Factor analysis. The questionnaire data were imported into SPSS 23.0 software for factor analysis. At first, the principal component method was used to extract common factors according to the criterion that the Eigenvalue is greater than 0.8. The results are presented in Table 6:

Table 6. Principal component analysis.

| Component | Initial eigenvalue | Sum of squares of rotating loads |
|-----------|-------------------|----------------------------------|
|           | Initial eigenvalue | Sum of squares of rotating loads |
| Component | Total              | Variance percentage | Accumulate % | Total              | Variance percentage | Accumulate % |
| 1         | 2.461              | 2.750                  | 39.284       | 39.284             | 1.630               | 23.290       |
| 2         | 1.110              | 1.028                  | 14.685       | 53.970             | 1.606               | 22.944       |
| 3         | 1.058              | .949                   | 13.559       | 67.529             | 1.491               | 21.295       |
| 4         | .768               | .703                   | 10.040       | 77.569             |                      |              |
| 5         | .604               | .587                   | 8.386        | 85.955             |                      |              |
| 6         | .530               | .557                   | 7.956        | 93.911             |                      |              |
| 7         | .468               | .426                   | 6.089        | 100.000            |                      |              |

In Table 6, the first column represents the characteristic roots of the variable correlation matrix, which are arranged in descending order of size, i.e., from big to small; the second and third columns respectively list the contribution rate and cumulative contribution rate of each component, which represents the percentage and cumulative percentage of every component that might contain the total information. It is clear from the table that the three principal components have been extracted according to the principle that the characteristic root is greater than 0.8, and their cumulative contribution rate reaches 67.529%, which indicates that these three components are better for the derivation of the original information.

In order to better classify and name the common factors in SPSS operating system, factor rotation is carried out using the maximum variance method, and the component matrix after rotation is obtained as follows:
Table 7. Composition matrix after rotation.

| Component                      | 1  | 2  | 3  |
|--------------------------------|----|----|----|
| Mobile phone                   | .813 | .219 | -.056 |
| Game                           | .731 | -.043 | .359 |
| Learning atmosphere            | .531 | .367 | .193 |
| Epidemic situation             | .005 | .173 | .868 |
| Family                         | .330 | .145 | .727 |
| Teacher                        | .183 | .814 | .148 |
| Teaching methods               | .098 | .842 | .130 |

Table 7 above demonstrates that in the first principal component, the factor load of mobile phones is the highest, followed by the game and learning atmosphere, all of which are influenced by external interference due to the lack of self-control in students, which the authors refer as external interference factor. The contribution rate of this factor is as high as 39.284%. It can be marked that students' learning is most affected by external factors. The second principal component poses a huge load on the teaching methods and teachers, both of which are related to the curriculum, which has been referred to as the curriculum factors. The third principal component mainly concentrates on the epidemic situation and family members, which have a great impact on students' emotions, and this factor has been mentioned as the emotional factor. The load of emotional factors is small, which shows that college students have strong self-regulation abilities, and the impact of the epidemic situation on their emotions is not great.

4. Strategies for improvement of the ‘learning effect’

Previous studies [8] done on the influencing factors of University achievements have established that the influence of curriculum factors is relatively high. However, this study found that in the exceptional phase of the epidemic, with no restrictions and management from the school, students' learning effect is most seriously affected by external factors, which highlights that even the college students' self-control is very poor. It is, therefore, necessary to improve learning efficiency by reducing the external factors and proper supervision. Besides, the curriculum itself along with the emotional factors exerts a definite impact on students' learning. Given this information, the present paper puts forward more effective improvement measures. The overall proposed framework is shown in Figure 2:

**Figure 2.** Improvement measures.

4.1. Enhancing the sense of learning procedure and eliminating external interference

Research [13, 14] shows that a proper sense of the procedure can enhance work efficiency. To create a good learning atmosphere at home, students should practice the following during the learning period: 1. Turning off the machine before learning, and students with poor self-control must leave their mobile phones with their parents for proper self-management; in case they view the course through mobile phones, they should devise their own learning time, and must complete the planned course within the specified time to avoid playing on mobile phones during learning even unconsciously; 2. Dedicating a separate learning space, with no other interference items on the desk except for learning supplies, to create a good learning environment; 3. Practice wearing formal clothes during the study period, in which girls may wear light make-up and improve their attention through a strong sense of decorum. A
primary school that required students to wear school uniforms at home and red scarf for online classes found this kind of learning method full of ritual sense, as recognized by the majority of teachers and students; 4. The head-teacher must communicate with the parents so that the parents can accordingly supervise the students at home in the early stages, help the students develop good learning habits, and better comprehend home-school co-operation.

4.2. Optimizing the course mode and improving teaching quality

At present, there are three acknowledged ways in which students can learn online at home: live broadcast lessons, recording of lessons, and network sharing of the course. According to a survey of 160 students, the distribution of students' liking for these three modes is represented in Figure 3:

![Figure 3. Students' favorite teaching mode.](image)

Most students prefer recording and live teaching, while a few suggest sharing of courses on the internet. For better results, teachers may use the form involving recording + live teaching. The main methods include recording of theoretical knowledge according to the plan every week and uploading of data on relevant platforms (learning links, wisdom trees, etc.) so that students can download and learn independently. To ensure students learn on time, tracking of students' learning trends by arranging tasks and tests may be practiced. Opening of direct broadcasts (use of learning software that enables face-to-face communication between teachers and students, such as Tencent meeting, Ding Talk, Wisdom Tree, and other learning software) at a fixed time every week for discussing and answering questions can help in the successful implementation of the idea.

It must be ensured that after recording, the course video is saved in AVI or HD mode, and the uploaded platform must support mobile phone as well as computer viewing at the same time. The recorded course must follow the strategy of imparting knowledge in "small steps" [15], and a complete course must be sectioned into different recorded videos based on points that need to be explained. The courseware must be vivid and listing of extensive text must be avoided. It must be made as interesting as possible. During a live broadcast, the teachers should try to get out of the camera, pull in the rapport with students, and make students feel the state of having been returned to the classrooms; teachers must slow down, watch the public screen more often, and be attentive to the state of students' learning at every point of time; teachers must interact with students to a greater extent in the live broadcast as they do in schools.

4.3. Seeking psychological intervention and maintaining good mood

It is difficult to avoid emotional fluctuation after staying at home for a long time. On the one hand, colleges and universities have opened psychological counseling channels, where students can actively contact with the head-teacher or the school for psychological counseling; on the other hand, students should reinforce their own workouts in addition to studying at home [16], and maintain good mood through physical exercise.

5. Summary

This article mainly analyzes the factors affecting students' learning during the crisis of novel coronavirus and puts forward corresponding countermeasures based on the analysis of three different
sorts of public factors. The analyzed data come from the students, which are real and effective. The surveyed students were randomly selected, which also maintains definite representativeness. The proposed countermeasures, if abided by students, can quickly help improve their learning efficiency during the epidemic period, which is apt.

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