A Questionnaire Survey on System Dynamics Education in China

This study uses a questionnaire survey and interviews to investigate the status quo of System Dynamics education in the Chinese mainland. It shows the overall situation at the teacher level and student level, as well as various difficulties in the teaching process specifically in terms of teaching design, pedagogy and teaching materials, etc. It is the first time that a panoramic view of SD teaching and learning is available across the Chinese mainland.

The survey is supported by the "Professor Qifan Wang System Dynamics Outreach Project", initiated by Prof. John Richardson in 2020 with the aim to raise the profile of systematic thinking and System Dynamics in China. Meanwhile, another aim of this project is to honor the life and work of Professor Qifan Wang by providing a biography, a comprehensive curated and highlighted access to his works of most lasting value, and cherish the memory of his great contribution to the System Dynamics teaching in China by colleagues and students who knew him the best. With the cooperation of SDS, Jenson Goh, and two research assistants, Min Xiang and Ella Shen, the China Chapter website is built and several research projects are undertaking with the participation of China chapter lead members, Haiyan Yan, Ying Qian, and Linlin Wang.

Introduction

System Dynamics is more than 60 years old and has been introduced to the Chinese mainland for more than 40 years. Initiated by advocates such as Tongyi Yang, Qifan Wang, Qingrui Xu, Yukui Hu, Zaipu Tao, etc., System Dynamics has experienced considerable development since the 1980's (Wang, 2004). As a pioneer and leader in this field, Professor Qifan Wang established the China Chapter of System Dynamics Society and the System Dynamics Committee of Chinese System Engineering Society. He learnt from Professor Jay Forrester at MIT in 1981 and was admitted as a life member of the System Dynamics research center in 1983. Professor Qifan Wang was the President of the System Dynamics Society (2006-2008). He has visited and given lectures to more than 40 countries and regions and more than 100 universities and research institutions, attended more than 40 international academic conferences, hosted and organized more than 20 international and domestic academic conferences on System Dynamics. It is the leadership and significant contribution of Professor Qifan Wang that enables Chinese scholars to grasp the frontier of this discipline and the establishment and development of System Dynamics in China, especially the indelible contribution to the education of System Dynamics in China. Professor Qifan Wang attached great importance to teaching and educating people. He has trained a large number of talents for China, assisted a number of universities to establish the discipline of System Dynamics, and promoted its popularization and promotion.

System Dynamics is a powerful tool for identifying the causes of problems and finding strategies to address them, especially for today's China. As one of the engines of growth of the world economy, accelerating the sustained and stable development of the Chinese economy will also contribute to the

growth of the world economy. However, there are increasingly complex problems that are difficult to address, for example, ecological poverty alleviation (Wang et al., 2022), city planning (Shen et al., 2009; Liu et al., 2019), food security (Herrera de Leon & Kopainsky, 2019; Stave & Kopainsky, 2015), sustainability (Dyson & Chang, 2005; Saysel et al., 2002), public health (Homer & Hirsch, 2006; Qian et al., 2021), etc. By using System Dynamics, decision-makers in China can better understand how factors interact and impact the whole system and solve problems more effectively. Hence, it is an important opportunity for systems dynamics as a field to contribute to policy formulation in China now.

System Dynamics used to be quite popular in China in the 1980's with around 2000 scholars at its peak. It is now applied in various fields such as business, engineering, economics, and social sciences. It focuses on practical applications and case studies, using computer software to model and analyze complex systems. Over the years, the teaching of System Dynamics in China has evolved. Many universities and institutes in China now offer courses and degree programs in System Dynamics. These programs typically include theoretical and practical components and often use case studies and real-world examples to illustrate the concepts being taught. While the challenges in developing the field to meet the demands in the real world have been difficult, e.g., lacking of sufficient know-how in the teaching of Systems Thinking and System Dynamics effectively and low awareness of the industry about the usefulness of the method, etc. Taking the development of System Dynamics in China as a stock, we can see that the inflows are capabilities of educators and practitioners, public awareness and application in fields; and the outflow is people giving up and switch to other fields. With the development of System Dynamic in China, the capabilities of System Dynamics educators and practitioners will help to tackle the challenges and meet the society need. That’s why we investigate the status quo of System Dynamics education in the Chinese mainland and the main challenges faced by the current china chapter, which can be lessons to the rest of the world.

In the past 40 years, a series of representative papers, hundreds of monographs and textbooks, the establishment of the China Chapter, System Dynamics Society and System Dynamics committee, Systems Engineering Society of China, show the leap development of System Dynamics in China. Compared to the boom years, the scope and influence of System Dynamics in China are not currently reaching their full potential. The annual attendance of Chinese scholars in the international System Dynamics Conferences has been around 10-25 in the last five years, which is not a big number. Most recently, the numbers of papers presented by Chinese scholars in the 2021 and 2022 international System Dynamics conference were 20 and 24 respectively. System Dynamics teaching serves as the basis and contributes a lot to its potential development. Data about System Dynamics courses are scares and incomplete from public sources. Therefore, we launch an online survey to investigate System Dynamics teaching in the Chinese mainland.

Research Questions and Methodology

This survey aims to understand the status quo of System Dynamics teaching in the Chinese mainland, and scrutinize the difficulties and problems commonly existing in System Dynamics teaching. The findings of this survey would serve as the basis for possible solutions for the future improvement of System Dynamics in China.

We try to involve as many scholars who teach System Dynamics-related courses in Chinese universities and research institutions as possible. We contacted participants from the WeChat group "System Dynamics Theory and Practice", which is the official Wechat group established by China System Dynamics Committee. The group includes 271 scholars in the Chinese mainland who are teaching or doing research or are interested in System Dynaics. Then the group members helped us to invite others who were not in the group but are teaching or doing research in System Dynamics to participate in the survey.

The research method includes two main parts. The first part is conducting questionnaire surveys. A questionnaire is designed and sent out to the WeChat group "System Dynamics Theory and Practice". The questionnaire survey method is simple and convenient. It can be created and published online, which is conducive to widely collecting various situations and data. The Self Reporting Questionnaire is a useful survey tool about personal attitudes and experiences (Cui & Liu, 2023). It aims to collect the state-of-the-art System Dynamics teaching in universities and research institutions (high schools as well) in the Chinese mainland, including the background of teachers, course design, students, challenges, and potential improvements or assistance. In detail, the questions address seven aspects as shown below:

- The regional distribution of System Dynamics scholars and practitioners
- The basic information about System Dynamics course, including the time and frequency of courses, teaching method, teaching material as well as teaching contents
- Teacher information: such as their educational background, the scale, and age structure
- Students information: the number of students and their grade distribution
- Teacher experience: difficulties, and suggestions in teaching System Dynamics
- Student experience: the level of satisfaction of teachers and students toward system dynamics courses
- Other comments

The second part is interviews. With the information obtained during the interview, we can discuss the results of the survey in conjunction with the views of the professors. Due to the inconvenience of organizing an in-person session in the pandemic prevention and control, we conducted 8 interviews online via Tencent Conference and Wechat Video calls from August to November, 2022.

Results (Statistical summary of the survey)

Distribution of system dynamics researchers

According to the members' remarks in the WeChat group, researchers with a background in System Dynamics are distributed in at least 64 universities or research institutions throughout the country (The researchers who participated in the questionnaire survey are distributed in 12 provinces and cities, of which Shanghai, Beijing, and Jiangxi have the largest number of participants (Figure 2).

Figure 1).

The researchers who participated in the questionnaire survey are distributed in 12 provinces and cities, of which Shanghai, Beijing, and Jiangxi have the largest number of participants (Figure 2).

Figure 1 distribution of System Dynamics researchers

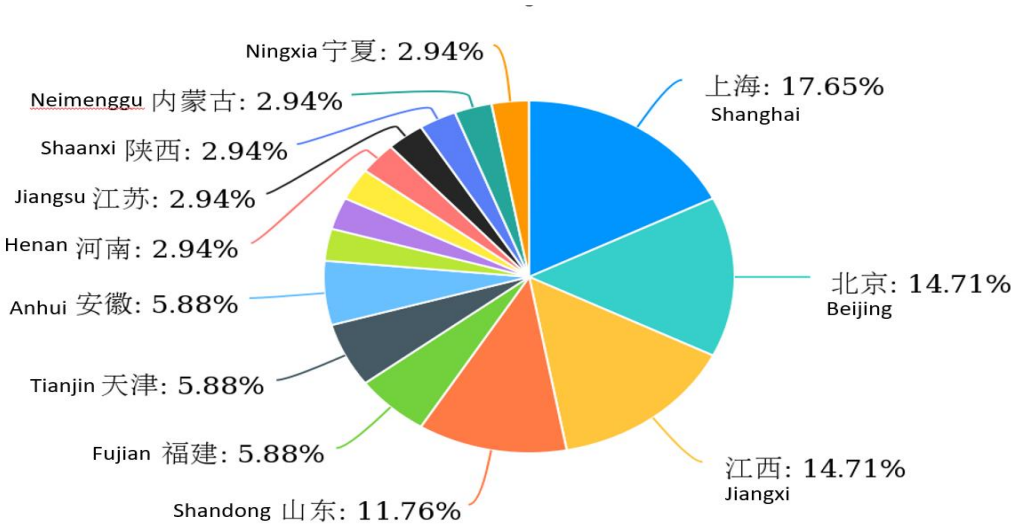

Figure 2 Distribution of System Dynamics researchers by provinces

Teachers

38 participants from the WeChat group "System Dynamics Theory and Practice" filled out the questionnaire. As table 1 shows, there are 32 universities from 15 provinces that offered a total of 55 System Dynamics courses. Among them, Shanghai is the city with the most universities, while Jiangxi is the province with the most teachers and courses. In addition, High School Affiliated to Nanjing Normal University is the only institute that teaches System Dynamics to students below the bachelor-degree level.

Table 1 Summary of system dynamics teachers

Province	**Institutes**	**No. of teachers**	**No. of curriculums**
Shanghai	University of Shanghai for Science and Technology	2	3
	Shanghai Academy of Social Sciences	1	1
	Shanghai University of International Business and Economics	1	1
	Fudan University	1	1
	East China Normal University	1	1
	East China Jiaotong University	1	1
Jiangxi	Nanchang University	3	4
	Jiangxi University of Finance and Economics	1	2
	Jiangxi Science and Technology Normal University	1	3
	Nanchang Hangkong University	1	2
Beijing	Beijing University of Civil Engineering and Architecture	2	3
	Central University of Finance and Economics	1	2

	Beijing Jiaotong University	1	2
	Beijing University of Technology	1	1
	Shandong University	2	2
Shandong	Shandong Technology and Business University	1	2
	Qingdao University	1	2
Anhui	University of Science and Technology of China	1	2
	Huaibei Normal University	1	1
Jiangsu	China University of Mining and Technology	1	2
	High School Affiliated To Nanjing Normal University	1	1
Tianjin	Tianjin University of Science and Technology	1	2
	Tiangong University	1	1
Fujian	Huaqiao University	1	1
	Xiamen University of Technology	1	2
Henan	Henan Agricultural University	1	2
Shaanxi	Xi'an University of Science and Technology	1	2
Sichuan	South Western University of Finance and Economics	1	2
Yunnan	Yunnan University	1	1
Chongqing	Chongqing College of Mobile Communication	1	1
Guangdong	Sun Yat-sen University	1	1
Inner Mongolia	Inner Mongolia Agricultural University	1	1

According to this survey, teachers who teach System Dynamics courses are mainly between 40 and 59 years old (76.47%), and all have Master's degrees or higher degrees. The academic background is concentrated in the three subjects of management science, engineering, and management. 14.71% of the researchers obtained the highest degree abroad, and most researchers (67.65%) did not teach in the same institutions where they got the highest degree. In addition, 55.88% of the participants had the title of professor.

Students

In 2022, 2,220 students from high school to Ph.D. degrees will participate in System Dynamics-related courses. 57% of the students are undergraduates, and 41% are masters and Ph.D. students. In addition, 56% of the courses are provided for Master's and Ph.D. students. The distribution of students and courses is shown in the figure below (From the perspective of class size, the data shows System Dynamics is mainly taught in large classes with more than 50 students. Two courses are even taught in classes with more than 100 students: Chinese culture and modern management at Yunnan University (180 students), Management system engineering at Tianjin University of Science and Technology (120 students).

Figure 3).

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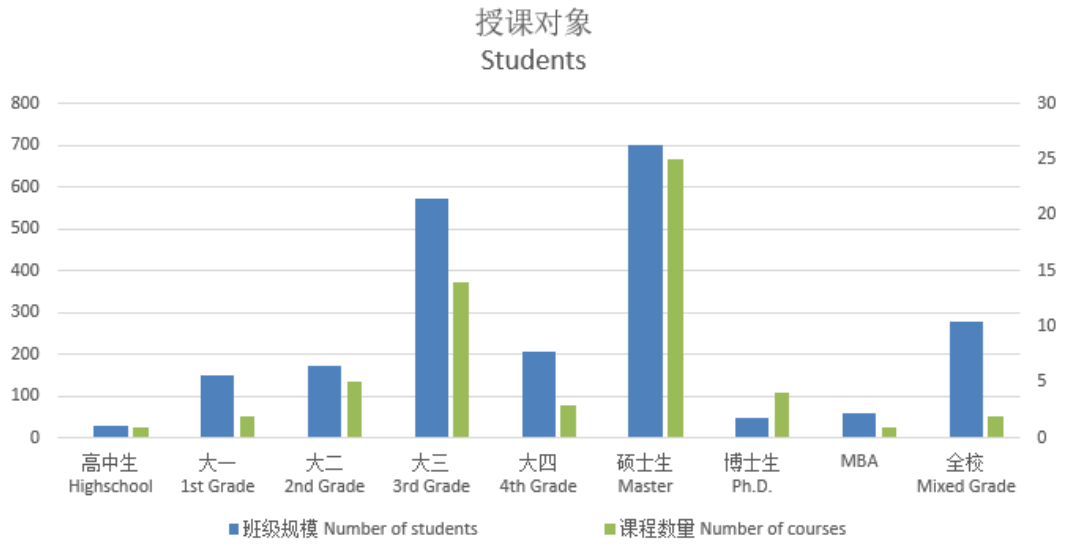

Figure 3 Grade distribution of Students

**Some courses are taught to two grades simultaneously, so the number of students is averaged for each grade in statistics.*

System Dynamics-related courses

Back in 1983, Professor John Sterrman was invited to give lectures on System Dynamics at Fudan University, which should be the earliest System Dynamics lectures in China. Since then, many universities started to offer courses and lectures, and some of them established research directions of

System Dynamics. The number of schools offering System Dynamics courses has increased rapidly, especially around 2010. It must be particularly pointed out that the first course offered to senior high schools was in the middle of the 1990s in Jiangsu province.

Course Content

The survey includes 55 courses related to system dynamics, of which 41% are compulsory courses, and most courses (80%) are offered once a year. The course covers many fields, including Systems Dynamics, systems engineering, public management, modeling, simulation, etc. The classification is shown in the figure below (

Figure 4).

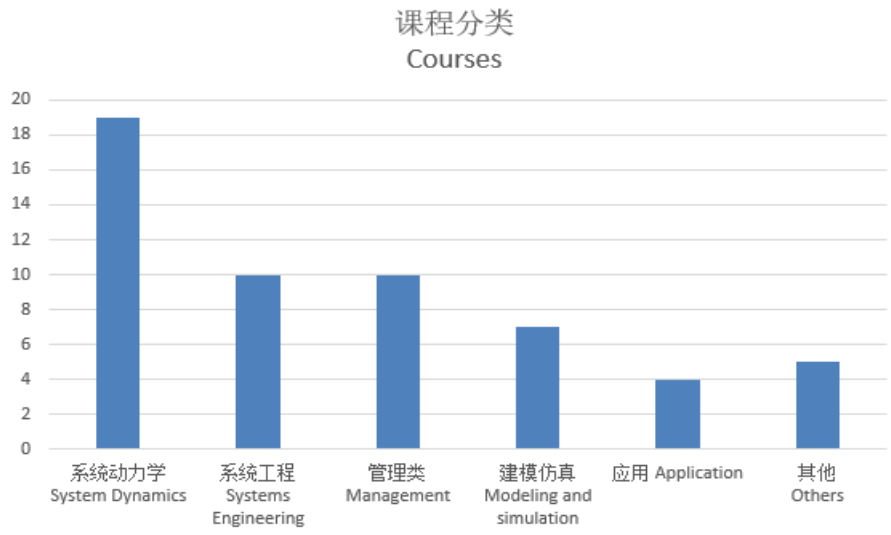

Figure 4 Courses content

In addition, 35% of teachers teach two System Dynamics-related courses at the same time, and there is one teacher from Jiangxi Science and Technology Normal University who teaches three System Dynamics-related courses simultaneously.

Curriculum Design

Because four researchers only participated in the Group Note in the WeChat group, we missed the details of these four courses, so only the information from 33 questionnaires is summarized in this section.

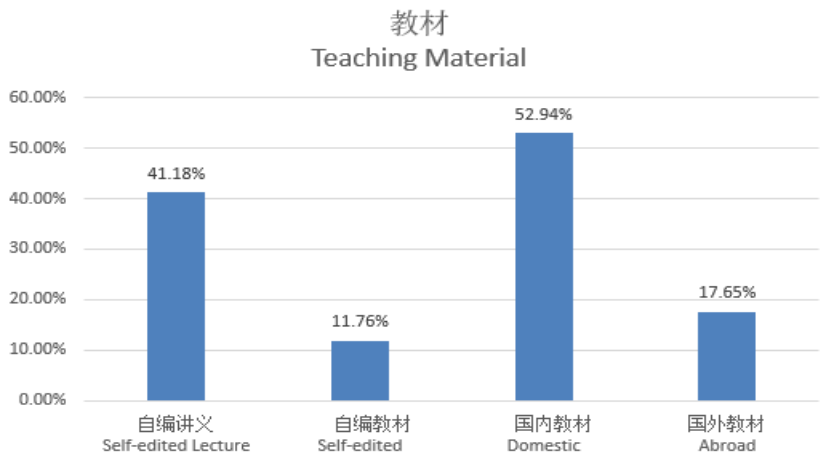

Figure 5 Curriculum Design – teaching material

Most teachers (52.94%) use domestic teaching materials and a considerable number of teachers (41.18%) use self-designed materials for teaching System Dynamics (

Figure 5). Moreover, all courses more or less use English materials.

Besides lecturing, group cooperative learning, case study, group modeling project, independent learning, and literature reading reports and discussions are also used when teaching System Dynamics (

Figure 6). The cases come from literature, news, social events, and scientific research projects.

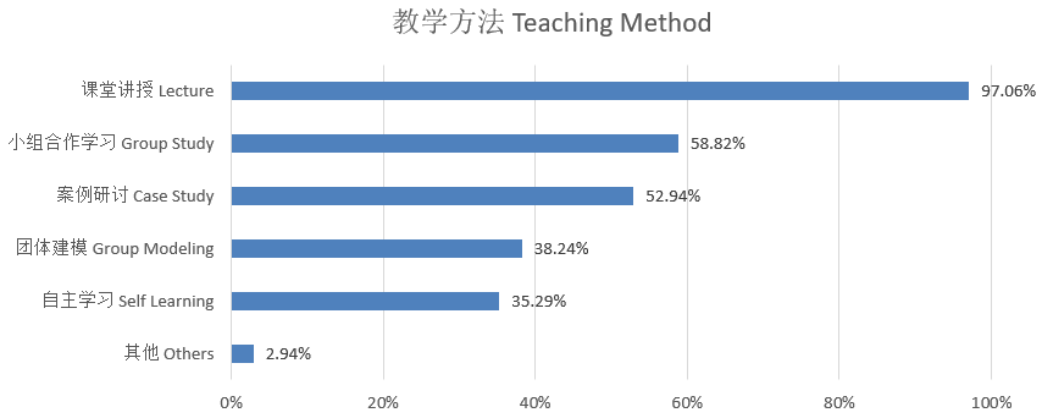

Figure 6 Curriculum Design teaching methods

Teaching feedback

Overall, both teachers and students were satisfied with the System Dynamics courses. 76.47% of the respondents believed teaching System Dynamics-related courses promoted academic research. Most teachers agree that System Dynamics courses can improve students' critical thinking ability (94.12%) and modeling ability (70.59%); they can help students in scientific research work, such as paper publication (50%) and competitions (11.76%). To improve the teaching effect, teachers mentioned the most important thing is that they should combine theory and practice. Furthermore, case studies are an excellent way to raise students' interest and self-thinking. Some teachers believe that quantitative analysis is helpful for students to learn and apply System Dynamics.

In the teaching process, teachers face some difficulties, especially in the building of the teaching team (55.88%) and the course platform (41.18%). Some teachers have not found suitable teaching material (29.41%) or cannot get strong support from their institutions (14.71%). Moreover, some think the System Dynamics method is not ideal in practical application (29.41%). At the same time, some teachers pointed out that the irregularity of the past literature misled students, and the students lacked practical ability. Some teachers also mentioned that System Dynamics needs a more solid foundation to work with modern mathematics. Some teachers also proposed that the International System Dynamics Association should support China more, and the System Dynamics software is not advanced enough.

For future teaching, many teachers hope to find a better way to combine theory with practice, find more cases that are suitable for the students, cultivate students' practical ability, and cooperate between different institutions, like preparing lessons jointly across schools.

Expectations of System Dynamics Society

Most teachers hope that the System Dynamics society can provide opportunities for international collaborative research (67.65%) and support for academic conferences (64.71%). Half of the teachers hope the System Dynamics society can provide training courses and organize modeling competitions. Some teachers also hope to have joint training degree programs (41.18%). They also hope the System Dynamics society can help obtain literature and materials (29.41%). More opportunities should be created for scholars to publish research papers using System Dynamics methodology. Some teachers also suggested that the China Chapter should develop System Dynamics software with independent intellectual property rights, optimize software, and provide virtual platforms for teaching and research platforms available to high school students.

Problems existing in the teaching practice

1) In terms of geographical distribution, it is mainly concentrated in Shanghai, Jiangxi, Beijing, and other provinces and cities. The geographical distribution of universities offering System Dynamics teaching is not evenly distributed. How to expand the reach of System Dynamics teaching and learning through a variety of approaches such as MOOC and enhancing cross-campus curriculum exchange, especially for the Midwest, is also a very important aspect of increasing the influence of System Dynamics.

2）In terms of the age of the lecturers, there is a predominance of middle-aged teachers and a lack of participation by young teachers. An insufficient teaching team could limit the development of System Dynamics. The survey shows that more than half of the System Dynamics courses are aimed at master/Ph.D. students, most of whom are likely to be future System Dynamics disseminators and educators after graduation. How to retain System Dynamics talent and ensure that they continue to teach and research in System Dynamics is also an important issue raised by many academics in the survey. Young teachers are the driving forces of teaching and research, and only by maintaining a reasonable structure, can we ensure the sustainable development of the subject.

3) In terms of the target audience, System Dynamics teaching is mainly for students at the undergraduate level and above. Compared to Korea and Singapore, our System Dynamics teaching in the K-12 education system need to be improved. The High School Affiliated To Nanjing Normal University has done a fruitful job in this area, and its experience and model are worth promoting and replicating.

4）In terms of textbooks and other teaching materials, there is less use of classic foreign language textbooks. For language reasons, although Chinese textbooks are more accessible to students, there is a risk that the rhythm of the original text is lost in the translation process. Among teachers who have tried to use English textbooks, there is also feedback, such as "*I teach one System Dynamics course in*

English for university students majoring in International Business this autumn semester. *For the teaching process, it seems that it is quite new for them to learn System Dynamics concepts and modeling methods".* In addition, "*Some published papers and research are misunderstanding or misuse System Dynamics, which are bad models for students to refer".* Thus, there is an unmet need for normative cases and teaching materials suitable for different levels of teaching audiences in China.

Conclusion

This study combined the methodologies of survey and interviews to explore the development of SD education in China. It is the first time that a panoramic view of SD teaching and learning is available across the Chinese mainland. The 38 teachers who participated in the survey represent 32 universities, research institutions and schools, on behalf of most of the leading forces in SD teaching and learning across the Chinese mainland. Although there are problems with this study in terms of its lack of breadth of scope, the slight singularity of the research channels, and the depth of analysis that needs to be improved. However, the status quo of SD teaching reflected in the study shows the overall situation at the teacher level and student level, as well as various difficulties in the teaching process specifically in terms of teaching design, pedagogy and teaching materials, etc.

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Appendix

Questionnaire

This survey aims to understand the teaching of systems dynamics (SD) in China, to provide decision-making support for the International Society for Systems Dynamics China Chapter to serve better and support the development and promotion of SD teaching in China. The survey is anonymous, and the results will only be used for research purposes and will not negatively influence you. Please do not hesitate to fill in the relevant information truthfully. Thank you for your support and cooperation!

SD China Chapter

August 5, 2022

Part I. Personal information:

1. Your name:
2. Your affiliation (specific to the college):
3. Your age: 20-30, 30-40, 40-50, 50-60, 60 and above
4. Your highest degree: undergraduate, master's degree, doctoral degree, or above
5. The subject of your highest degree:
6. Where did you obtain your highest degree: current university, other domestic universities, foreign universities
7. Your academic title: Lecturer, Associate Professor, Professor

Part II. SD teaching situation:

8. The name of the SD-related course you teach:
9. The earliest time that your university offered the SD course:
10. The frequency of the SD course you teach: every semester, every year, other

    students: undergraduate lower grade, undergraduate higher grade, master's degree, doctoral degree (multiple choices)

11. The size of the class: 20-30 people, 30-40 people, 40-50 people, 50-60 people, other (please fill in the specific number)
12. It is elective courses or compulsory courses
13. The main teaching methods you use: classroom lectures, group cooperative learning, self-learning, group modeling, case studies, other -
14. Teaching materials: Self-compiled lecture notes, self-compiled teaching materials, foreign teaching materials

15. What is the proportion of foreign materials used in your SD teaching? Very large, large, moderate, small, very small, none
16. How satisfied are you with the overall teaching effectiveness of the course? Very satisfied, satisfied, general, dissatisfied
17. How satisfied are the students with this course? Very satisfied, satisfied, general, dissatisfied
18. In your opinion, what are the main benefits for students learning the SD? Critical thinking ability, modeling ability, participation in academic competitions, paper publication...
19. What are the main problems and difficulties you have found in your teaching?

    Teacher team building

    Insufficient support from the school

    Insufficient funds

    Lack of course platform construction

    Unsatisfactory effect in practical application

    Teachers are concerned that Intellectual property rights cannot be guaranteed

    Students are not interested

    Lack of appropriate teaching materials

    Other:

20. In your opinion, does teaching SD help to promote your and your team's related academic research?

    Very helpful, General effect, No effect

21. In what areas do you hope that SD International Society and China Chapter can provide services?

    International cooperation research

    Provide training courses

    Organize modeling competitions

    Opportunities for a cooperative degree program

    Literature and material acquisition

    Academic conference support

Others:

22. What is the greatest experience in teaching the SD course? Can you share your teaching experience?
23. In what areas do you think can be improved in SD teaching?

According to your knowledge, which domestic universities/research institutes, etc., or who is also teaching SD-related courses? Can you help us forward the questionnaire? Thank you!