



The Construction of Python Advanced Computing Virtual Teaching and Research Laboratory

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Abstract. This paper analyzed the status and problems of Python curriculum across China at present, introduced the virtual teaching and research laboratory program launched by the Ministry of Education, and designed the construction scheme of Python Advanced Computing virtual teaching & research laboratory. The virtual laboratory provides a platform for teachers across the country to share abundant teaching and research resources, and jointly carry out teaching and research activities which can improve the quality of teaching. The virtual laboratory proposed in this paper can integrate the strength of college teachers across the country, improve teachers' teaching & research ability, and thus assist to cultivate students' computational thinking ability.

Keywords: Python · Virtual Teaching & Research Laboratory · Teaching Resource sharing

1 Introduction

At present, among all the general-purpose programming languages, Python, concerned mainly with computational problem solving, is the closest to the natural language. Its lightweight syntax and high-level language representation expresses the computational thinking concept [1].

In fact, Python, with its concise syntax, strong gluing of modules, and rich third-party resources in various technical fields, has become one of the most popular programming languages all around the world. In the past few years, Python has been chosen by more and more colleges and universities as the introductory programming language course for non-computer majors. In the courses offered by various universities and online teaching platforms, a number of excellent teachers and course resources can be found.

In the “Internet +” era, online and offline blending teaching has become a popular teaching mode [2, 3]. Many teachers make beneficial attempts to take advantage of various teaching platforms such as MOOC, SPOC, Rain Classroom, Python123, for teaching reform, and accumulated rich experience.

How to make full use of the existed abundant teaching resources, how to integrate various strength to produce more excellent teaching resources, and how to promote the

experience of excellent teachers and put their advanced teaching concepts into practice, is the focus of this study.

2 Backgrounds

2.1 Python Teaching Status

In China, Beijing Institute of Technology started to offer Python program design courses for non-computer majors at the earliest in 2013. In recent years, Python has become a hot topic of teaching reform. More than 20 courses related to Python, given by many universities including Beijing Institute of Technology, have been opened on the MOOC platform [4].

During the process of curriculum development, a number of excellent teachers and course resources have emerged, including textbooks, teaching cases, experiment designs, etc. With the popularization of online and offline blending teaching modes, various platforms and tools have been used in course teaching, such as MOOC, SPOC, Rain Classroom, Python123. Some effective teaching methods have been explored and played a great role in cultivating students' computational thinking ability.

According to the statistics of Smart Education of China Higher Education Platform [5], among all the courses opened online, PYTHON PROGRAMMING, given by Mr. Tian Song from Beijing Institute of Technology, is the most popular one. It has been opened for 17 times on MOOC online platform, and the total number of students has exceeded 4 million. Another two curriculums, PYTHON WEB CRAWLER AND INFORMATION EXTRACTION and PYTHON DATA ANALYSIS AND PRESENTATION have accumulated more than 600,000 and 400,000 enrolments respectively.

However, the curriculum practice of Python has not been carried out for a long time and the development situation is very uneven. In most of the universities and colleges, compared with other traditional courses, the development of Python curriculum is still faced with the problem of lack of experience and shortage of professional teachers, especially in the western underdeveloped areas.

A nationwide exchange and sharing platform for teachers of Python programming language needs to be established, where excellent teachers can share their teaching materials and experience, lead and mentor other teachers in curriculum development. What they share will become a valuable asset to other teachers and greatly improve their teaching qualities. Students in the underdeveloped areas will be the ultimate beneficiaries, they can acquire a better educational experience which helps to improve their abilities as a result.

In addition to acting as a learning platform for new teachers and inexperienced teachers, the nationwide platform can also serve as a platform of exchange and cooperation. This platform enables teachers to find like-minded research partners to carry out teaching reform and research activities. Professional teachers from different universities can promote and inspire each other, brainstorm, apply collective wisdom, and produce more high-quality intellectual achievements together.

As a platform used by teachers and students in universities across the country, this platform can also collect big data for analysis, providing better data support for teachers' teaching and scientific research reform activities.

2.2 Virtual Teaching and Research Laboratory

The basic teaching organization, which takes the teaching and research section as the main form, is the cornerstone of promoting the connotative development of higher education in China [6]. The teaching and research laboratory in colleges and universities has gone through four basic stages: initial stage, finalizing stage, restoration and transformation stage, and imaginary stage [7]. The new economic development, which is characterized by new technology, new industry, new business form and new model, requires higher education to realize all-round innovation from concept, content, standard and method [8], including the forms of teaching organizations.

The Ministry of Education issued an announcement on the first batch of virtual teaching and research laboratories construction pilot (Letter of the Office of Education and High Education, no. 2, 2022) [9]. According to the announcement, 439 virtual teaching and research laboratories have been approved to pilot construction, and Python advanced computing virtual teaching and research laboratory is among them.

There have been some practice in virtual laboratories, but some of them just simply copy the physical teaching and research sections to the virtual community [10], some carry out cross integration of traditional entity teaching and research departments just in a limited number of cooperative universities [11, 12], some take the form of teaching organization facing students directly, such as platforms serving for multi-university joint talent cultivation [13]. Compared to these laboratory forms, the virtual teaching and research laboratories have more connotation.

Relying on modern information technology, the virtual teaching and research laboratories program aims at exploring the modes of constructing a new fundamental teaching organization, building a community of teachers, fostering a quality culture, Guiding teachers to return to teaching, love teaching, research teaching, improve teaching ability, providing strong support for the high-quality development of higher education.

The construction tasks of the virtual teaching and research laboratories program include:

- Innovate teaching and research forms: Make full use of information technology, explore efficient, convenient, diversified, online and offline blending teaching and research modes which can break through time and space restrictions, and form a new idea, new method and new paradigm for the construction and management of grassroots teaching organization.
- Strengthen teaching research: Guide teachers to strengthen the research and exploration of professional construction, curriculum construction, teaching content, teaching methods, teaching means, teaching evaluation and other aspects, improve the awareness of teaching research, condense and promote research achievements.
- Build high-quality resources together: Virtual teaching and research laboratory members, on the basis of full exchange, cooperate to build talent training programs, syllabus, knowledge maps, teaching videos, electronic courseware, exercises, teaching

cases, experimental projects, practical training projects, data sets and other resources, form a high-quality and shared teaching resource library.

- Carry out teacher training: Carry out regular teacher training, give full play to the demonstration and leading role of national teaching teams and first-class courses of famous teachers, promote mature and effective talent training models and curriculum implementation plans, and promote the teaching development of front-line teachers.

The construction target and tasks of the virtual teaching and research laboratories program are highly compatible with the problems and platform requirements of the Python programming language course. As one of the first batch of virtual laboratories, we have seen the development opportunity and direction of the course from the construction tasks of the virtual laboratories.

3 Construct Scheme of Python Advanced Computing Virtual Teaching and Research Laboratory

3.1 Membership and Organizational Structure

The members of Python advanced computing virtual teaching and research laboratory are mainly from “Python Language Working Group” of China University Computer MOOC (CMOOC) established in January 2016, the majority of which are Python course teachers in universities across China. According to a preliminary investigation, about 1000 teachers are planning to participate in this virtual teaching and research laboratory, covering more than 500 colleges and universities, including more than 30 in western China. There are also members who are representatives of enterprises that have substantial cooperation with Beijing Institute of Technology in the field of industry-education integration and collaborative education, including Huawei, Microsoft, Xilinx, Higher Education Press, Green Alliance, etc. All members can join and withdraw from the virtual teaching and research laboratory voluntarily.

The teaching and research laboratory adopts flat management mode. A laboratory management office is set up in Beijing Institute of Technology, responsible for the daily operation, maintenance and operation of the work group, drafting and formulating the annual plan, summarizing the annual work, etc. All members can directly participate in the teaching and research activities of the laboratory. Members from the same area can also set up a regional office to process area affairs. The overall organizational structure is shown in Fig. 1.

According to the development goals and tasks of the virtual laboratory, five groups are set up: curriculum group, new course group, teaching and research Group, platform group and teachers group. The curriculum group is responsible for the construction and sharing of the existing curriculum content and new curriculum resources. The new course group is responsible for the course application, development and resource construction of new courses. The teaching and research group is responsible for education and teaching research, teaching model exploration, academic exchange organization, integration of industry and education; The teachers group is responsible for training young teachers, improving teachers' ability, teaching evaluation and competition; The platform group is

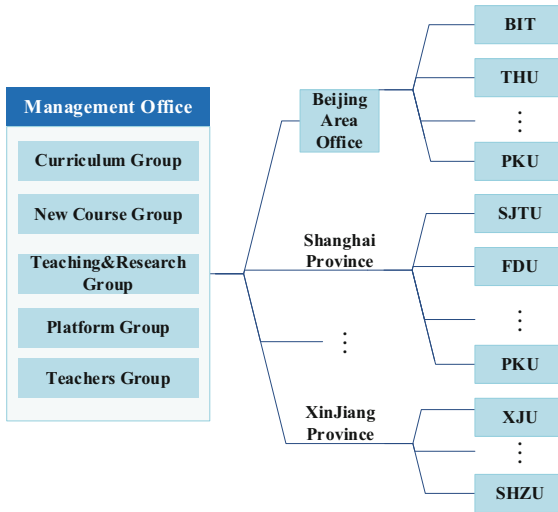


Fig. 1. Organizational Structure

responsible for the formulation of management rules and regulations and the maintenance of the digital platform.

3.2 Course System

The mission of Python advanced computing virtual teaching and research laboratory is to promote the development and reform of public courses in “advanced computing”. The laboratory takes advanced computing as its teaching orientation, carries out the reform of a series of advanced computing public courses, including Python Programming Language, Data Analysis, Big Data Processing, Artificial Intelligence Literacy, Artificial Intelligence Programming, Artificial Intelligence Application, Network and Information Security, etc.

At the foundation period of the virtual laboratory, three curriculums are chosen to be the first batch of courses to be constructed, including “Python Language Programming”, “Python Data Analysis” and “Python Artificial Intelligence Programming”. All the three curriculums have already been running in Beijing Institute of Technology for several years and have accumulated abundant experience. With the three curriculums, the first steps of the advanced computing system path of “programming - Data Analysis - Artificial intelligence Development” have been constructed.

The overall course system of the virtual laboratory is shown in Fig. 2.

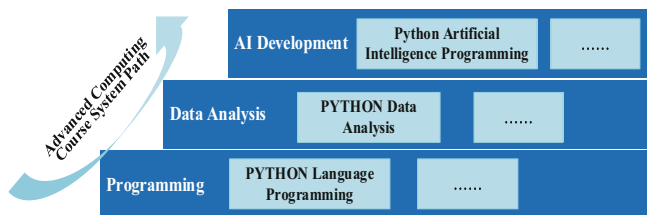


Fig. 2. Course System

3.3 Construction Scheme

The main tasks of Python advanced computing virtual teaching and research laboratory include basic platform construction, teaching system construction, education and teaching research, and teaching reform activities, etc. The purpose of the construction is to realize resource sharing, teachers' mutual assistance, and material co-construction, improve teachers' abilities and benefit students as a result.

The main tasks of Python advanced computing virtual teaching and research laboratory include basic platform construction, teachers exchange activities, resource library construction, education and teaching research, and practical achievements promotion. The overall construction scheme is shown in Fig. 3.

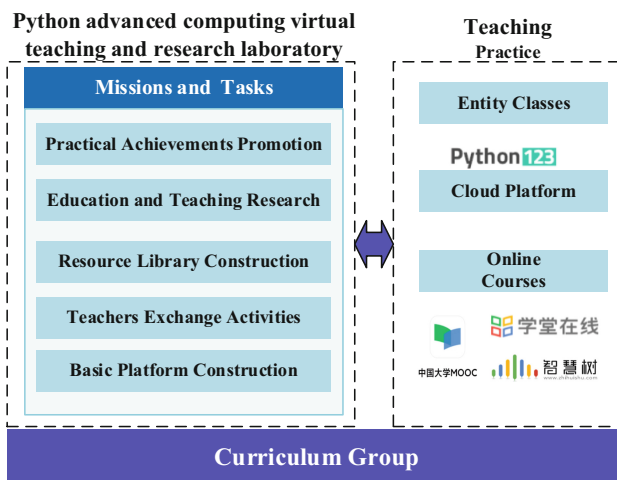


Fig. 3. Construction Scheme

Each construction task has its characteristic contents and products, as is shown in Table 1.

All the construction tasks are based on a basic national open platform, the development of which is also one construction task of the laboratory. Basic platform construction means mainly the development of the platform, which can provide management functions for the laboratory. For example, the platform can support membership management,

Table 1. Contents and products of each task

Task	Content and Products
Basic Platform Construction	Platform Development, Membership Management, Resource Display & Download, Activity Releasement, etc.
Teachers Exchange Activities	Teachers Training, Discussion, Teaching Evaluation & Competition, Project co-construction
Resource Library Construction	Syllabus, teaching video, electronic courseware, exercises, teaching cases, experimental projects, knowledge map, data sets
Education and Teaching Research	The educational reform paper The educational reform Practice
Practical Achievements Promotion	Promotion of new teaching concept, teaching methods, teaching modes and evaluation model, high-quality MOOC

resource display, document upload & download, activity releasement, etc. The platform is developed and managed by the laboratory management office. Members can register on the platform to participate in the construction of the teaching and research laboratory.

The development of the platform is based on Ali's DingTalk, and can provide technical support for laboratory's information dissemination, communication and document management.

Teachers exchange activities construction releases exchange activities initiated by the laboratory, such as teaching training, teaching communication, and discussion. The laboratory can also release some teaching research project and solicit participants who are interested.

Resource library construction can collect and organize diversified Python course resources, including talent training program, syllabus, teaching video, electronic courseware, exercises, teaching cases, experimental projects, knowledge map, and data sets. The resource library can be shared by and provide support for all the Python course teachers and greatly improve the course quality, especially in the western underdeveloped areas.

Education and teaching research construction can express excellent achievements of teachers' teaching research, such as papers. Teachers can also carry out teaching research cooperation in groups with the help of the platform and explore new teaching methods and teaching means.

Practical achievements promotion construction introduces new teaching concept, teaching methods, teaching modes, evaluation models, and the means of how to put them into reality. For example, a high-quality MOOC course can serve as the material of a flipped classroom.

As is shown in Fig. 3, teachers of the curriculum group can take advantage of the products and achievements of the construction procedure, put them into their teaching practice, including entity classes, cloud experimental platforms such as Python123,

online courses on platforms such as MOOC. By utilizing the high quality resources on the virtual laboratory platform, teachers can put the innovative concept and modes into reality. During their courses, teachers can collect teaching data, for example, students' scores or feedbacks, which can be used as the basic platform's input to produce better achievements.

3.4 Benefit for Teachers and Students

The construction of new engineering is a timely response of higher education to the requirements of talent training, and cross-integration & cross-field training has become the inevitable choice of new engineering talent training mode [14]. The construction of Python advanced computing virtual teaching and research laboratory is an important reform and innovation of new engineering education in the field of advanced computing. Both teachers and students can benefit greatly from the construction of the virtual laboratory, as is shown in Fig. 4 and Fig. 5.

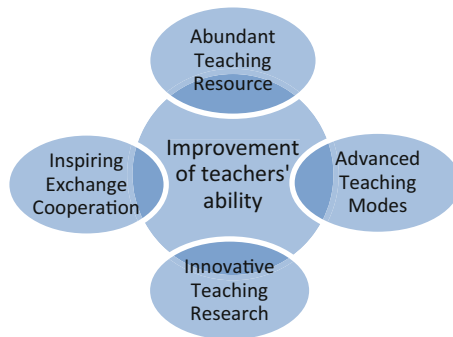


Fig. 4. Benefit for teachers

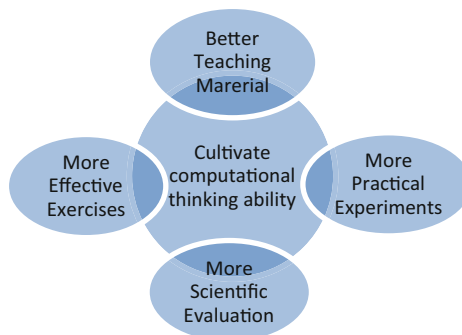


Fig. 5. Benefit for students

4 Problems to Be Solved

In the construction scheme of Python advanced computing virtual teaching and research laboratory, there are still some problems to be solved:

Firstly, how to fully protect the intellectual property rights of content providers in communication and sharing activities of the laboratory is still questionable.

Secondly, incentive needs to be developed to motivate enthusiasm of members.

Thirdly, how to promote demonstrative results of teachers' teaching and research, put teachers' advanced ideas and achievements in educational reform into practice is still an urgent problem to be solved.

5 Conclusion

With the continuous advancement of the pilot work of the virtual teaching and research laboratories, colleges and universities teachers will continue to deepen the exploration of the teaching organizations, promote the collaborative teaching and research, improve the quality of curriculum construction, promote the cross integration of disciplines, and promote the formation of new teaching paradigms and new mechanisms [15].

Though there are still some problems to be solved, it is hoped that Python advanced computing virtual teaching and research laboratory can break through the time and space constraints, combine online and offline models, bring an effective and diversified teaching and research modes for Python teachers across the country, play an important role in the equalization of education nationwide and the improvement of the overall teaching quality of Python advanced computing curriculums.

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References

1. Song, T., Huang, T., Li, X.: Python language, the ideal choice of program design course teaching reform. *China Univ. Teach.* **2**, 42–47 (2016)
2. Zhao, H., Wang, K., Gao, P., Wang, G.: The effect of blended teaching on basic computer courses in universities. *Comput. Educ.* **10**, 118–120, 124 (2018)
3. Li, F.: The theoretical basis and teaching design of blended teaching. *Mod. Educ. Technol.* **26**(09), 18–24 (2016)
4. Zhao, X., Zhang, X., Han, Z., Song, T.: The training practice of problem solving ability and innovation ability in Python language teaching. *Comput. Educ.* **9**, 6–10 (2017)
5. <https://www.chinaooc.com.cn/>. Accessed 30 May 2022
6. Zeng, J., Wu, S., Zhang, C.: Virtual Teaching and Research Laboratory: innovation and exploration of universities grassroots teaching and research organization, no. 11, pp. 64–69 (2020)
7. Hong, Z.: Evolution and reconstruction of grassroots teaching and research offices in Colleges and Universities. *Univ. Educ. Sci.* **3**, 86–92 (2016)
8. Wu, Y.: New engineering: the future of higher engineering education. *Res. High. Eng. Educ.* **6**, 1–3 (2018)

9. <http://four-e.tju.edu.cn/info/1016/1341.htm>. Accessed 30 May 2022
10. Su, L., He, Q., Su, C.: Virtual community of teaching and research offices: a new model of informatization construction of teaching and research offices in Colleges and universities. *J. Jiangxi Youth Vocat. Coll.* **12**, 45–48 (2014)
11. Hu, J., Chen, H., Zhang, J.: Improving the teaching quality by relying on virtual Teaching and Research Office: a case study of “Double Training Plan” of Beijing Jiaotong University. *Beijing Educ.* **5**, 56–58 (2018)
12. Cai, D.: Practice research on cross-regional joint Training of talents in universities under the “Internet +” environment: a case study of the “Double Training Plan” project of animation major. *Art Educ.* **13**, 210–211 (2018)
13. Wang, J., Dong, M., Lou, X.: Construction of virtual teaching and research platform combined by multiple schools. *Digit. Technol. Appl.* **8**, 224–225 (2019)
14. Li, Z., Liao, R., Dong, L.: *Res. High. Eng. Educ.* **2**, 20–25 (2018)
15. Zhan, D., Nie, L., Tang, D., Zhang, L.: Virtual teaching and Research Room: a new form of collaborative teaching and research. *Mod. Educ. Technol.* **3**, 23–31 (2022)