

The Implementation of the Pocket Lab Tool (PLT) in Online Practical Teaching and Learning

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Abstract: Pocket lab tool (PLT) is a kind of micro tool that miniaturizes the functions of traditional experimental devices onto a small board. It is small in size, convenient to carry and operate, and students can carry out experiments anytime and anywhere. With the development of society and the continuous improvement and innovation of teaching methods, many colleges and universities begin to choose online teaching. Through the exploration and implementation of PLT, this study designed suitable PLT to facilitate students to experiment anytime and anywhere, promote the application of professional knowledge, improve professional practice ability, and provide reference for the teaching of practical courses in the post epidemic era.

1. Introduction

In recent years, many countries and regions have been affected by various disasters [1]. Especially in the education system, there are nearly 1.6 billion students in more than 200 countries, schools, institutions and other learning places, and even more than 94% of the world's students are affected [2]. In order to meet the educational needs of modern society, the teaching methods of many colleges and universities in China have changed from face-to-face teaching to online learning or distance education, and are even ready to switch between online and offline at any time[3].

The teaching of practical courses is the core course for engineering students in colleges and universities. In the traditional teaching mode, the practical experimental courses are all completed by teachers teaching students in the laboratory. However, in recent years, with the continuous rise of online courses, the continuous emergence of various online platforms, and the continuous improvement and innovation of teaching methods, many colleges and universities have changed the educational tools and strategies of practical course teaching. From traditional face-to-face learning to online learning, guided by digital survival theory, the teaching method of combining online teaching with offline practice closely optimizes the teaching quality of practical courses through digital means.

E-learning tools have played a key role in modern online new teaching, so that students who should have been on time for practical courses in the laboratory regardless of wind and rain can now learn normally through online courses [4]. Therefore, this study aims to explore a new

e-learning education tool - pocket laboratory tool, and apply it to practical teaching, so as to facilitate students who need to take practical courses to experiment at any time and anywhere, promote the application of professional knowledge, improve professional practical ability, and provide reference for later practical course teaching.

2. Implementation of PLT

The place where this research is implemented is Wuyi University in Fujian Province, China. This is an application-oriented undergraduate university. Application-oriented undergraduate education is a new type of education. It plays a positive role in meeting the needs of China's development for high-level application-oriented talents and promoting China's higher education. The college takes the applied technology type as its orientation, the applied professional education as its foundation, the cultivation of high-level applied talents as its guidance, and the development of practical ability as its goal. According to the characteristics and connotation of applied talents, practical teaching courses play a decisive role in our college. Therefore, in combination with the importance and existing problems of the practical teaching system, this study proposes specific measures for the implementation of the pocket laboratory, improves the practical teaching effect and cultivates high-quality application-oriented talents by improving the practical teaching methods, integrating and optimizing the laboratory's allocation of resources, and improving the practical teaching evaluation.

2.1 Design of PLT

(1) Design and complete 60 sets of PLT

The PLT in this study are composed of pulse signal generator, single pulse generator, switch circuit module, led logic indicator module, 8-bit nixie tube display module, FPGA / CPLD connection interface module, pcf8591 digital to analog conversion module, RC delay module, relay module, thermistor, photoresist, DS18B20 digital temperature sensor and other sensor modules. The kit size is 15.06cm * 11.03cm, and the no-load power consumption is about 0.5W. It meets the requirements of low power consumption, no load operation no more than 5w, and size less than 25cm * 18cm. A total of 60 sets of PLT have been designed, as shown in Figure 1.



Figure 1: Bottom plate of PLT

(2) Compile pocket laboratory tool kit experiment manual

An experimental manual suitable for the kit is compiled, including the basic use tutorial of quartusii13.0, as well as seven experimental contents such as the design and testing of combinational logic circuits, decoders and their applications, data selectors and their applications, flip flops and their applications, counters and their applications, 555 time base circuits and their applications, and digital contest responders.

(3) Experimental template

In order to improve students' efficiency in pin mapping and module calling, and pay more attention to mathematical system logic design, experimental templates are designed for students to use in experiments to accelerate students' rapid introduction to digital system design, which is well received by students.

2.2 Application of PLT in practical teaching

Based on the Quartus II development platform, this study is applicable to the practical teaching of the "Digital Electronic Technology" course of Wuyi University. The overall shape of the practical teaching is shown in Figure 2. This course is a practical compulsory course. In the past,, students should go to the experimental building for face-to-face classes. From November 2021, students can use the designed PLT to carry out experiments in the dormitory or at home spontaneously. Teachers can teach online directly. Students can repeatedly check the videos recorded by teachers, and can also share and discuss with roommates.It greatly alleviates the tense atmosphere of students completing the experiment within the specified time, which is more humanized. Figure 3 shows the use of PLT among students.



Figure 2: The specific application of PLT in teaching



Figure 3: Students' use of PLT

3. Outcomes of the PLT Implementation

Many researches on the application of PLT in education have achieved positive results [5] [6] [7]. Compared with the traditional face-to-face practical course teaching, the experimental effect of this study has also been significantly improved after the use of pocket experimental teaching tools, mainly in the following aspects:

(1) The use of PLT for experimental teaching not only enhances students' practical ability, but also greatly promotes their mastery of classroom theoretical knowledge. Students have a more solid grasp of the experimental principles and basic knowledge that have been done with PLT, and truly combine theory with practice, so as to improve their theoretical knowledge and practical ability.

(2) Students' interest in learning practical courses has improved significantly. They listen carefully in class and finish the homework assigned by the teacher after class. Even some students with good foundation will use pocket experimental tools to carry out independent experimental research. The number of college students participating in practical training projects has increased significantly, and they have won many awards in difficult discipline competitions such as the National Electronic Design Competition.

(3) The students' comprehensive application ability has been significantly improved. PLT teaching method is based on practice. It not only trains students' autonomous learning ability and hands-on practice ability, but also trains students' ability to collect data, analyze circuits and write code. Help students improve their comprehensive learning ability and application ability, and consolidate their professional foundation.

4. Discussion

PLT have just been used in the Digital Electronic Technology Experiment and Digital Electronic Technology Course Design for the 2020 electronic information engineering major of Wuyi University. Teachers can use online video classes, and students can use QUARTUSII to model and simulate on the dormitory or home computers, and then download them to the development board for actual measurement and verification. This not only trained the students' ability of independent learning and hands-on practice, improved the efficiency of the experiment, but also updated the

experimental teaching content of digital electronic technology, making the experimental teaching methods even higher.

5. Future research and implication of the study

The purpose of this study is a pocket laboratory tool designed to adapt to modern teaching and suitable for engineering students to carry out practical teaching. It allows students to carry out independent experimental training and innovation anytime and anywhere in space and time other than the classroom, which not only improves students' independent analysis ability and problem solving ability, but also helps to improve their hands-on practical ability.

Considering the increasing popularity of PLT in engineering practical courses and the benefits of its application in practical courses, this study is of great significance, which can help educators develop effective PLT curriculum design and provide some guidance for future research. Effective application of PLT can enhance teaching and learning, and improve students' innovative thinking and practical ability, which are the skills that engineering students in the 21st century should have. So far, some studies have proposed and applied PLT in the teaching of practical courses in a certain subject [8] [9]. It is also important to apply PLT to different types of practical courses, which will help the teaching of practical courses in the future. Future research can explore this.

As a summary of the analysis results, some suggestions for future research on PLT are put forward. The review shows that PLT plays an important role in the cultivation of students' various abilities. However, due to the funding problem, the application of PLT is not wide enough and the popularity rate is not very high. In order to save funds, some universities only get a set of tools from a group of 3-4 students. If the students in the same group want to use PLT, they have to wait in line.

Therefore, future research should take these defects into consideration. In the future, we should invest as much money as possible in the production of PLT, strive to work together, let more participants participate, increase the application of PLT, and improve students' practical ability.

6. Conclusion

At present, PLT has been used by more than 600 students in more than 10 classes in four majors of Wuyi College for more than one year. After the implementation of PLT, from the feedback of practice units and employers, students' practical ability, engineering quality and innovative thinking have been significantly improved. In addition to the overall progress of students, students with good foundation and strong practical ability have made more progress. Some students have begun to use PLT to carry out independent experimental research, which has laid a good foundation for further study of professional courses in the future and participation in various related competitions. In general, the application of PLT to practical courses is a great new educational concept and means, which provides a useful reference for practical teaching of other courses. This kind of practical teaching based on PLT in Wuyi University not only meets the requirements of the national new engineering talent training strategy, but also conforms to the growth environment and psychological characteristics of modern young students. It is a direction worth continuing to adhere to and strive for. PLT will be further applied to more professional students, and related work is in progress.

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