The reform and practice of university computer assessment based on computational thinking and ability development

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Abstract: The course "Fundamentals of Computers" is a compulsory general education course for non-computer science majors in undergraduate colleges and universities, and the course is very important for cultivating students' information literacy and computational thinking skills. This course analyzes the previous examination methods of BIPT and analyzes the current assessment methods in the light of the new curriculum reform objectives, and finally proposes further improvement ideas for the currently used assessment methods.

Keywords: fundamentals of computers, assessment methods, computational thinking, ability development

1. Introduction

With the rapid development of computer technology, computer application ability has become an important symbol of the new generation of college talents, which is the basic requirement for college talents to adapt to the development of society. College Computer is an introductory course for non-computer science students to learn computer knowledge, the core course of basic computer teaching in higher education, and an important part of university general education [1]. Its teaching purpose is to cultivate the computational thinking ability and information literacy of college students, to enable them to master the basic knowledge and methods of computing disciplines, and to have the initial ability to use computers to process and solve problems, the ability to communicate based on information technology means and the ability of continuous learning.

In response to the problems of uneven level of students and reduction of teaching hours in the course of "University Computing", many universities have carried out course teaching reform in terms of course system, course content and teaching methods [2-4]. Academic assessment is an important link in the process of education and teaching in colleges and universities, and also an important part of the teaching management system, with the functions of evaluation, diagnosis, monitoring and supervision, which is an important means to guarantee the quality of talent cultivation in colleges and universities [5]. At present, some colleges and universities have carried out reforms in the assessment link of the University Computer course [6-9]. In this paper, taking Beijing Institute of Petrochemical Technology as an example, we analyze the examination methods of our university in previous years and analyze the current assessment methods in the light of the new curriculum reform objectives, and finally put forward further improvement ideas for the currently used assessment methods.

2. Past examination methods and analysis

2.1 Written examination method

The written examination method mainly uses paper as the examination medium, and this examination method has been used in our university since the earliest time. Due to the large number of students taking the examination of "University Computer" course, this examination method presents many disadvantages: the written examination needs to go through the process of paper issuing, paper printing, invigilation, and paper reading, etc., all of which increase the workload of teachers and bring

great pressure to their work; secondly, after the examination, the work of paper reading is a great headache for teachers, who often have to correct thousands of papers within the specified time. The work is very intensive, and it also affects the accuracy of the marking work, so it may cause the error of students' performance; the course of "University Computer" is characterized by strong practicality, using the written examination mode can only simply test whether the students' knowledge is mastered, but not in the real sense to assess the students' practical computer operation ability, so this single examination mode is not suitable for this course. Therefore, this single examination method is not suitable for this course.

2.2 Combination of big homework and written test

In order to better test the students' practical computer operation ability, our university made a preliminary reform of the examination method of "University Computer" course, changing the original purely written examination method to a combination of large assignments and written examinations, and the overall assessment is based on 20% of the usual grade, 20% of the large assignments and 60% of the written examinations.

The major assignments are mainly for the three modules of office (word, excel and powerpoint) to give students the corresponding assignment topics, and students are required to submit electronic version of the assignments before the written exam, and the written exam is mainly filled with multiple choice questions and short answer questions to test students' knowledge of basic computer knowledge. This kind of examination method examines students' practical computer skills in a certain sense, and also enhances students' attention to practical operations in the learning process, so that it also achieves the goal of improving students' practical computer skills to a certain extent. However, there are some disadvantages of this kind of exam: first of all, compared with the traditional written exam, this kind of exam increases the workload of teachers, who not only have to go through all the work processes and links of the written exam, but also have to review the students' large assignments. Secondly, the students submit the finished large assignments, which cannot be monitored in the middle of the process, so some students' assignments may not be realistic enough, and in the long run, students will learn the time-saving method to deal with large assignments, which is still not ideal for improving students' computer skills in general.

2.3 Combination of machine examination and written examination

Based on the shortage of large assignments and written examinations, our university built a new computer room and purchased a machine examination system to conduct machine examinations for the more operational contents of the "University Computer" course. This way of examination avoids the disadvantage of using large assignments to test students' operation ability, and can truly test students' ability to operate computers. However, due to the limitation of hardware facilities at that time, the capacity of the computer room was not large and the number of students who could take the test at the same time was small, so we needed to take the test in several batches for the whole school. Because of the limitation of the computer room, we could not let students practice the test system, so teachers needed to conduct pre-test training before each batch of students, explaining the test process and precautions, which also added some pressure to the teachers' invigilation work. This type of exam still does not alleviate the work pressure caused by the written exam, so further reform is needed.

3. Current assessment methods

According to the reform idea of the University Computer Instruction Committee, our university has also carried out corresponding curriculum reform, setting the teaching goal as cultivating students' computational thinking ability and the ability to use computers to solve problems in this specialized field. The teaching content is adjusted to computer operation part, computer principle part, program and algorithm part. The teaching method of the computer operation part is task-oriented plus students' independent completion, i.e. the teacher assigns experimental tasks, students complete them in the upper class and under class, and the teacher provides offline guidance during the upper class time and online guidance at other times. The computer principles section and the programming algorithms section are conducted by a combination of class and hands-on approach. In the programming algorithms section, the focus is on developing students' problem solving skills without forcing them to acquire knowledge of programming syntax. In order to accommodate the above various reforms concerning the course, we have reformed the way the course is assessed.

3.1 Process evaluation

In order to urge students to study hard at ordinary times, pay attention to the training of computer operation ability, and avoid the phenomenon of surprise attack before the final examination, we strengthen and standardize the process assessment which is the main basis of ordinary grades. The usual grade is composed of usual performance, homework, lab test, quiz, etc., accounting for 40% of the total final evaluation grade. The usual performance includes the attendance (signing in to the cloud class) and classroom performance (answering classroom questions in the cloud class); the homework, i.e., after-class assignments, involves theoretical knowledge points; the experimental assessment is based on the experimental project assignments submitted by the students in the cloud class, which involves the operational skills of office software; the quiz results are derived from the students' online mock exams, which are similar to the official exams in terms of question type. The questions in the mock exams are similar to those in the official exams, with a slightly smaller number of questions, which are also randomly selected from the question bank. On the one hand, the mock exams can familiarize students with the use of the exam system, and at the same time, they can also detect students' weak points, so that they can strengthen the practice of the corresponding modules in a targeted manner.

3.2 Machine Examinations

In order to correspond to the reform of teaching content, the final examination is divided into three types of questions: operation questions, multiple-choice questions and program fill-in-the-blank questions, accounting for 60% of the overall final assessment grade. The operation questions mainly test students' ability to operate office software, with each set of questions including Word, Excel, PowerPoint and Access (as shown in Figure 1); the multiple-choice questions mainly test students' mastery of basic computer knowledge, including computer hardware and working principles, operating systems, office software, computer networks, databases, information security, etc. The multiple-choice questions test students' knowledge of basic computer knowledge, including computer hardware and working principles, operating systems, office software, computer networks, databases and information security; the fill-in-the-blank questions test students' problem solving skills in the form of perfecting a C program to solve a specific problem (as shown in Figure 2).
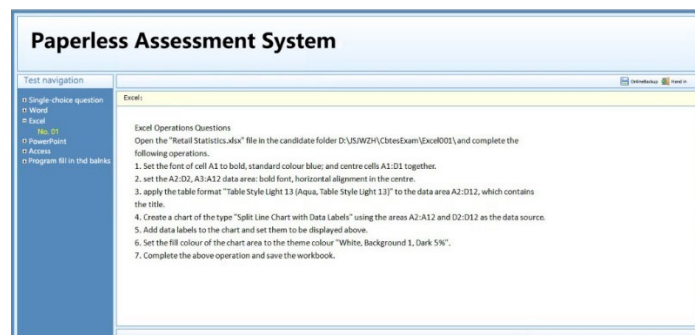

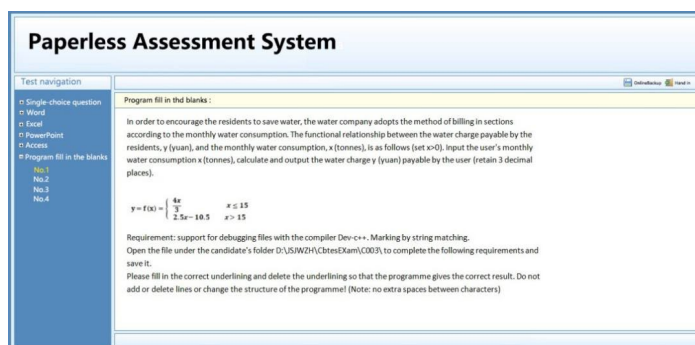*Figure 1: Examples of manipulative questions*

Figure 2: Example of a program fill-in-the-blank question

The whole examination process is done on a computer. Before the examination, the teacher imports the basic information of the students into the examination server, where the examination template is drawn up according to certain rules and the examination question bank is formed (as shown in Figure

3). During the examination, students randomly select a set of question papers from the question bank by entering their examination numbers and download them to the students' computers for answering (as shown in Figure 4). At the end of the exam, the server can export a breakdown of each candidate's exam results, including the exam results for each question type (as shown in Figure 5).
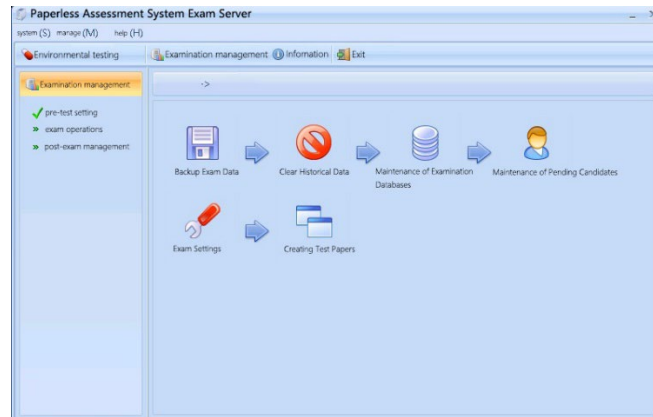

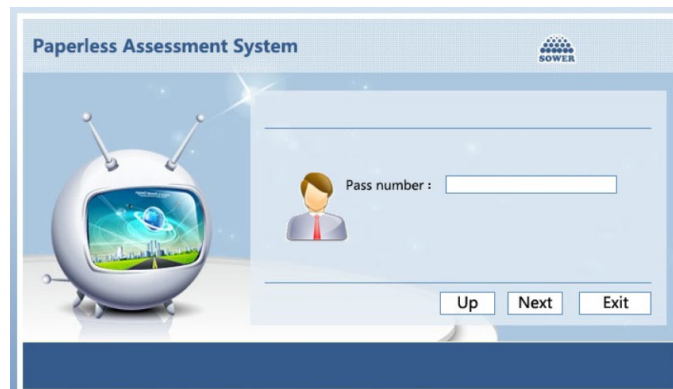*Figure 3: Server-side interface of the examination system*

Figure 4: Candidate login screen

Pass number	Date	Grade	Multiple-choice	Word	Excel	PowerPoint	Access	Fill-in-the-blank
2022311483	2023/5/7 9:59:43	92.00	60.00	3.94	4.58	2.92	0.56	20.00
2022311449	2023/5/7 9:59:42	91.80	56.00	4.13	3.75	2.92	5.00	20.00
2022311528	2023/5/7 14:00:44	91.47	57.00	4.58	5.00	4.06	0.83	20.00
2022311575	2023/5/7 15:57:00	90.72	54.00	5.00	4.17	4.55	5.00	18.00
2022311578	2023/5/7 15:56:54	90.70	56.00	4.70	5.00	4.00	5.00	16.00
2022311546	2023/5/7 14:00:43	90.67	54.00	5.00	4.50	5.00	4.17	18.00
2022311555	2023/5/7 15:56:38	90.65	53.00	4.39	4.09	5.00	4.17	20.00
2022311573	2023/5/7 15:56:51	89.55	57.00	4.13	3.33	4.09	5.00	16.00
2022311571	2023/5/7 15:56:30	88.74	54.00	3.57	5.00	4.50	1.67	20.00
2022311557	2023/5/7 15:57:11	88.49	56.00	5.00	2.86	1.88	2.75	20.00
2022311417	2023/5/7 8:00:10	87.81	57.00	3.26	3.75	4.55	1.25	18.00
2022311541	2023/5/7 14:00:50	87.28	57.00	3.94	4.09	1.25	5.00	16.00
2022311572	2023/5/7 15:57:09	86.94	52.00	4.44	4.58	3.75	4.17	18.00
2022311413	2023/5/7 8:03:08	86.40	53.00	5.00	4.55	4.79	3.06	16.00
2022311523	2023/5/7 14:00:38	86.35	51.00	4.85	5.00	4.50	5.00	16.00
2022311567	2023/5/7 15:56:38	86.27	54.00	4.77	5.00	4.50	0.00	18.00
2022311398	2023/5/7 7:59:47	85.74	56.00	3.41	5.00	3.33	0.00	18.00
2022311554	2023/5/7 15:57:06	85.48	52.00	3.26	3.50	4.55	4.17	18.00
2022311440	2023/5/7 9:59:54	84.79	50.00	3.44	3.64	4.38	3.33	20.00

Figure 5: Breakdown of examination results

3.3 Analysis of the current assessment method

The current assessment method strengthens and standardizes the process evaluation, which is conducive to improving students' initiative in the teaching process, effectively urging students to think more and practice more in the learning process, and helping to cultivate students' practical computer operation ability. The current final examination adopts the machine examination mode, which greatly reduces the workload of teachers in issuing and reading papers, and facilitates teachers to have time to do more thinking and reform in teaching contents and methods. The random sampling mode of the machine exam increases the difficulty of students simply taking the test, forcing them to think more and practice more in the usual learning process, which improves their learning effect. In addition, the server-side exported machine test results by each type of topic score breakdown, teachers can analyze the test results to facilitate the next step of teaching methods and approaches to improve.

4. Conclusion

After the reform of teaching contents and methods of university computer foundation courses based on computational thinking and ability cultivation, the assessment methods should be reformed accordingly to adapt to the new teaching; on the other hand, scientific and reasonable assessment methods will in turn promote the teaching reform. Our university started to popularize the university-wide teaching of basic university computer based on computational thinking and ability cultivation from the fall semester of 2022, and adopted this new examination method to assess students, which promoted students' independent inquiry-based learning and improved students' ability to dare to use innovative thinking to solve practical problems, and the reform has achieved initial results.

Based on the current machine examination system, there are still directions for improvement, mainly two points: First, we can increase the construction of the question bank, especially the operation questions, and need to adjust the examination direction according to the current practical application and increase the examination topics; Second, we should improve the adaptability of the examination system, at present, there are still many problems when the students' own computer environment is connected with the server, and later we should improve the adaptability of the examination system to the students' computers. In the future, we should improve the adaptability of the exam system to the students' computers and enhance the flexibility of the students to use their own computers to log in to the server for simulation practice in class.

Acknowledgement

References

[1] Steering Committee for Teaching Computer Courses in Universities of Higher Education. Basic requirements for teaching basic university computer courses [M]. Beijing: Higher Education Publishing House, 2016:32-33.

[2] Huang Yourong, Luo Juan, He Zaihong, et al. Exploration and practice of competency-oriented multidimensional process evaluation of basic university computer courses [J]. Computer Education, 2023, No. 339(03): 51-55+60. DOI:10. 16512/j.cnki.jsjjy.2023.03.039.

[3] Zhou Wei, Xu Hongli, Wang Yizhi et al. Intelligent-empowerment: research and practice of university computer basic laboratory teaching [J]. Computer Education, 2022, No. 328(04):65-69. DOI:10.16512/j.cnki.jsjjy.2022.04.014.

[4] Lu H, Gong Z, Zhao JF. Student-centered hybrid first-class course construction in university computing [J]. Computer Education, 2022, No. 328(04): 124-128. DOI:10. 16512/j.cnki.jsjjy.2022.04. 029.

[5] Zheng Ruoling, Yuan Wei. Exploration of the evolution of the academic examination system in the Republican universities [J]. Modern University Education, 2019(3):55-62.

[6] Yang Tongle, Chen Chunli, Wang Zhenhua, Hou Xinbao. The practice of paperless examination reform for undergraduate computer public courses--China University of Geosciences (Beijing) as an example [J]. China Geological Education, 2020, 29(04):78-81. DOI:10. 16244/j. cnki. 1006-9372. 20201120. 002.

[7] Wang Lu, Guan Haiou, Wang Xue, Yang Dongfeng, Cai Yueqin. The reform and practice of assessment method of "university computer foundation" course [J]. DOI:10.16661/j.cnki.1672-3791. 2209-5042-3062.

[8] Qu LC, Qu YH, Lv Jiao, Wu YAL. Research and practice on evaluation of computer teaching effectiveness with multi-competency training[J]. Computer Education, 2020(07):79-82. DOI: 10. 16512/j.cnki.jsjjy.2020.07.018.

[9] Tian Xianghua, Sen Gan, Li Li. Exploring the reform of formative evaluation of basic university computer courses [J]. Computer Knowledge and Technology, 2019, 15(24):158-159+176. DOI: 10. 14004/j.cnki.ckt.2019.2856.