Teaching Reform of Data Analysis and Visualisation Courses with Focus on Student Development

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Keywords: Student development, data analysis and visualisa-tion, pedagogical reform

Abstract: As one of the important courses for computer science students, the data analysis and visualisation course can teach students how to extract useful knowledge from a large amount of data, find out the implicit useful information, and help them to make efficient decisions. In this paper, we take students' development as a guide in the course content setting stage, and divide the teaching process into three stages: pre-course, learning in the classroom, and post-course development, so as to achieve hybrid online and offline teaching. It stimulates students' interest in learning and enables them to acquire appropriate course knowledge, while reinforcing the qualities of teamwork, academic rigour and lifelong learning.

1. Introduction

The digital age is leading to innovation in concepts and models of education, bringing profound changes to the cultivation of talents and teaching methods in higher education [1]. Therefore, a more integrated, flexible and practical teaching and learning system is needed to develop innovative and practical integrated data analytics talent in the digital age. This paper takes a course on data analysis and visualisation as an example and proposes ideas for reform in terms of teaching content and process with a focus on student development, which can be used as a reference for other similar courses.

2. Current Status

Some universities have experimented with using research or open innovation projects as case studies to drive teaching. Dou [2] built a semi-physical simulation platform for the safety monitoring of moving trains to introduce students to the practical problems of railway information system integration through four experiments. Zhu [3] introduced a content-oriented targeted analysis, jointly conducted by the laboratory and Tencent, to provide more in-depth material for students to think about. On this basis, it was possible to optimise how to update the teaching content with a focus on students' development and facilitate students' exploration of innovative projects [4].

There are also some shortcomings in the teaching of data visualisation courses.

- The course content is multidisciplinary and highly theoretical, so there is no guarantee that students will be able to understand the theory behind the different parts of the course [5,6].
- Machine learning technology has ushered in rapid innovation, but the relevant textbook content is updated slowly, resulting in a lagging situation. In addition, the teaching method generally adopts multimedia, the teacher introduces algorithms, and students passively receive knowledge points, so the teaching means is relatively single, and students' interest in learning cannot be efficiently mobilised.
- The course is mainly assessed by a combination of closed book exams and major course assignments. The closed-book exam is based on the assessment of knowledge points and algorithmic ideas, while the major assignment requires students to complete general data analysis and visualisation cases for the course. The actual needs and development of the students are not taken into account, and the theory and students' ability to apply their knowledge cannot be

incorporated.

3. Ideas for Pedagogical Reform

3.1. Increase the Number of Cross-Curricular Cases Related to the School's Characteristics

In terms of selecting teaching cases, they can be combined with the characteristic disciplines of the school. Taking Shandong Management College as an example, course cases related to trade unions can be appropriately selected to promote the cross-curricular integration of data analysis and visualisation courses with special features [7]. Through cross-curricular cases that reflect the characteristics of the school, it will not only promote students' understanding of the characteristics of the school, but also facilitate students' understanding of the processing process of data analysis and visualisation for practical projects and achieve innovation.

3.2. Curriculum Design Based on Student Interests and Needs

Practical features should be emphasized and students' needs should be the guide. In terms of course design, students are allowed to master the whole process of data mining technology operation from problem identification, method selection, data collection and data cleaning; at the same time, students are encouraged to take the initiative to understand the theoretical knowledge of data analysis and visualisation in depth and improve their practical skills, driven by the needs of technology application, to ensure that the course cultivates students' application exploration ability and plays an important role in solving practical problems.

3.3. Teaching Materials are the Core and the Teaching Reference is the Complement

The combination of paper and electronic versions will be used to build a teaching resource library [8,9], achieving a certain balance between the depth and breadth of teaching content, so that learning has scalability; cutting-edge papers related to the knowledge points of the course will be appropriately recommended to achieve students' understanding of cutting-edge technology or new applications on the basis of completing the learning of course knowledge, and to improve students' basic scientific research skills.

3.4. Optimising Course Assessment Schemes

With the development of technology, there are more and more open challenges in data analysis and visualisation, covering different fields such as finance and healthcare. Students can complete the assessment by participating in the challenges according to their own needs, and can gain a comprehensive understanding of the practical application scenarios of data mining analysis and visualisation techniques. This kind of programme can combine students' individual needs, cultivate their data application and innovation, and improve their overall ability to analyse and solve practical problems. At the same time, the challenge-driven course assessment encourages students to participate in the challenge as a team, which not only ensures that students complete the course assessment, but also develops their sense of teamwork, while ensuring that they understand and master the whole process of data analysis and visualisation operations.

4. The Mixed Mode Teaching Practice with Student Development as the Centre

In the teaching process, we use the university's online teaching platform and Rain Classroom to break the "monophonic" teaching, and the whole process is reasonably designed and guided by a variety of learning resources and learning activities from before, during and after class, from online to offline, and reasonably integrated with each other, with attention to its practicality and flexibility, combining the advantages of face-to-face teaching and online teaching to optimise the teaching process in all aspects, The entire teaching process is divided into four sessions, and all teaching sessions and interactions with students are conducted through the online education platform, Rain Classroom, and Tencent Conference and QQ push. The complete teaching process is shown in Figure 1.

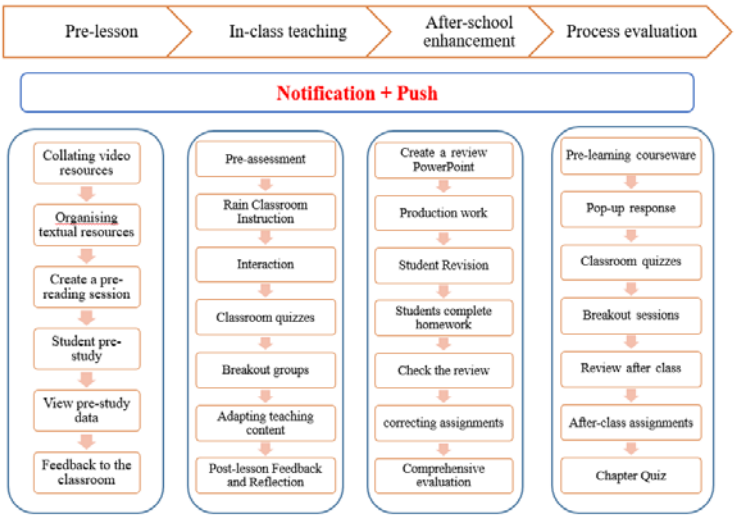

Figure 1 Process of a blended learning model based on an online learning platform

4.1. Pre-Course

In the pre-lesson phase, a pre-lesson PPT is delivered 2 days before the lesson, which includes a review of the lesson, the lesson objectives, a warm-up of the lesson content and relevant videos for students to study and practice. The purpose of this warm-up is to allow students to test their mastery of what they have learned, so that they can identify problems and try to solve them independently or in teams. Unresolved problems will be answered and solved by the teacher in the formal lesson.

4.2. Learning in the Classroom

In class, students are asked to join Rain Classroom by scanning the code and sending the content of this course. In response to the feedback from the pre-course study phase, combined with the key points of knowledge, the intermediate topics that have been pushed in advance of the class are explained and the results with better completion scores are displayed, discussed and shared. Lectures are followed by 1-2 mini-questions designed for real-time interaction so that students can consolidate their new knowledge while keeping up with their learning level and eliminating blind spots in their knowledge, and mini-exams are given in stages to encourage students to review and summarise their knowledge on a chapter-by-chapter basis. Some of the data are shown in Table 1.

Table 1 Live interactive section

Student ID	Interaction Data		
	No. of exercises submitted	Answer rate	Score
200506070227	64	96%	95
200506070236	65	97%	93
200506070235	65	97%	88
200506070210	65	97%	84
200506070238	63	94%	94
200506070217	64	96%	95
200506070223	66	99%	93
200506070204	66	99%	95
200506070218	63	94%	93

To address content monotony, cross-curricular cases related to the characteristics of the school are added to the selection of cases for the course. For example, in Shandong Management College, course cases related to trade unions were appropriately selected to promote the cross-curricular integration of data analysis and visualisation courses with special features such as labour relations analysis and trade union development analysis. Through cross-curricular cases that reflect the

characteristics of the school, it not only promotes students' understanding of the characteristics of the school, but also facilitates students' understanding of the whole process of data analysis and processing for practical projects, and realises school-friendly thinking and education.

Regarding the enrichment of teaching materials, by introducing scientific research projects and academic papers related to the course into the classroom, students can broaden their intellectual horizons and validate or apply what they have learned in the course, thus internalising and gradually improving their independent thinking skills. If a student develops an interest in one of these aspects, he or she can be guided to apply for a University Student Innovation and Entrepreneurship Project by searching relevant literature, designing a reasonable programme topic, screening the best programme, planning the progress, analysing and solving the practical problems that arise, explaining the experimental phenomena that occur, storing the raw data, and processing and collating the data until the academic thesis is written.

4.3. Post-Course Development

After each session, students are given a week to work independently or in teams on more challenging topics. Students are then asked to submit their results and reflections to the online learning platform. In order to understand the students' final mastery, a survey is launched in the QQ group to collect feedback on the difficulty of each question, independent completion and time spent, to understand the students' confusion and lack of understanding.

5. Effectiveness of Teaching and Learning across the Curriculum

In the teaching process, emphasis is placed on the integration of thinking and political education, and blended teaching itself is a form of expression of the integration of thinking and politics in the teaching of the course. Independent study before class cultivates students' self-learning ability, self-discipline and honest attitude to learning; presentations, discussions, exchanges, seminars and other forms in class can stimulate students' interest in learning and cultivate their ability to express themselves as well as their ability to cooperate and learn in groups. The summaries and group extensions at the end of the lesson further develop students' positive and creative awareness and their ability to cooperate and investigate, thus establishing a correct outlook on life, values and world view.

By breaking down traditional teaching content into modules, designing self-study content and discussion topics according to the modules, designing teaching content or learning to apply cases, guiding students to do independent study and group discussion before and after class, identifying problems and analysing them, it helps students to form correct learning attitudes and study habits, and to resist the temptation of online entertainment while making full use of the advantages of the Internet; in the process of learning and discussion, students' teamwork, verbal skills and critical thinking skills are exercised. The class is structured so that the teacher teaches, asks questions, students think and discuss, and gives feedback. Through the teacher's lecture, students are able to grasp professional knowledge, thus overcoming their fear and self-confidence.

By introducing academic papers or research projects into the classroom, students learn both theoretical knowledge and a certain intuitive, three-dimensional understanding of the process of data analysis, mobilising their learning initiative, stimulating enthusiasm for learning, developing research ideas, exercising the ability to synthesise knowledge and solve problems independently, reinforcing the concept of research, and developing students' practical skills and innovative thinking. Through independent study, students are able to expand their knowledge, exercise their self-learning and independent thinking skills, thereby developing their interest in professional studies, increasing their recognition of the profession, and feeling the power of knowledge and the joy of seeking knowledge through study and reflection. Through the analysis and discussion of cases, students are able to learn to apply professional knowledge to solve practical problems and have a down-to-earth, realistic and scientifically rigorous research attitude.

6. Conclusion

This dissertation has achieved student-centred teaching reform in terms of course content and curriculum design, and in the process of implementation it aims to link with the school's distinctive background and disciplines, so that students can learn about the course while increasing their sense of belonging and identification with the school, as well as improving their comprehensive application skills for various disciplines. By incorporating students' individual interests and needs into the design and application of the Data Analysis and Visualisation course, an effective teaching reform plan for the course has been realised, providing a valuable reference for teaching data analysis and visualisation in higher education and a model for other computer science courses to follow.

However, there are also some problems that need to be optimised.

- Learning requires repetition and accumulation, and the design of subsequent class assignments and tasks should be further strengthened to achieve diverse repetition of knowledge and gradual progression, and to promote students' long-term memory of knowledge by allowing them to repeat their knowledge and reinforcing the stimulus.
- Attention to individual differences and teaching according to ability. The course content is not sufficiently extendable and does not support students who have the ability to learn. The follow-up should focus on the accumulation of learning material for students to learn independently.

Acknowledgements

This work was supported by the Shandong Management College School-level Teaching Reform Research Project (Grant Nos. YJG2022-03).

References

[1] Wu M H, Sun J P, Hung J Y, et al. Research on applying digital technology and infusing innovative teaching to courses of business administration education. Frontiers in Artificial Intelligence and Applications, 2015, 275: 15-27.

[2] Dou Bennian, Xu Chungen. Exploring research methodology education in cryptography courses (in Chinese). Computer Education, 2018 (3): 4.

[3] Zhu M, Yao L, Gan QH. Innovative project-driven teaching practices for data visualization courses (in Chinese). Computer Education, 2021 (11): 5.

[4] Holden J, Young A. Innovative teaching practices in computing education (poster session): the TLA project. Acm Sigcse Bulletin, 2001, 33 (3): 174.

[5] Zhang Y, Dong J, Junming W U. Research on Innovative Practice Teaching and Quality Evaluation System for Software Engineering Speciality. International Journal of Advancements in Computing Technology, 2013.

[6] Barco B, S Mendo-Lázaro, E Felipe-Castaño, et al. Team Potency and Cooperative Learning in the University Setting. Revista de Psicodidáctica (English ed.), 2017.

[7] Domik, G. Fostering Collaboration and Self-Motivated Learning: Best Practices in a One-Semester Visualization Course. IEEE Computer Graphics and Applications, 2012, 32 (1): 87-91.

[8] Hao Z. The Study of Teaching Reform for the Data Structure Course. Computer Education, 2011.

[9] Jiang M, Yang H. Research on the teaching reform of information technology courses in big data environment. Computer Era, 2018.