Application and Practice of APT Teaching Model in Teaching Metals and Heat Treatment

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Abstract. The combination of information technology and modern university classroom has become a trend in higher education reform. In this study, APT teaching model is applied to metallurgy and heat treatment courses which is difficult for student to study, advocating "the main learning" information technology teaching philosophy. Taking "Iron and carbon phase diagram" in "Metallography and Heat Treatment" as an example, this paper designs and implements teaching activities based on the APT teaching model, and uses the experimental research method to compare the teaching effects of the APT teaching mode under the traditional and informational environments. The results show that the teaching mode of APT in the information environment has promoted students' interest in the study of metallurgy and heat treatment courses, and their achievements have obviously improved, but also increased the students' learning load.

Keywords: APT teaching model · Metallography and heat treatment · Teaching reform · Multimedia

1 Introduction

Learning how to learn and becoming a lifelong learner is a major mission for education in the 21st century. In the framework of 21st century learning ability proposed by 21st Century Skill Alliance, learners are required to possess the innovative ability, critical thinking and problem solving ability, communication and cooperation ability, self-orientation and individual adaptability needed in the information age. China promulgated the "national long-term education reform and Development Planning (2010–2020) "also emphasizes the importance of promoting the formation of individualized learning methods and mobilizing students to participate actively and autonomously in their studies [1]. In order to cultivate students' learning abilities in the 21st century, autonomous learning, cooperative research and research learning become the three new learning methods in current education reform. However, the traditional classroom teaching methods and conditions can not meet the needs of new learning methods [2–5].

Metallography and heat treatment is a compulsory major course in materials engineering. In material forming and control engineering professional training program of our school, the course schedule involves 48 h (including 10 h), mainly describes the structure and properties of metal materials, the organization and performance control of

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metal materials, steel heat treatment principle and technology and metal materials, etc. This course is a combination course of theory and experiment, informative and comprehensive and practice. Meanwhile, this course is a course to guide students to enter the field of specialization, training students with the ability to apply own innovative ability, which plays a crucial role in the training of personnel in the aspect of materials. In the past, students encountered many problems when they were studying. For example, many new concepts and abstractions were difficult to understand, their knowledge of knowledge was disorderly, and their systematicness and logic were not strong and difficult to remember [6–8] Leading to the beginning of the course can keep up with the majority of students in the course of the beginning of learning difficulties, after the end of the course some students still do not know the main content of this course. Part of the reason are the nature of the course, mainly because students did not pre-learn, did not master the learning methods for this course, there is no self-learning ability; another reason is that teachers did not improve teaching methods according to the characteristics of this course and the status quo of student learning at present. There are teaching methods to improve, teacher-centered classroom teaching only emphasizes the imparting of knowledge, while ignoring the students' ability to accept, and always place the students in a passive position, thus losing their interest in learning the course.

With the rapid development of information technology, it has provided conditions for the development of new learning methods. Promote the "Four Changes" of Teaching Reform in Metallography and Heat Treatment Course through Informatization: ① Transformation from predominance of teaching to learning-oriented ② transformation from a combination of general education to general education and professional education ③ From To classroom teaching mainly to the class, combination of extracurricular ④ From the results of evaluation mainly to the combination of results and process, the heart process evaluation. Effective teaching of information technology support is inseparable from the integration of a variety of factors, such as teaching methods, teaching content, teaching evaluation, technical tools. Teaching methods play an important role in teaching activities.

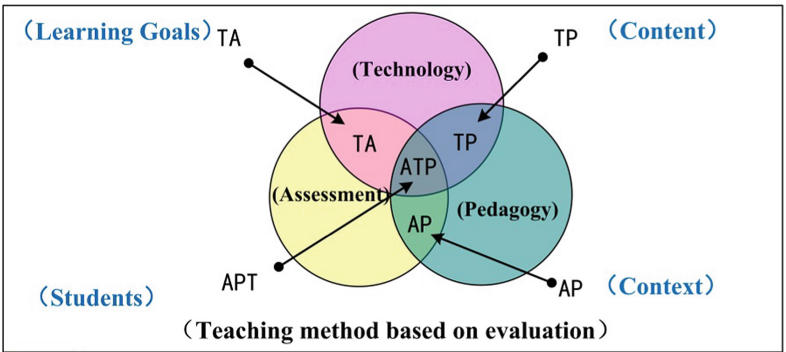
Teaching evaluation and classroom teaching activities are an indivisible organic whole [9]. A single result evaluation can not feedback the teaching process information, and it is difficult for teachers to monitor the dynamic changes of students in the teaching process. Teachers need to use a combination of procedural and evaluation of the results of a wide range of evaluation tools to fully examine the learning process of students for the regulation and improvement of classroom teaching. Fareed found that using instant evaluation methods such as Clicker interactive tools can enhance the interaction between teachers and students to facilitate the timely adjustment of teaching activities [10] TPACK theoretical framework proposed by Koegler and Mishra, emphasize the pedagogy, technology and disciplines The important role of content in the effective integration of information technology and teaching [11]. As early as 1998, Black & William pointed out that evaluation can effectively support learning, actively involve students in the evaluation process, and make students learn more actively. Focus on immediate assessment of classroom teachers can cultivate and stimulate student learning enthusiasm and self-confidence.

Thus, technology, teaching method and evaluation are three indispensable elements in teaching. Classroom teaching evaluation is an important part of classroom teaching

and is based on quantitative or qualitative description of value judgments. The scientific evaluation system is an important guarantee to achieve the goal of the course. Teaching methods play an important role in the process of teaching activities, but also are key factors affecting the teaching quality.

2 APT Teaching Model Based on Evaluation

Learning activities based on ability cultivation in the 21st century are important components in cultivating students' ability of critical thinking and problem solving, effective communication, collaboration and innovation. Students who become qualified in the 21st century are currently educated major mission. Effective teaching in the information environment can not be separated from the depth integration of evaluation, teaching methods and information technology. As shown in Fig. 1, APT teaching model highlights the importance of teaching evaluation [12–15], advocating information-based teaching students under the environment, the openness of teaching space.



A	Diagnostic evaluation, formative evaluation, summative evaluation; self-evaluation,
B	Cooperative Learning, Mobile Learning, PBL Teaching, Inquiry Learning
T	Padlet、Educreation、QQ、Mind Vector、iMovie……
TA	Based on instant evaluation of the questionnaire star, iBooks e-book based
TP	Independent collaborative learning based on iPad ...
AP	Based on the peer-to-peer inquiry learning, Autonomous learning based on instant assessment……
APT	Peer-to-peer peer review based on Padlet in collaborative learning……

Fig. 1. ATP teaching model

As shown in Fig. 1, the model advocates the design of a scientific and multi-dimensional evaluation system based on in-depth analysis of the characteristics of learners and the content of teaching contents. It not only pays great attention to summative evaluation but also pays more attention to procedural evaluation. After the evaluation, the comprehensive use of tests, gage, teacher observation, learning contract, real-time evaluation, electronic portfolio, peer assessment and other evaluation tools; Meanwhile, a variety of teaching should be carried out under the information environment, including task-driven Type teaching, research teaching, connected teaching, guided teaching, game teaching, role play, collaborative learning and other teaching methods; make full use of a variety of hardware and software tools, such as whiteboard, electronic double board, iPad and other hardware Environment, and forums, concept maps, office tools, e-mail and APP software. Through the scientific and reasonable integration of evaluation methods, teaching methods and technical tools, students are transformed into independent, cooperative, inquiry and ubiquitous learning styles to create Efficient classroom teaching, students' knowledge acquisition, sharing, construction, innovation ability, promotion Health innovation and cooperation and active learning ability.

3 Innovative Teaching of APT Teaching Model to Promote Students' Deep Learning

《2017 New Media Alliance China Higher Education Technology Outlook: Horizon Project Regional Report》 predicts one of 9 key trends in China's higher education technology adoption over the next five years: the shift from higher education to deep learning. The Deep Learning Project (SDL), conducted by the William and Flora Hewlett Foundation in cooperation with the U.S. Institute, divides deep learning into three dimensions: cognitive area, interpersonal field personal and personal area (Table 1).

Table 1. The alpha-coefficient of the questionnaire.

Cognitive area	Master core discipline knowledge
	Critical thinking and complex problem solving
Interpersonal field	Teamwork
	Communicate effectively
Personal area	Learn to learn
	Learn perseverance

Deep learning, as opposed to surface learning, aims to develop students' higher-order thinking skills and to guide students to finish the changes from surface learning such as memorization, understanding and application to deep cognitive process, such as analysis, evaluation and creation, etc. And train students critical thinking, innovative ability, problem solving ability, improve students' interest and motivation, investment,

etc., and promote students' learning in the field of cognitive, ability and emotional attitude, As shown in Fig. 2.

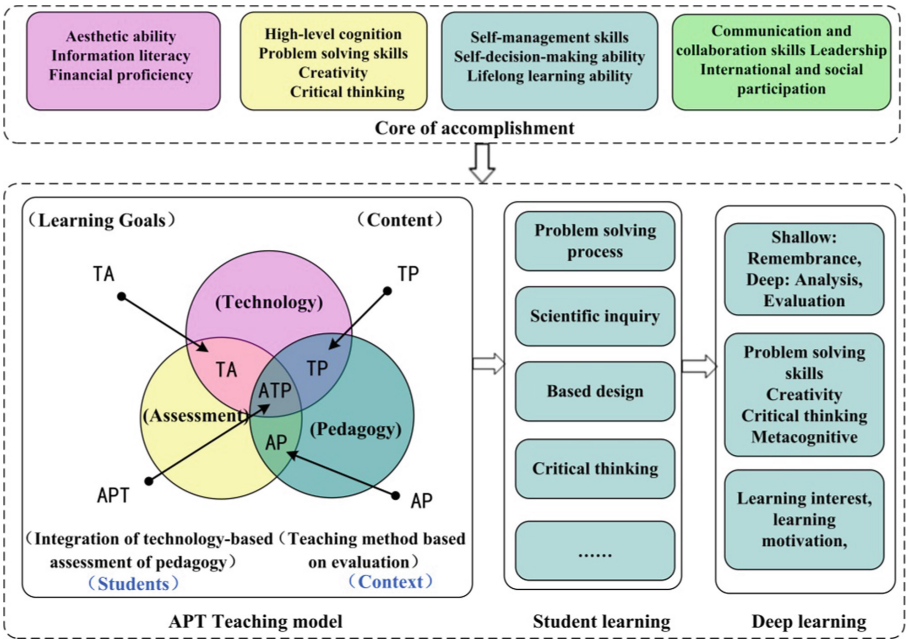


Fig. 2. APT promote student learning in depth model

4 Application of ATP Teaching Model in Metallography and Heat Treatment Courses

Based on "Questionnaire Star", Knowledge Construction Worksheet, "Micro-aided Teaching" Learning Platform and Clicker Feedback Tool, taken the phase diagram of "iron and carbon alloy phase diagram" in the course of "Metals and Heat Treatment" for example, the teaching process consists of three parts: Pre-class learning, classroom teaching and after-school reflection, teaching design.

4.1 Study Before Class

Pre-lesson learning begins with the analysis of learner characteristics. Teachers use the Questionnaire star to upload a questionnaire and analyze basic knowledge of the students, available knowledge, motivation, learning style and so on. According to the characteristics of students' study and the contents of this chapter, teachers design the pre-course list of "Iron-carbon alloy phase diagram" together with learning resources and upload them to the "Micro-teaching and Learning" platform resource section. Students prepare and submit homework according to the pre- Students preview the situation, at the same time, teachers guide students to ask questions through the forum

of platform and collect prevalent teaching problems. Before class, middle school students choose research topics in the form of small groups, put forward their research goals and problems, and finally write research programs. In this process, teachers through the network platform and the learning groups are closely linked, and upload the evaluation plan of iron carbon alloy phase diagram learning program for learners to reference. The specific design of pre-class learning is shown in Table 2.

Table 2. Learning design before class

Teacher activities	Student Activities	Evaluation method	Teaching method	Technical tools
Upload "learning status quo" questionnaire	Complete the questionnaire	Questionnaire analysis		"Questionnaire Star"
Upload "iron carbon alloy phase diagram" pre-order and materials		Job evaluation		"Micro-teaching aid" platform
Guide students in discussion forums to preview doubts	Ask questions	Forum interaction		"Micro-teaching aid" platform
Instruct various groups to choose research tasks, design iron carbon phase diagram research programs, and upload evaluation rules	In the group as a unit, the design method of iron and carbon-phase drawing method, analysis of iron-carbon alloy crystallization process		Research teaching, Cooperative learning	"Micro-teaching aid" platform

(1) Study guide

① Project Title: Iron-carbon alloy phase diagram.
② Achieve the goal: complete the task of "independent learning task list" to master the iron carbon alloy phase diagram by watching the teaching video, reading teaching materials, analysis of given learning materials, Learning Methods and Recommendations:
③ Learning method and suggestion: Learn iron carbon alloy phase diagram based on three basic phase diagrams; It is suggested that the basic phase and phase diagrams of iron-carbon alloys be understood in connection with allotropic transformation.
④ Classroom learning form notice: a, analysis of the typical iron-carbon alloy crystallization process in the group; communicate painting techniques of Iron carbon alloy phase diagram with each other in the group. b, class promotion

job (paint iron carbon alloy phase diagram without any reference). c, by consulting the literature data, each group summed up the application of a carbon-carbon alloy in the class exchange.

(2) Learning tasks: answer the following questions

① What are the basic iron-carbon alloy phase?
② What are the basic organization of iron-carbon alloy? What is the relationship with the basic phase?
③ How to build Iron-carbon alloy phase diagram? How many steps?
④ What is the relationship between allotropic transformation of pure iron and the basic phase of iron-carbon alloy?

(3) Confusion and advice: This content is filled out by the students after their own study.
Learning resources include textbooks, reference books, essays, video resources, teaching video which is the focus of learning resources. Teaching video production process includes analysis of teaching objects and capabilities, finishing courseware, pictures, audio, video files and production of the script, marked each segment of the video presentation, production and distribution of video, according to the views and suggestions of students to modify the teaching video.

4.2 Classroom Teaching

APT teaching model advocates a student-centered teaching of this class starting from the teaching, and gradually into the teaching content. The teacher presents the learner with the problems in the preview in the order of the teaching contents. The students discuss and answer the questions. The teacher determines the next teaching activity based on the answer. After the explanation of the problem is completed, the teacher throws different kinds of practical engineering application cases to guide the students to respond. Finally, the teacher organizes the students to report the work done in the pre-class study (reflected in the work of knowledge construction) as a group and organize the students to evaluate each other. Evaluation and promotion are advocated in this teaching.

4.3 Reflections After Class

After class teaching, teachers guide students to self-reflection, and write a reflection report submitted to the "micro-teaching aid" platform. Finally, based on student electronic files, the group reported the situation and student testing, teachers analyze the teaching effectiveness and reflect classroom teaching.

5 Application of ATP Teaching Model in Metallography and Heat Treatment Courses

(1) Under the teaching environment based on APT teaching model, there is a significant difference between students' academic performance and the traditional multimedia classroom. Before the beginning of the class teaching, in order to

ensure that students in the control and experimental groups had the same level of competency, teachers conducted a pretest of students in both classes. After the implementation of the teaching, teachers once again post-test students to compare the two grades of students' academic performance changes. And through the independent sample T test in SPSS, the two classes were analyzed whether there are significant differences before and after the test results, the specific results are shown in Table 3.

Table 3. Comparison of the results of the study

Variable	Group	Student class	Sample size	Average value	Standard deviation	t值
Front side	Test group	Material 1 class	58	7.51	1.61	1.52
	Control group	Material 2 classes	55	7.92	1.97	
Back side	Test group	Material 1 class	58	8.71	1.34	3.11
	Control group	Material 2 classes	55	7.87	1.96	

As shown in Table 3, in the front-test sectin, the average scores of students in experimental group and control group were 7.51 and 7.92 respectively, and the standard deviations were 1.61 and 1.97. The P-value of significance test of two independent samples was greater than 0.05, indicating that there are no significant differences between classes. In the post-test section, the average scores of students in experimental group and control group were 8.71 and 7.87 respectively, the standard deviations were 1.34 and 1.96. The significant P-value of T test in independent samples was less than 0.01, indicating that there were significant differences between the two classes, And the average score of experimental group are higher than the control group and the degree of dispersion is lower than that of the control group. That is, the learning effect of the experimental group is obviously better than that of the control group.

(2) The experimental group had higher cognitive load than the control group, and the appropriate cognitive load was beneficial to the improvement of students' academic performance.

Cognitive load is related to the way in which human beings solve their learning goals through their cognitive framework during the learning process. The cognitive load is measured from the two dimensions of mental stress and mental effort. The mental stress is related to the cognitive load caused by the amount of information presented to the students at the same time. Teaching based on APT may have an impact on students'cognitive load, However, a larger cognitive load is conducive to improving students' academic performance to a certain extent.

6 Research Conclusions and Discussion

Applying the teaching model of APT to the teaching of metallurgy and heat treatment under the mobile environment, this paper designs a teaching mode based on the teaching model of "Iron and Carbon" and compares the classroom teaching results by experimental teaching method with based on the APT Teaching model of classroom teaching results, the conclusions are as follows:

(1) Students in the mobile environment based on the APT teaching model have better academic performance than traditional multimedia environments. The comparison between pre-test and post-test shows that the average of pretest scores of experimental group (based on APT teaching model in mobile environment) is slightly lower than that of control group, and the standard deviation is slightly higher than that of control group. By the independent sample T test, There is no significant difference between the two groups and the level between two groups can be considered equivalent; by analyzing the test results found that the independent sample T test significant probability of less than 0.01, indicating significant differences between the two groups, and the experimental group was significantly better than the control group.
(2) The cognitive load of students based on APT teaching model in mobile environment is higher than that of traditional multimedia environment, but in a certain range, higher cognitive load is beneficial to the improvement of students' academic performance.

The research is still in the exploratory stage. There are still some problems in the teaching process of teachers under the APT environment, such as technical operation, classroom time control and teaching activities organization. The questionnaire data did not achieve the expected results. The practice of research has a preliminary validation of the "evaluation to promote learning" effectiveness. In the future teaching, how to further improve the integration of teaching evaluation, teaching methods and information technology, integrate the application of diverse teaching resources, and really return the class to the students still need further exploration and reflection.

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