

Mining Classroom Observation Data for Understanding Teachers' Technological Pedagogical Content Knowledge Structure

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Abstract

On the basis of teachers' pedagogical content knowledge proposed by Shulman, Koehler and Mishra explicitly put forward technological pedagogical content knowledge (TPACK) framework. The study shows that TPACK is a necessary knowledge for teachers to use technology for carrying effective teaching (Koehler & Mishra, 2005). It has been found that technological pedagogical knowledge (TPK) has a significant influence on TPACK structure of pre-service teachers (Zhang, 2015). This paper mainly explores the teaching structure of classroom and the TPK structure presented by teachers. Based on the existing video analysis and coding system, this study adapted and revised a curriculum teaching code table. Methods of quantitative and qualitative combination and comparative analysis are used to explore four aspects: teaching links, students' expected cognitive level, teaching media and TPK. This study uses the classroom video analysis method to make a comparative analysis of short teaching video of award-winning teachers and non award-winning teachers in a competition and explores the influence of teaching activities and TPK structure of teachers on teaching effect. The statistical analysis of the results showed that the teaching link, the teaching media, and the student's expected cognitive level have no significant

effect on the teaching effect, and TPK has a significant impact on the teaching effect.

Key words: Classroom teaching video; Video analysis; TPACK; TPK; Teaching evaluation

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INTRODUCTION

The integration of information technology into curriculum of all subjects in primary and secondary schools is the fundamental way to deepen reform of subject teaching. Moreover, the focus of educational reform lies in the reform of teaching structure. He pointed out that the teaching structure directly reflects what kind of educational thought and theory teachers will use in their class to organize their teaching activities process. Therefore, it is concentrated expression of educational thought, teaching theory and learning theory (He, 2007). At the same time, he pointed out the systematic method of studying teaching structure. Modern teaching environment is an organic whole formed by four elements of teachers, students, teaching materials and teaching media, which are interrelated and interact with each other (He, 2005). To analyze teaching structure integrated with information technology, we must analyze four elements how to interact each other firstly. Then further analyze the stable structure of teaching process formed by interaction of four elements (Yu, 2003). In recent years, this research paradigm has been widely used and recognized. Shimizu and Horita have conducted a series of studies on the use of information technology in classroom. They studied links and functions of frequency, timing and background

relevance in use of information technology in classroom, and studied the stable form in teaching of similar teaching structures, instead of paying attention to traditional teaching model (Shimizu, 2008; Horita, 2008). On the basis of study of He, Zhang and Wang proposed a research method framework based on classroom video analysis method and carried out an empirical study on information technology integration teaching structure based on traditional classroom behavior method, classroom video analysis method and teaching media classification method (Zhang et al., 2010).

The deep integration of information technology and classroom puts forward new requirements for teachers' abilities. In 1986, Shulman proposed the concept of pedagogical content knowledge (PCK) on the basis of reflection on teacher knowledge (Shulman, 1986). Based on this, Mishra and Koehler clearly put forward TPACK framework. In their study, TPACK is a necessary knowledge for teachers to use technology for effective teaching (Koehler & Mishra, 2016). And they elaborated on seven elements of TPACK framework. TPACK framework includes three core elements of content knowledge (CK), pedagogical knowledge (PK) and technology knowledge (TK), as well as four complex elements that interact with three core elements above-pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK) and technological pedagogical content knowledge (TPACK). Among them, TPACK is the knowledge of three core elements interacting with each other and higher than three core elements (Koehler & Mishra, 2016). Cox proposed a refined framework for TPACK framework based on interviewing with Mishra, Koehler, and others and summarized the current definition of TPACK framework (Cox, 2008). Zhang investigated 384 pre-service teachers in a normal university in China using structural equation model analysis method. It is concluded that in TPACK structure of pre-service teachers, the single element has a positive impact on TPACK through compound element, of which the technological pedagogical knowledge (TPK) has the most significant influence (Zhang, 2015).

Measurement methods of TPACK include self-assessment scale test, open questionnaire survey, interview method, observation method, etc. (Xu, 2013). In addition, structural equation modeling, video analysis and discourse analysis can also be used to assist research. Researchers can also use structural equation model to explore relationship between structure and quantity of variables in TPACK structure. Using video analysis or discourse analysis to explore the structure and characteristics of teachers' TPACK deeply by study of coding and quantization.

Classroom video analysis provides new methods and techniques for obtaining data and improving the empirical level of research for the study of teaching and learning processes and their near causes. Classroom video

analysis method helps solve the problem that traditional classroom research method ignore study teaching process. This method records the classroom teaching process and then analyzes recorded video and transcribed text. Due to the development of modern information technology, video recording, storage, playback and analysis have become technically easy to implement, so that the process and scene of classroom teaching can be recorded and reproduced. If previous research methods can tell us what factors have been affected and what methods are effective, classroom video analysis can further explain how these factors or methods are affected and how it works.

The most influential analysis systems for analysis of classroom behavior include classroom interactive behavior analysis system developed by Flanders (FIAC system) (Flanders, 1970), Bellack's classroom teaching analysis (Bellack, 1966), Cazden's classroom sociolinguistic analysis (Cazden, 2001), Mehan's classroom conversation analysis (Mehan, 1979), and Mio's video analysis system in class (Mio, 1997). By classifying and quantifying the interaction between teachers and students in class, this kind of method provides a set of effective analysis methods by analyzing frequency, duration and migration path of various types of behavior, and scientifically analyzing the teaching process. In 2010, Zhang and Wang proposed a research method framework based on classroom video analysis and a code table of classroom behavior and teaching media. They are proposed based on classroom interactive behavior system represented by FIAC and teaching media classification method of Laruilaurd. According to the coding table, Zhang developed a classroom analysis record form. (Zhang et al., 2010).

Educational data mining methods study how to effectively use the data in the education system. Excavating and analyzing educational data in the classroom teaching process to better understand the teaching process. The classroom video analysis method can record and save the real-time classroom teaching, which is convenient for mining and analyzing useful and objective information in the classroom.

Therefore, based on video analysis method, this study analyzes classroom structure by analyzing short teaching videos of multiple teachers from multiple disciplines, and analyzes the classroom structure, studies teacher's behavior and knowledge structure, and deeply explores the factors that affect the teaching effect. In order to develop a teacher evaluation system based on data and conclusions.

1. METHODOLOGY

1.1 Participants and Methods

Teaching videos used in this study is collected from MOOC Center of East China Normal University. These videos come from a teaching video match and include award-winning videos and non award-winning videos.

This study adopts method of random sampling to select short teaching video of high school courses, including 7 series of award-winning courses in liberal arts courses (WH), 7 series of non award-winning courses in liberal arts courses (WW), 10 series of science award-winning courses (LH) and 10 series of science non award-winning courses (LW). Among them, arts courses include Chinese, English, politics, history and geography, and science courses include mathematics, physics, biology and chemistry.

This study recorded and encoded teaching behaviors of teachers in selected courses by means of video analysis. In analysis process, we used Windows Media Player to play courses video and used WPS form to record data. In process of sample analysis, winning information of samples was concealed, and samples were repeatedly observed and recorded. In order to avoid subjective attitude of researchers affecting the scientific of data collection and recording in process of sample analysis, this study covered award information of samples. In order to ensure reliability and validity of study, all samples are coded three times. This study made the data preliminary sorting and converting, deleted invalid data, gathered statistics on the coding of each dimension, and visualized the data by WPS and E-charts.

1.2 Experimental Instrument

This study formed a TPK perspective teaching coding table. This table refers to classification codes of classroom behavior and instructional media proposed by Zhang, Wang and He (Zhang et al., 2010), and combined with Bloom ‘s cognitive taxonomy (Anderson, 2001) to marked the student expected cognitive level and designed the teaching video record form.

**Table 2
 Teaching Video Recording Form**

Continuous unit serial number	Length of time	Codes of teaching links	Codes of teaching media	Codes of TPK	Remarks
Series courses N					

2. RESULTS AND DISCUSSION

This part organizes and visualizes the collected data, and analyzes the influence of four factors of teaching process, student’s expected cognitive level, teaching media and teacher TPK on teaching results.

In this section, WH stands for award-winning teaching videos in liberal arts, WW stands for non award-winning teaching videos in liberal arts, LH stands for award-winning teaching videos in science and LW stands for non award-winning teaching videos in science.

2.1 Comparison and Analysis of Teaching Process, Student’s Expected Cognitive Level and Teaching Media

According to the experimental data, the following analysis results are obtained.

In the teaching link, arts and science courses are both taught by new courses mainly. The total frequency and

**Table 1
 Teaching Coding Table From TPK Perspective**

Dimension	Classification code	Classification content
Teaching process	1	Teaching introduction
	2	New course teaching
	3	Consolidation & practice
	4	Summary & upgrade
Student expected cognitive level	R	Remember
	U	Understand
	Ap	Apply
	An	Analyze
	E	Evaluate
	C	Create
	NC	No above state
	TL	Traditional declarative media
	TI	Traditional interactive media
	TP	Traditional productive media
Teaching media	IL	Information technology support for declarative media
	II	Information technology supports for interactive media
	IC	Information technology support for communication media
	IA	Information technology support for alterable media
	IP	Information technology supports for productive media
	verbal	Teacher language teaching
	TK	Technology Knowledge
	PK	Pedagogical Knowledge
	TPK	Technological Pedagogical Knowledge
	N-obvious	No TK, PK and TK presented

duration of teaching introduction, consolidation exercises and summary promotion links are about 30%. There is no significant difference in the distribution of time between the texts and science award-winning groups and the non-winning groups coaches in each teaching session.

In the student’s expected cognitive level, proportion of duration and frequency of student expected level of cognition in award-winning courses and the non-winning courses is uniform. The student’s expected cognitive level has no direct impact on the effectiveness of the course.

In the teaching media usage dimension, due to differences in the nature of disciplines, liberal art courses have fewer types of teaching media than science courses. And in four groups of courses, IL is the main type of teaching media using in class. The teaching units coded “verbal” in award-winning group courses are lower than the non-winning group.

2.2 Comparison and Analysis of TPK Structure

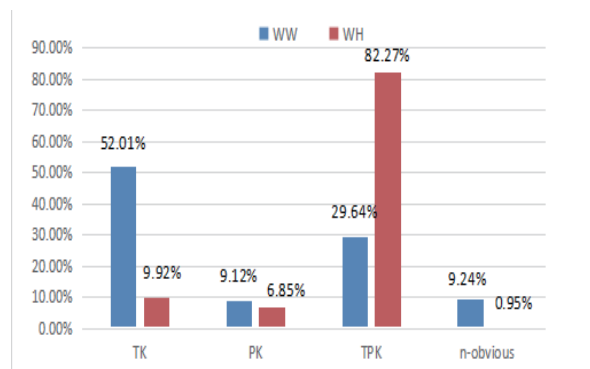
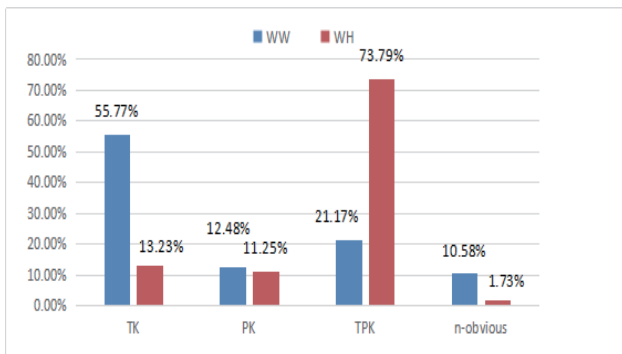


Figure 1 Frequency (left) and duration (right) ratio of TPK elements for histogram in WH /WW group

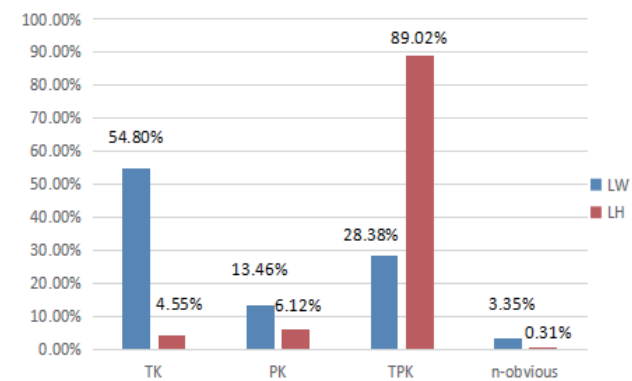
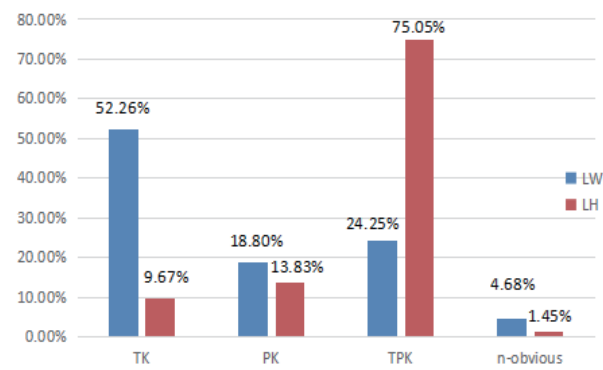


Figure 2 Frequency (left) and duration (right) ratio of TPK elements for histogram in LH /LW group

The data comparison between four groups courses shows that there is no significant difference between WH and WW, LH and LW group courses in occupation ratio and type of PK. Performance of teachers of WH and LH group courses is superior to that of WW and LW group courses in comprehensive application of TK, PK and TPK. Teachers of WH and LH group is more effective in integrating TK and PK. Teachers in WW and LW group courses have abundant TK, but their understanding of mutual support, support and restriction between technology and teaching and learning is low. They also fail to integrate TK and PK, so that the external performance is not ideal.

To sum up, award-winning group courses are similar in frequency and duration of TPK elements, teachers of this group have a deeper understanding of how teaching and learning are changed due to the use of specific techniques. While WW and LW courses are also consistent with frequency of each element of LW group. Because teachers fail to fully understand the role of technology in teaching and learning, TK and PK is scattered, and the frequency ratio of TPK shows a low level and is lower than 30%. Therefore, the ability of integration of TK and PK is an important indicator of teaching effectiveness, and has nothing to do with nature of subject.

2.3 Comparison and Analysis of Correlation Between Teaching Links and TPK Elements

2.3.1 Correlation Analysis Between Teaching Links of Liberal Arts Courses and TPK Elements

Analyze the Figure 3 and notes from experiment we can know:

- In group WH, data comparison shows that WH group courses integrate TK and PK better, so frequencies of dispersive TK and PK account for less. The formation of TK and PK is seriously dispersed in each teaching unit. WH group has a better teaching effect compared with WW group.

- In new course teaching link, TK and TPK show sharp data comparison in WH and WW group. Teachers of group WH are good at using technology to promote PK, so as to achieve higher teaching results and make their teaching content easy to understand for students.

- In consolidation & practice link, according to data and note information obtained from coding, the summary evaluation of technical support is coded as TPK, which shows that teachers use techniques to present exercises and guide students to think and explain mistakes and miscible point by combining with new and old content to get good consolidation practice effect. The link coded as TK is most for teachers to present exercises and to give

direct answers or without any feedback. Thus reducing enthusiasm of students and unable to achieved anticipate results. Teaching units of two groups courses marked as “PK” are show as explanation of teaching process mostly. Teaching units that “n-obvious” marked are blank pages between exercises more.

- In summary & upgrade link, two groups courses

show higher proportion of TPK. WW group courses also contain certain proportion of TK and PK that are scattered in various teaching links. Teaching links represented by “n-obvious” also occupy a proportion of up to 14.29%. Therefore, there are differences in integration of technology and teaching ability between two groups courses in this link.

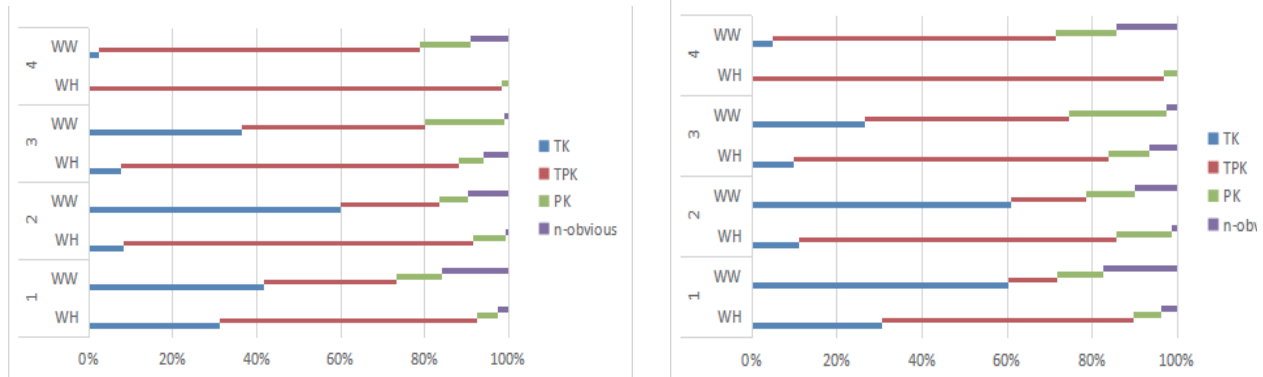


Figure 3
 Frequency (left) and duration (right) ratio chart of TPK elements in each teaching link in WH/WW group

2.3.2 Correlation Analysis Between Teaching Links of Science Courses and TPK Elements

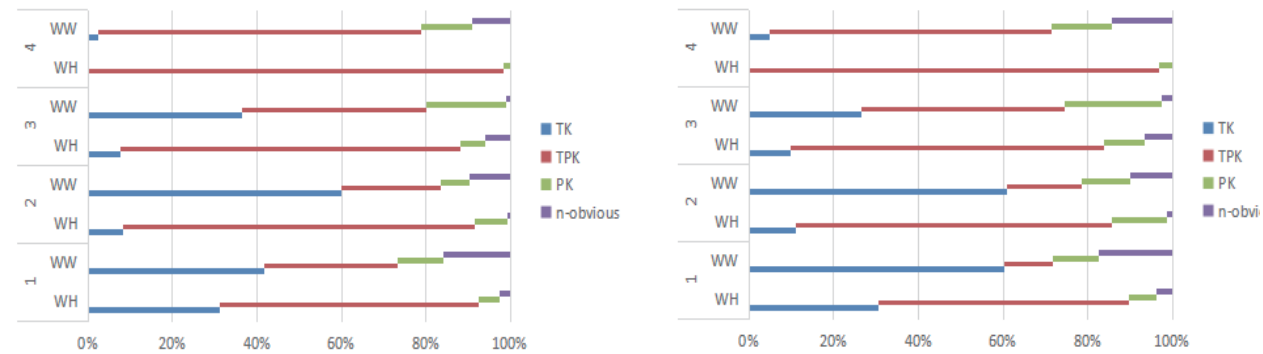


Figure 4
 Frequency (left) and duration (right) ratio chart of TPK elements in each teaching link in LH /LW group

Analyze the Figure 4 we can know:

- In teaching introduction link, integration of TK and PK of LH group courses is good. So their teaching effectiveness is well.
- In new course teaching link, frequency and duration of TPK of LH group courses is far higher than LW group. There was significant difference in integration of TK and PK between two groups. External performance of group LH course is better than that of group LW.
- In consolidation & practice link, according to note information obtained from coding, group LH courses often use technology to present discussion questions, think questions, or instruct students to complete experimental reports, organization charts, and show them in the next class. The ratio of TPK frequency is up to 90%. LW group courses often present exercises through power point, and give answers directly or have no answer. So LW group courses show high degree of dispersion of TK and PK under the data.

- In the summary & upgrade link, TPK ratio in group LW is slightly lower, but in this link, the level of integration is higher.

To sum up, there are significant differences in TPK elements of three teaching links between award-winning group and non award-winning group in teaching introduction link, new courses teaching link and consolidation & practice link, and there is no significant difference in summary & upgrade link. Combined with note information from coding, we can see that summary & upgrade link of each course can enhance effect of summarizing contents.

2.4 Comparison and Analysis of Correlation Between Students' Expected Cognitive Level and TPK Elements

This section will explore whether TPK's support for students' expected cognitive level is one of the factor that affect teaching effect.

2.4.1 Correlation Analysis Between Expected Cognitive Level and Frequency and Duration of TPK Elements in Liberal Arts Courses

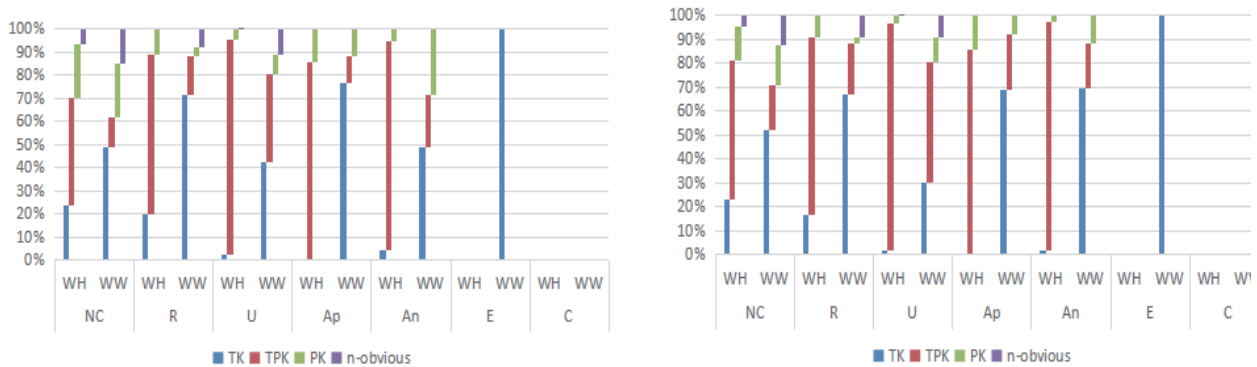


Figure 5 Frequency (left) and duration (right) ratio chart of TPK elements and student expected cognitive level in WH / WW group

The horizontal axis from left to right indicates that two groups of WH and WW courses' seven cognitive levels: have no cognitive (NC), remember (R), understand (U), apply (Ap), analyze (An), evaluate (E), and create (E). The longitudinal axis indicates the support of TPK elements at each cognitive level.

Analyze the above chart we can know:

- "NC" represents a teaching unit without complex cognition. The cognitive level is commonly seen in teaching introduction link, transition between various teaching links, and playing of sound, video and pictures in new course teaching link. Teachers of WH group courses have a deep understanding of how technology supported teaching, could concentrate attention, arouse students' interest in learning and avoid dull sense. WW group courses fail to integrate TK and PK and lead to low teaching efficiency. The application rate of TK, PK and TPK in WH group is higher than that in WW group.

- "R" stands for remembering. It is often used to declarative knowledge such as memorizing concepts, methods, procedures and rules in consolidation & practice link and new course teaching link. WH group courses have high integration of TK and PK. It supports learners' adjustment of knowledge structure by means of contrast, theory and examples. WW group courses have less PK in this level. It is found that WW group courses present declarative knowledge presented by technology and teacher language statement mostly, and it is seldom explained with PK.

- "U" means understanding. It often shows as explaining examples, instances, concepts and principles, and generalize conclusions or rules for teachers. The positive influence of technology on implementation of teaching helps learners to form ability to describe, explain, choose, distinguish, induce, illustrate and enumerate the above knowledge materials in LH. In two group, PK scattered in the teaching links is not integrated with

TK, which helps learners to understand the knowledge materials, but lacks intuitive experience. TK that WW group course does not integrate with PK is mostly example of Power Point presentation, but there is no explanation. In this cognitive level, teachers of group WH can make full use of TPK element in course teaching.

- "Ap" means applying. It is mainly applied to phrases and grammatical sentences, application method steps and analysis materials. WH group courses have integrated TK and PK better. And it has significant effect in guiding students to apply it to actual life. In group WW, the frequency of TK accounts for 76.47%. When power point presents application examples of words and grammar, teachers do not explain them with PK and read instance in language. This situation is not easy for students to use their knowledge flexibly.

- "An" means analyzing, which is commonly seen in consolidation & practice link and new course teaching link. Profound understanding of WH group teachers for technical support learning evaluation makes WH group courses achieve favorable effect in evaluation level. In depth analysis of note information, WH group courses are mostly used to present exercises with technology, but behaviors of giving answers directly or giving no feedback lead to lower evaluation results. PK of WW group dispersed in teaching links is higher. Explanation is easily influenced by teachers' language clarity, language speed and degree of knowledge abstraction, causing cognitive burden of students. In this cognitive level, two groups of courses made full use of TPK elements.

- "E" means evaluating. This cognitive level is only involved in WW group courses. Combined with note information, the cognitive level is presented as presenting examples with technology, and reading reference answers by teacher. They all not combined with PK to explain.

- The creating cognitive level represented by "C" is not involved in WH and WW group.

2.4.2 Correlation Analysis Between Expected Cognitive Level and Frequency and Duration of TPK Elements in Science Courses

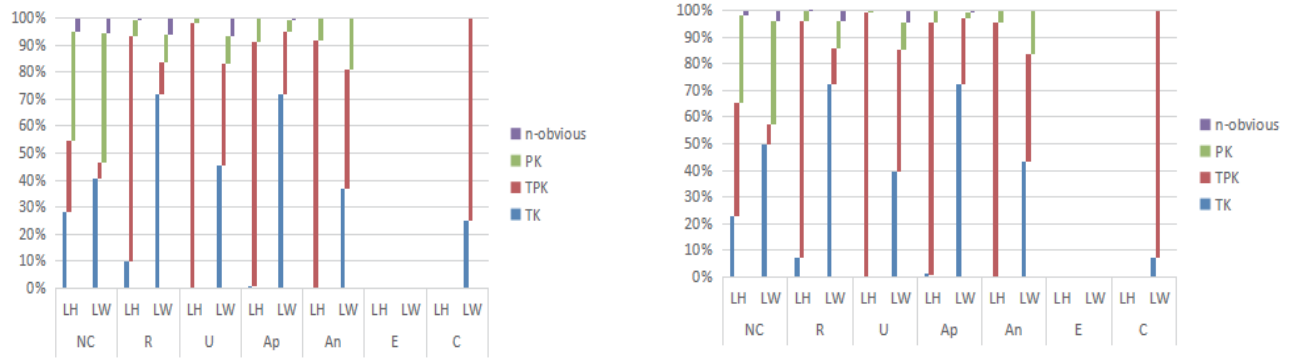


Figure 6 Frequency (left) and duration (right) ratio chart of TPK elements and student expected cognitive level in WH/WW group

Analyze the above chart we can know that frequency and duration of TPK in LH group is higher, and WW group have higher frequency and duration of PK and TK.

- In cognitive level of “NC”, science courses often include informing subject of course or teaching objectives, teacher greetings, situation introduction, presenting examples and multimedia, teacher language instruction, and transition language between various teaching units. It can be seen that LH group can effectively use TK to support realization of teaching in above teaching units, and thus have good results in teaching effect. In LW group courses, duration of TK and teaching link without TPK element is longer than that of LH group.

- Cognitive level of “R” is common in review and explanation of concepts, rules, principles, characteristics, classifications, formulas in science courses. LH group courses could effectively integrate TK and PK to provide learners with a visual and easy declarative knowledge to understand. Combine with note information, LW group courses tend to provide technical support for presentation of above declarative knowledge without explanation of PK, which leads to failure of students to integrate memorized knowledge into existing knowledge structure in time. Teachers of two groups make full use of TK, PK and TPK.

- Understanding level in science courses is often present in new course teaching link, consolidation & practice link and summary & upgrade link. In LH group courses, TPK is fully utilized to promote learners to understand course content. In PK, it shows that teachers achieve the goal of understanding the content of the course through language explanation in LH. LW group courses show short transition segments between various teaching links, playing a role in arousing learners’ thinking or learning interest. Frequency and duration of dispersed TK are higher, and the feedback information of consolidation exercises is less or no.

- The applying level is often related to design, process and operation of experiments or surveys in science courses and so on. LH group courses often use IA to record

and explain experimental scene, or to develop learners’ mathematical thinking or emphasis on experimental attention with IL. While in LW group courses, this level corresponds to the experimental scene recording, and the result is not good for subjects or contents without experiment. In LH and LW group courses, teaching units in LW group courses are explanation of experiment process and phenomenon in language, without corresponding technical support. In group LW, there are massive TK dispersed in each teaching link. The main performance is the investigation or experimental procedure, process and method presented by Power Point reading by teachers. In this level, group LH and group LW have applied TPK fully.

- The analyzing level exists in teaching introduction link, new course teaching link and consolidation & practice link. High frequency and duration of TPK in LH group courses shows that teachers guide students to give feedback in time to combine course content or actual life. In PK, LH group courses are mostly for teacher language to guide learners to think or to instruct learners to watch video combined with problems. LW group courses are mostly transitional language or teaching instruction, and the degree of integration with TK is low. In group LH, TK and PK are highly integrated in this cognitive level. There are more TK in LW group courses, which present exercises and brief answers for power point mostly. Two groups of courses apply TPK fully.

- Group LH and LW courses do not involve cognition of evaluating level, and group LW courses involve creating cognition level.

To sum up, TPK can concentrate attention of learners, arouse interest of learners, support learners to construct knowledge, promote learners to carry out summary evaluation, promote learners to apply knowledge and analyze actual situation when they reach desired cognitive level. While the application of a large number of TK not integrated with PK will cause students to feel bored and form a myth concept, resulting in low teaching efficiency

and low effectiveness. While the application of PK which is not integrated with TK is easy to cause cognitive burden of students at different levels because of the lack of visual experience, teacher language clarity, language speed and degree of knowledge abstraction.

2.5 Comparison and Analysis of Correlation Between Teaching Media Application and Elements of TPK

This section will present relationship between TPK structure and the frequency and duration of teaching media application in the way of fan graph and ring graph nesting. In picture, the inner sector area represents TPK structure, and the outer ring area represents type and proportion of teaching media corresponding to each element of TPK in course.



Figure 7 Frequency ratio chart of TPK elements and application of teaching media in WH (left)/WW (right) group

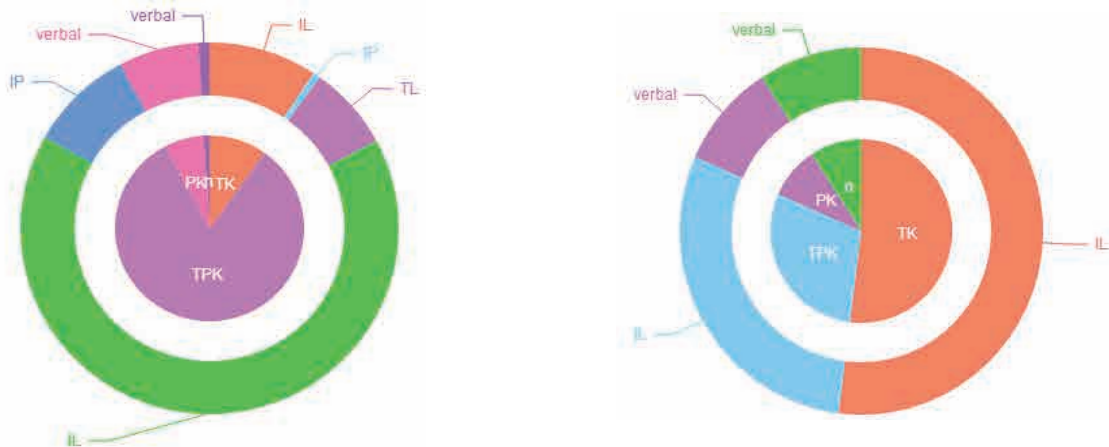


Figure 8 Duration ratio chart of TPK elements and application of teaching media in WH (left)/WW (right) group

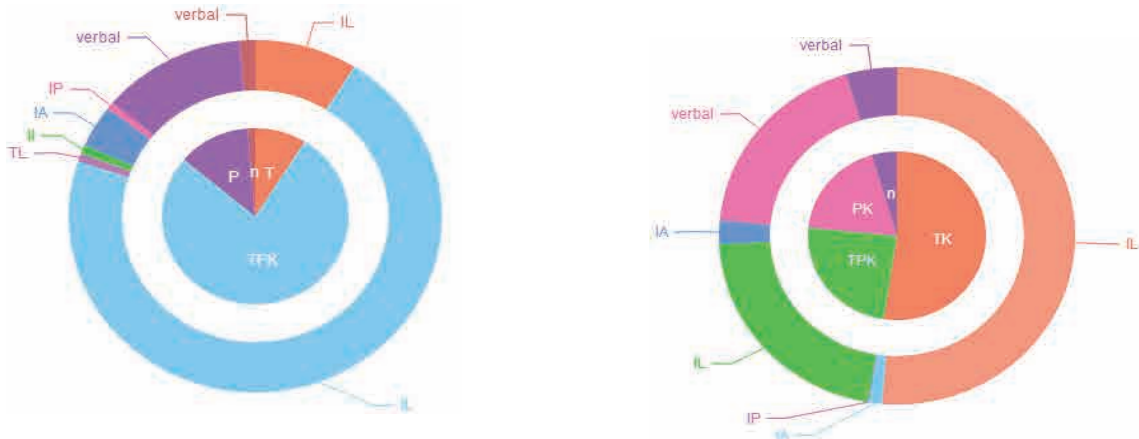


Figure 9 Frequency ratio chart of TPK elements and application of teaching media in LH (left)/LW (right) group

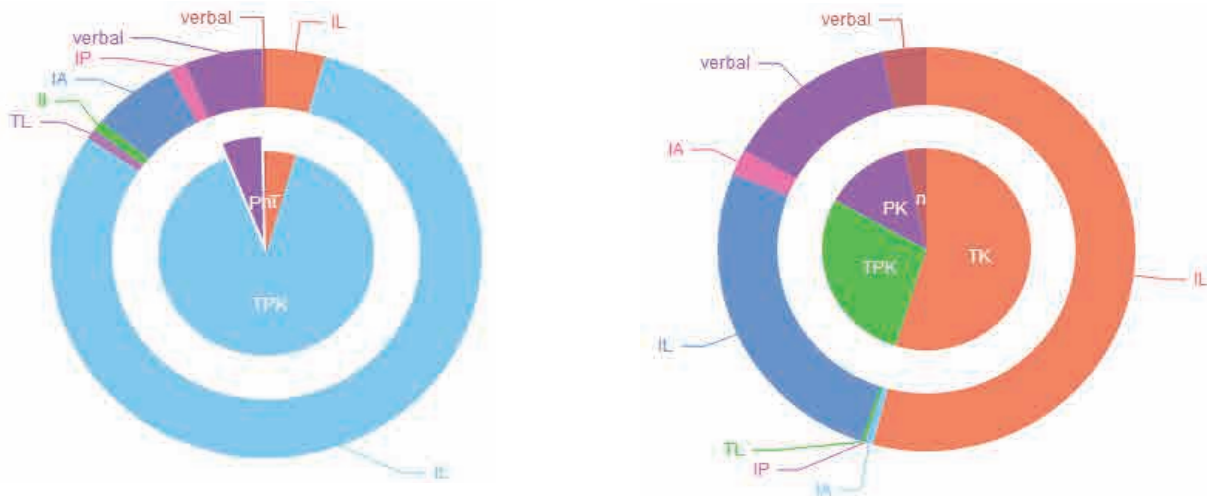


Figure 10
Duration ratio chart of TPK elements and application of teaching media in LH (left)/LW (right) group

According to above figures, under the condition that the IL is the main type of media used in the course, teaching teachers of award-winning groups of arts and sciences actively integrate them with PK. Except for a small number of IA not integrated with PK in non-award-winning group, most of IP, IA, II and TL have a positive impact on realization of PK. There is a significant difference between award-winning and non-award-winning group in integration of IL and PK. Therefore, how to effectively integrate IL and PK is one of the keys for non-award-winning group teachers to upgrade.

2.6 Suggestion

Combined with above conclusions, we can give suggestions for improving teaching effectiveness from TPK perspective.

- First, in teaching introduction link, we can review previous knowledge and lead to new content. These can help learners to understand course content and construct course content on basis of original knowledge structure. Teachers can make full use of declarative media to complete this link. In new course teaching link, teachers can make full use of various teaching methods such as discussion, contrast, experiment, and combine PK with technology, providing concrete and understandable experience for learners. In consolidation & practice link, IL often presents the most representative exercises and tasks, and gives a detailed explanation, and can also instruct students to complete open issues. In summary & upgrade link, teachers can use IL to present a contrastive summary and connection between various knowledge points.

- Secondly, teachers should apply TPK knowledge to help students in abstract knowledge point flexibly. In addition, teachers should pay attention to the combination of appropriate teaching media and give corresponding hints and enlightenment.

- Finally, selection of types of teaching media should be based on nature of subject and types of knowledge. Teachers should be able to apply media flexibly to explain knowledge. They should learn new technology actively and explore application in teaching of various disciplines and knowledge points.

CONCLUSION

In educational reform and educational practice, TPACK structure of teachers also affects structure and teaching effect of classroom teaching activities. This study makes use of video analysis method to analyze short video of excellent teaching of different teachers, and deeply excavate influence of classroom teaching structure and teacher's knowledge structure on teaching effect. The following conclusions are drawn.

- In terms of teaching time allocation, there is no significant difference between arts and science courses.

- The students' expectation of cognitive level has no significant influence on teaching effect of literature and science courses. Because of nature of subject and type of knowledge, each class presents differences in frequency and duration of four categories of remembering, understanding, analyzing and applying, but evaluating and creating of two types of cognitive levels are rarely involved.

- There are more kinds of teaching media in award-winning group courses, and the frequency and duration of non-media use are less than those of the non-award-winning group. Among them, IL is the most widely used media in class, TL, II, IA and IP take second place. TI, TP and IC have no application.

- TPK has a significant effect on teaching effect. Award-winning courses show high level of integration of TK and PK. TK and PK of non-award-winning group courses show a high degree of dispersion. Firstly, frequency and duration

of TPK in each teaching link have a significant impact on whether each link can achieve the expected effect. Courses of award-winning group and non-award-winning group have obvious differences in teaching introduction link, new course teaching link and consolidation & practice link, but there is little difference in summary & upgrade link. Secondly, frequency and duration of TPK of each cognitive level have significant impact on teaching effect. All cognitive levels of award-winning courses are supported by rich TPK support, while TPK support ratio of non-award-winning group is low. Finally, because of different nature of subject, teachers have different preferences on choice of teaching media. The integration of IL and PK is the difference between award-winning group courses and non-award-winning group courses.

LIMITATIONS AND FUTURE DIRECTION

This study is the first step in studying the impact of teacher behavior on teaching effectiveness in the classroom. There are some limitations in this study. First, the amount of courses in this study satisfies research needs, but does not cover all high school curriculums as well as junior high school and the primary school curriculum. The follow-up study hopes to expand scope of samples. Secondly, in the encoding of the course "students' expected cognitive dimension", the data obtained from the encoding of this dimension are in an average state due to the differences in educational background, specialty and actual learners' characteristics, and cannot be incorporated into the actual teaching and learning of different teaching modes and different learners' actual state. In the follow-up study, it is hoped that the "students' expected cognitive level" can be encoded in detail and more in line with the actual teaching and learning process. Thirdly, in the process of curriculum analysis, researchers found that TK, PK, TPK knowledge each contains different levels. In the follow-up study, different levels of above three kinds of knowledge are expected to be encoded and analyzed.

In addition, we plan to develop a classroom teaching evaluation system on the basis of this study to collect and analyze the data of teachers' classroom behavior. By using this tool, educational researchers and teacher training managers can easily know the level of teacher competence and the aspects of improvement.

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