

On the Problem-Solving Activity Model That Facilitates Teachers' TPACK Construction in Online Research and Studies

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ABSTRACT

In the information era, teachers' Technological Pedagogical and Content Knowledge (TPACK) is teachers' important knowledge foundation and guarantee, and online research and studies is a new pattern for teachers to develop education. In consideration of this, the mode of problem-solving is proposed in the paper to facilitate teachers' TPACK construction in online research and studies, and a problem-solving activity model is also established. Afterwards, the method of quasi-experiment is adopted to compare and verify the effect of the implementation of the aforesaid model. The main content of such verification is that in information-oriented instructional design and classroom record, the two-tailed probability p of information-oriented instructional design in the experimental group and control group is 0, which is significantly correlated, and the mean value of the experimental group is higher than the control group 2.5486. The mean value of classroom record in the experimental group is higher than the control group 11.2219. In conclusion, this model can satisfactorily facilitate teachers' TPACK construction.

Keywords: *online research and studies, Technological Pedagogical and Content Knowledge (TPACK), problem-solving, activity model.*

1. INTRODUCTION

The reinforcement of teachers' capability of information-oriented instruction depends on the construction of Technological Pedagogical and Content Knowledge (TPACK). Dr. Matthew J. Koehler and Dr. Punya Mishra from Michigan State University officially proposed the existing mainstream theoretical framework of teachers' information-oriented instruction training in the world in 2006---Technological Pedagogical and Content Knowledge (TPACK) [1]. This model mainly interprets a new type of knowledge structure that teachers need to possess during the application of information technology in the integration of discipline pedagogy. Furthermore, it is the knowledge foundation of teachers' capability of information technology application and the most effective form that supports teachers' pedagogical practices [2].

"Internet+teachers'education" has transformed the traditional learning mode of face-to-face instruction, implemented the new pattern of promotion which

integrates online research and studies, and field practice, and motivated teachers' study under network-based environment. If so, how can the construction of teachers' TPACK be implemented in online research and studies? At present, there are few research specialized in this aspect, and most research are concentrated on concept analysis, measurement of current situation [3] and teachers' TPACK based on the perspective of constructivism [4]. However, practically feasible application-based models have rarely been established. Explore the activity model through the analysis of characteristics of teachers' TPACK construction, and the relation between TPACK construction and problem-solving.

2. THEORETICAL FOUNDATION

2.1. Probabilistic automata

The characteristics of teachers' TPACK construction determines that the design of the activity model should maintain the consistency. Peng Xu (2013) indicated that the characteristics of TPACK are complexity, interactivity

and equilibrium [5]. Based on the research of a great deal of overseas materials in relevant fields, Huanqing Wu et. al. proposed that TPACK development should manifest the characteristics of situation-orientation, continuity, sociality, technicality systematization and design generativity [6]. In consideration of the existing research achievements, it is summarized in this research that teachers' TPACK construction should manifest the characteristics of practical applicability, specific situation-orientation, circulated continuity, social interactivity and design generativity. It has been verified by a lot of research [7-8] that teachers' TPACK construction must be tempered and improved, and information-oriented instruction design, technological resources and classroom videos should be designed and generated creatively in practice.

2.2 Teachers' TPACK construction and problem-solving

The core objective of problem-solving learning activity is to help learners establish their cognitive structure in specific knowledge fields [9]. This process is known as knowledge construction, which emphasizes the placement of learning in complicated and meaningful problem situations, so that learners could cooperate to solve practical problems, cultivate problem-solving skills, and simultaneously, establish a knowledge system. The objective and significance of problem-solving activity determines the effectiveness of teachers' TPACK construction, the systematic logicality of problem-solving activities determines the integrality of teachers' TPACK construction, and the reflective generality of problem-solving activities determines the hierarchy of teachers' TPACK construction.

3. MODEL CONSTRUCTION

3.1 Dimensionality of teacher group

Maintain the consistency with the characteristics of teachers' TPACK construction, innovate and design information-oriented teaching questions, and divide activities that facilitate teachers' TPACK construction in online research and studies into three sections in accordance with the problem-solving procedure. As it is shown in Figure 1, they can be implemented and learnt officially or unofficially. During the research and studies, teachers will generate and innovate generative resources, such as new information-oriented instructional design and teaching examples on the class. Furthermore, they can also conduct circulated and normalized online research and studies on this basis. Teachers' TPACK will be

constructed through spiral escalation, which is consistent with the SECI theory proposed by Ikujiro Nonaka, a Japanese knowledge management expert.

3.2 Dimensionality of training-undertaking institutions

Training-undertaking institutions mainly undertake tasks in three aspects, namely, guidance of problem-solving solutions, provision of resources and instruments, and monitoring of learning process. Experts of training-undertaking institutions should designedly provide feasible and effective analysis and guidance in an in-depth layer of the team of teachers. In links like problem analysis and self-learning activity, instruments and resources can be provided, such as concept map, micro-video and excellent teaching examples, which can be conducive to teachers' TPACK construction. Monitoring of learning process mainly includes monitoring of the cooperative relationship among teachers and the problem-solving process.

4. EFFECT VERIFICATION

4.1 Research design

4.1.1 Content of research

The method of quasi-experiment is adopted in this research to verify the effect of the model and implemented in a practical training program that aims at reinforcing primary and middle school teachers' information-oriented teaching ability. The main content of research is to evaluate the information-oriented instructional design and classroom records that are generated by teachers after the research and studies. Information-oriented instructional design can partially reflect teachers' TPACK construction. In the doctoral dissertation, yuan Qi mentioned: mature TPACK can effectively support instructional design under the environment of information technology, and will become an important knowledge foundation for teachers' information-oriented instructional design [10]. Classroom record, which is the ultimate form of expression of teachers' TPACK, is naturally adopted to inspect teachers' TPACK construction. The above two aspects of content are selected because the various concepts in TPACK framework have ambiguous meanings and boundaries [2]. It is quite difficult to independently distinguish all the constituent parts of teachers' TPACK in practice, and it is consistent with the concept of integrity propose by Niess if TPACK is considered as an integrity [7].

Table 1 Quantitative Statistics of Teachers

	Number of Teachers in Control Group	Number of Teachers in Experimental Group	Total Number
Original Number	99	104	203
Number of Remaining Teachers (elimination of those who failed to submit instructional design)	98	102	200
Number of Remaining Teachers (elimination of those who failed to submit classroom records)	94	100	194

TX training-undertaking institution which undertakes the training of primary and middle school teachers' information-oriented teaching ability has trained 203 primary school Chinese teachers in 2 workshops in A City, Guangxi from July 2016 to September 2016. Specifically speaking, there are 99 teachers from Workshop 1 and 104 teachers from Workshop 2, and the form of training is online research and studies. Workshop 1 is considered as the control group, while Workshop 2 is considered as the experimental group. 3 teachers out of the 203 teachers failed to submit their information-oriented instructional design after the completion of the online research and studies, and they were eliminated from the sample during the evaluation of the information-oriented instructional design; 9 teachers failed to submit their classroom records, and they were eliminated from the evaluation of the classroom records, as it is shown in Table 1.

4.1.2 Object of research

TX training-undertaking institution which undertakes the training of primary and middle school teachers' information-oriented teaching ability has trained 203 primary school Chinese teachers in 2 workshops in A City, Guangxi from July 2016 to September 2016. Specifically speaking, there are 99 teachers from Workshop 1 and 104 teachers from Workshop 2, and the form of training is online research and studies. Workshop 1 is considered as the control group, while Workshop 2 is considered as the experimental group. 3 teachers out of the 203 teachers failed to submit their information-oriented instructional design after the completion of the online research and studies, and they were eliminated from the sample during the evaluation of the information-oriented instructional design; 9 teachers failed to submit their classroom records, and they were eliminated from the evaluation of the classroom records, as it is shown in Table 1.

4.1.3 Preparation of research

Primary school Chinese teachers that are selected in A City have all participated in the diagnostic evaluation before the training, and the mean value of the control group and the experimental group is 59.3246 and 58.7567 respectively. It is believed that the original TPACK level of the two groups of teachers is basically equivalent, so comparative research is feasible here. The traditional web-based learning pattern is adopted in the control group for research and studies, namely, each teacher logs in the platform to watch videos and texts, and discuss and submit assignments, etc.; the problem-solving activity model is adopted in the experimental group for research and studies, and information-oriented instruction is emphasized in this group.

4.2 Data analysis

4.2.1 Comparison of information-oriented instructional design

The comparison of information-oriented instructional design adopts evaluation scale for data collection. Robert M. Gagne's ADDIE model for instructional design is taken as a reference in the formulation of the evaluation scale, which includes five modules, namely, instructional objectives, analysis, strategies, evaluation and environment. Each module includes variable numbers of secondary indexes. The scoring rule is: a value with the interval of 0.1 between 0.1 and 1 is recorded under the consistency with the index's requirements, a higher value suggests the greater effectiveness of the index, and inconsistency with the requirements or non-existence of the index is recorded as 0. SPSS23.0 is adopted to conduct a reliability test of the scale. In accordance with the

viewpoint of Minglong Wu (2010), the reliability coefficient of the scale is above 0.9, which suggests that the scale has satisfying reliability. The result of the rest suggests that the reliability coefficient of the scale reaches 0.903, which suggests that the scale has satisfying reliability as a whole. Through the exploratory factor analysis, it is achieved that the scale has satisfying reliability and validity, and can be considered as an instrument to evaluate quantization.

Documents of the instructional design generated by 200 teachers after the completion of the online research and studies are gathered, organized and classified, and experts specialized in education technology and primary and middle school disciplines are invited to evaluate and score in accordance with the scale of information-oriented instructional design. Through the analysis of the result of descriptive statistics and independent-sample T test of the control group and the experimental group, it is achieved

that the mean value of the control group and the experimental group is 7.0592 and 9.6078 respectively, and the value of the experimental group is higher than the control group; the value of p is 0.233, which is much higher than 0.05, the value of t is -10.629, and the corresponding two-tailed probability is 0.000, which is less than 0.05. It can be deemed that the level of information-oriented instructional design manifests significant differences between the control group and the experimental group.

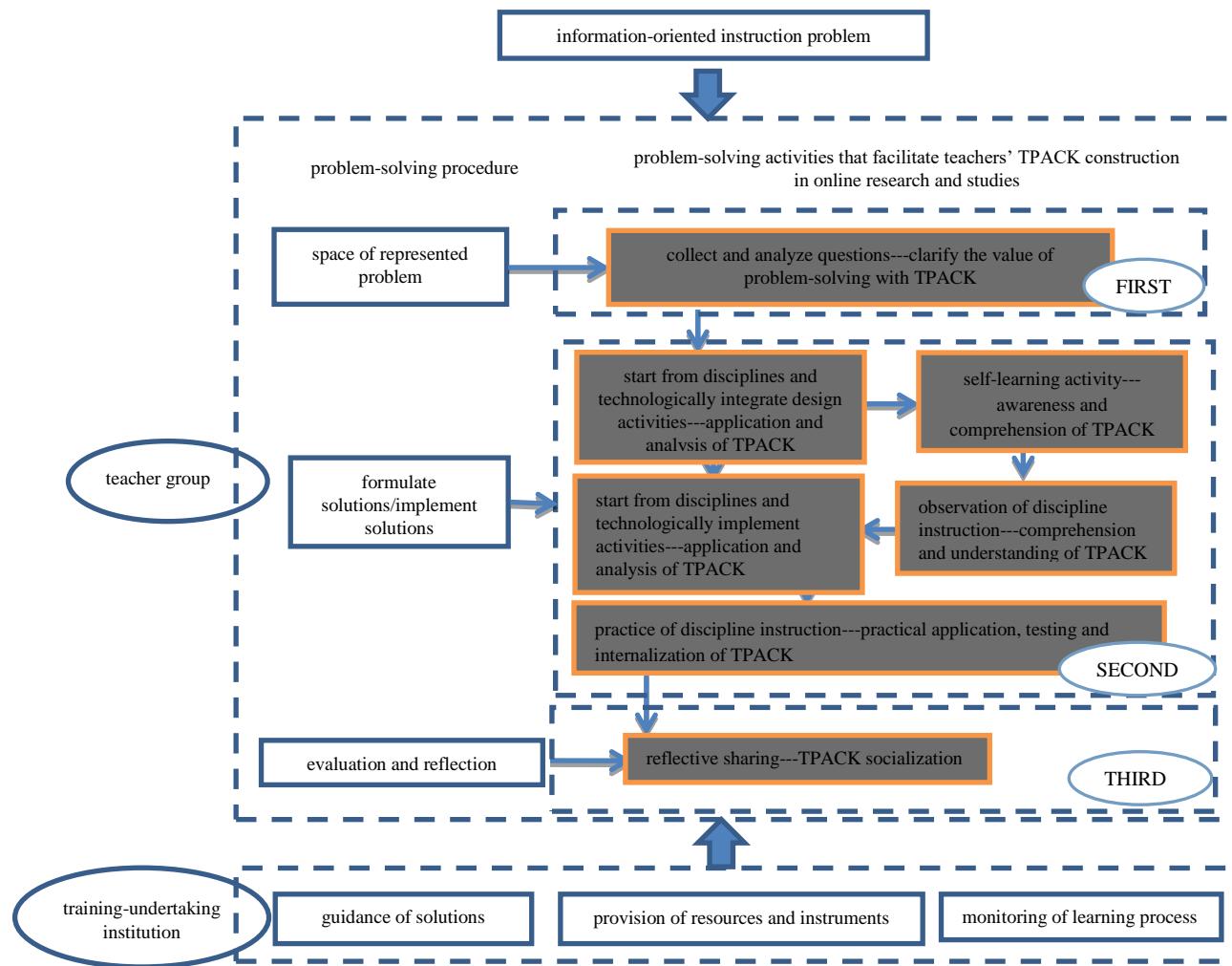


Figure 1 Problem-solving Activity Model that Facilitates Teachers' TPACK Construction in Online Research and Studies

The same method is adopted to compare the value of the various modules of instructional design in the control group and the experimental group. The unequal number of indexes in the various indexes makes it inconvenient to conduct the comparison, so the mean value is divided by the number of indexes in each module, and the value of the two groups is demonstrated in the radar map in Figure 2 below. The experimental group is higher than the control group in the five modules of the instructional design, and the instructional analysis and strategies are relatively apparent. The problem-solving activity model that facilitates teachers' TPACK construction is centered on information-oriented instruction under clarified objectives. As a result, the learning effect of the experimental group is superior to the control group, but the degree of such superiority is unequal in the various modules.

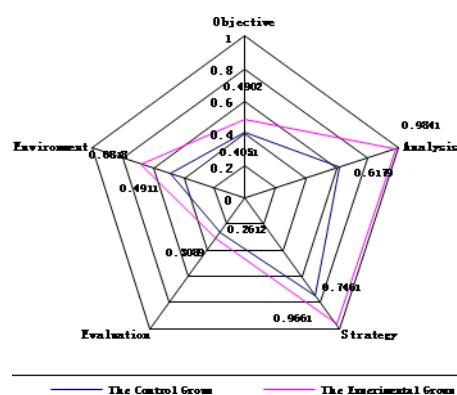


Figure 2 Comparison of Information-oriented Instructional Design in Various Dimensionalities

4.2.2 Comparison of classroom records

Classroom records of 194 teachers are analyzed. Information-oriented classroom instruction performance evaluation scale that was proposed by He Ma (2009) is taken as a reference here. This performance evaluation scale includes performance of assignments and relationships. Performance of assignments refers to the completion of assignments; performance of relationships refers to interpersonal and volitional behaviors of psychological and social relations. In this research, an emphasis is placed on the review of teachers' assignment performance in information-oriented classroom instruction after online research and studies. There are several secondary indexes under each first-class index (the effect, efficiency and effectiveness of instruction), and each secondary index is divided into four hierarchies, which are scored 4, 3, 2, 1 respectively from the first hierarchy to the fourth hierarchy. Experts specialized in education technology and primary and middle school disciplines are invited to evaluate and score the classroom records of the control group and the experimental group.

Independent sample T testing is conducted in the score of the two groups, $p=0.118>0.05$, $t=-10.216$, and the corresponding two-tailed probability p is 0.000, which is less than 0.05, which reaches the level of significance. Moreover, the difference of the average value is -11.2219, which suggests that there are significant differences between the control group and the experimental group, and the score of the experimental group is higher than the control group, which demonstrates that the online research and studies designed in accordance with the problem-solving activity model can facilitate teachers' TPACK construction and reinforce teachers' capability of information technology application.

5. CONCLUSION

Based on the existing research, a problem-solving activity model that facilitates teachers' TPACK construction is established in this research. By taking information-oriented instruction as the starting point, this model solves problems through online research and studies and implements teachers' TPACK construction during the process. Through the comparison and verification of the effect of the completion of the quasi-experiment, the experimental group is higher than the control group by 2.5486 in information-oriented instructional design, and the experimental group is higher than the control group by 11.2219 in assignment performance in classroom records. The two groups of data suggest that the problem-solving activity model can satisfactorily facilitate teachers' TPACK construction in online research and studies, and

will be adopted in intensified application and discussion in the subsequent teachers' training..

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