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Interaction Observation Tool Development in K-12 Smart Classroom

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Abstract: Smart classroom has some common features such as automatic sensing physical environment, flexible use of computing devices and physical settings, connected learning environment, and learning data tracking. These features can promote interaction among teachers, learning peers and resources entertaining needs of new generation learners. Interactions in smart classrooms have a higher level of complexity in comparison with traditional classrooms. In this study, an interaction observation tool in K-12 smart classroom was developed, based on the existing interaction tools and derived from the characteristics of smart classroom as discussed. The two major parts of the observation tool are interaction records in smart classroom and interaction support from the learning environment. The tool has been piloted in 14 selected primary and secondary schools in Hong Kong, Beijing and Shenzhen. The tool has been revised eight times after thirty times of in-class observation and ten times of video observation. The tool was evaluated in the dimensions of function, usability and data processing by 5 experts of educational technology, 10 K-12 teachers and 35 observers. The average mean scores of function, usability and data processing are 4.47, 3.98 and 3.94. The Kendall synergistic coefficient is W=0.471, Sig=-0.000, indicating that the tool was highly acceptable.

Keywords: smart classroom, interaction, classroom observation, interaction observation tool

1. Introduction

With the growth of technology, smart classroom has become the main focus of educational technology research (Huang, Hu, Yang, & Xiao, 2012). Smart classroom with the features of automatic sensing physical environment, flexible use of computing devices and physical settings, connected learning environment, and learning data tracking can fit the requirements of digital natives on strong interaction (Slotta, 2010). The study of interaction in smart classroom has become more and more popular.

Classroom observation is an important approach of interactive study (Hopkins, 2002). However, the classic observation tools, such as Flanders Interaction Analysis System (FIAS), Student-Teacher Analysis (S-T), Classroom Assessment Scoring System (CLASS), and Communicative Orientation of Language Teaching (COLT), still do not fit smart classroom. First, the questions are more suitable for traditional classrooms. Second, the collection time is fixed time slot (every three seconds). It will be easy to cause the issue about segmentation of meaningful unit (Yang, 2015). Third, the collected data and behaviors are quantization. It may cause that only the explicit behaviors can be observed. Fourth, the quantized data cannot reflect the real teaching context and teaching progress.

Interactions in smart classroom have a higher level of complexity in comparison with traditional classrooms. For example, in smart classroom, the relationships of interaction are multiple and directive connections, the objects of interaction are complicated and various, the state of interactive content are open, and the ways are convenient. It is necessary to develop a suitable interaction observation tool, based on the existing tools and derived from the characteristics of smart classroom as discussed.

2. A framework of interaction observation in K-12 smart classroom

2.1 Classroom interaction analysis model

The evaluation indicators of smart classroom have unique contents and features. The relationship between interaction and evaluation indicators is the keys to design interaction observation tool. Based on the literature review, we proposed accessing, showing, physical setup, activities and interaction as five factors for a smart classroom. We put interaction in learning activities as the core of the model, and could be analyzed from the other three indicators, as shown in Figure 1. The accessing factor focuses on the impact of the convenient usage for devices and resources, which is selected from Technology-Rich Classroom Environment Scales (TCES). The physical setup factor focuses on the impact of flexibility and automatically sensing for physical environment, which is selected from Computerized Classroom Ergonomic Inventory (CCEI) and Smart Classroom Scales (SES). The showing factor focuses on the impact of appropriation and optimization, which is selected from TCES. The activities part focuses on the impact of activity types on interaction, which is selected from ISTE Classroom Observation Tool (ICOT).

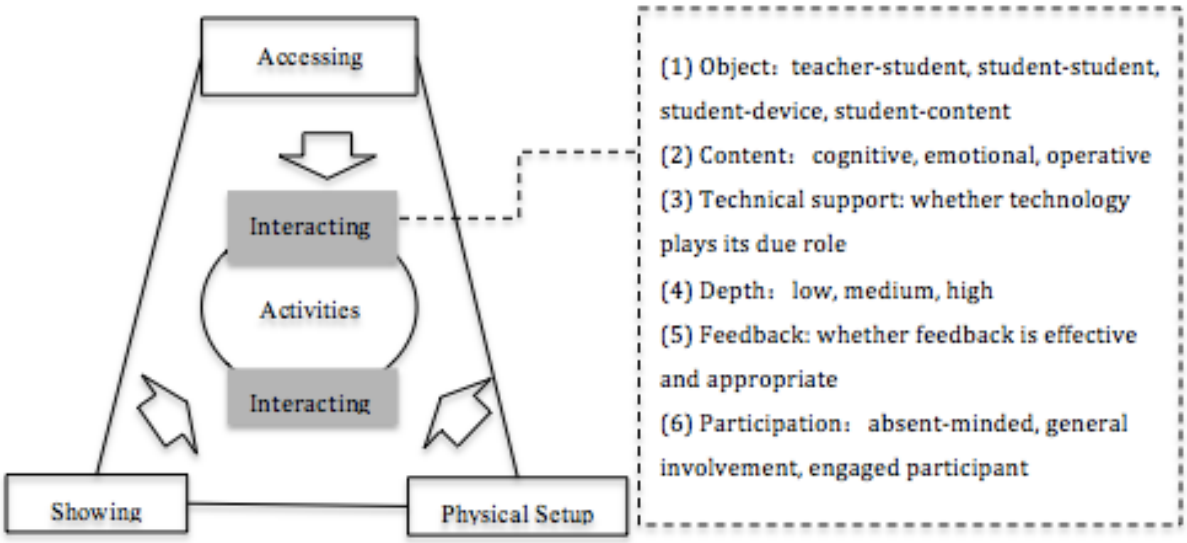


Figure1. Interaction observation perspective for smart classroom.

2.2 Indicators for evaluating environment support towards interaction

We developed a questionnaire based on accessing, showing and physical setup for observers to evaluate environment support towards interaction from overall experience in observation process. The questionnaires consisted of 12 items (see Table 1), on a likert-type scale with five-response choice, including 1=strongly disagree, 2=disagree, 3=moderate, 4=agree, and 5=strongly agree.

Table1 Indicators of environment support towards interaction.

Dimensions	Indicators	Items
Accessing	The conditions of digital devices and learning materials in classroom	1) The students could share the learning materials easily during collaborative learning. 2) The teachers and students could work together to mark and create the learning outcomes. 3) The teachers could keep fingers on the students' status based on the real-time response system. 4) The students could download the practice and homework easily from the platform.
Showing	The condition of presenting digital materials to others in classroom	1) Flexible multi-screen could accelerate the knowledge integration. 2) One-to-one device could enhance the equality of showing. 3) The students could see the presentation anywhere

		during the interactive process. 4) The teacher could see the whole process when the students answer the questions with the devices.
Physical setup	The layout and workspace in classroom	1) Flexible seating arrangement could support the interaction well during collaborative learning. 2) Comfortable classroom layout creates a good user experience to promote the interaction. 3) Monitoring equipment in the classroom could record all the interactive process. 4) Suitable socket design in the classroom could meet the requirement of group change during the interactive process.

2.3 Indicators for interaction records in smart classroom

Owing to the rapid development of ICT and new learning style of students, the subject, type, content and feedback of interaction in smart classroom is subtly different from traditional classroom (Higgins, Hall, Wall, Woolner, & McCaughey, 2005). We should pay attention to student-content and student-device in interactive subject, emotional interaction in interactive content, ICT impact on feedback and depth of interaction.

It is impossible to record every interaction in classroom (Stuhlman, Hamre, Downer, & Pianta, 2014). Lesson is segmented along learning process and learning activities to ensure the operability. Learning process has undergone the several stages of warming up, presentation, practice, production, summary and homework (Martin, Daley, Hutchings, Jones, Eames, & Whitaker, 2010). Learning activities in learning process has been divided into the segments of receiving presentation, giving presentation, creating presentation, running simulations, analysis, research, writing, taking tests, drill and practice, hands-on skills and discussion (ICOT, 2008). Observers could record the interaction based on the segments above. Interaction observation indicators in smart classroom are shown in Table 2.

Table 2 Interaction observation indicators in smart classroom.

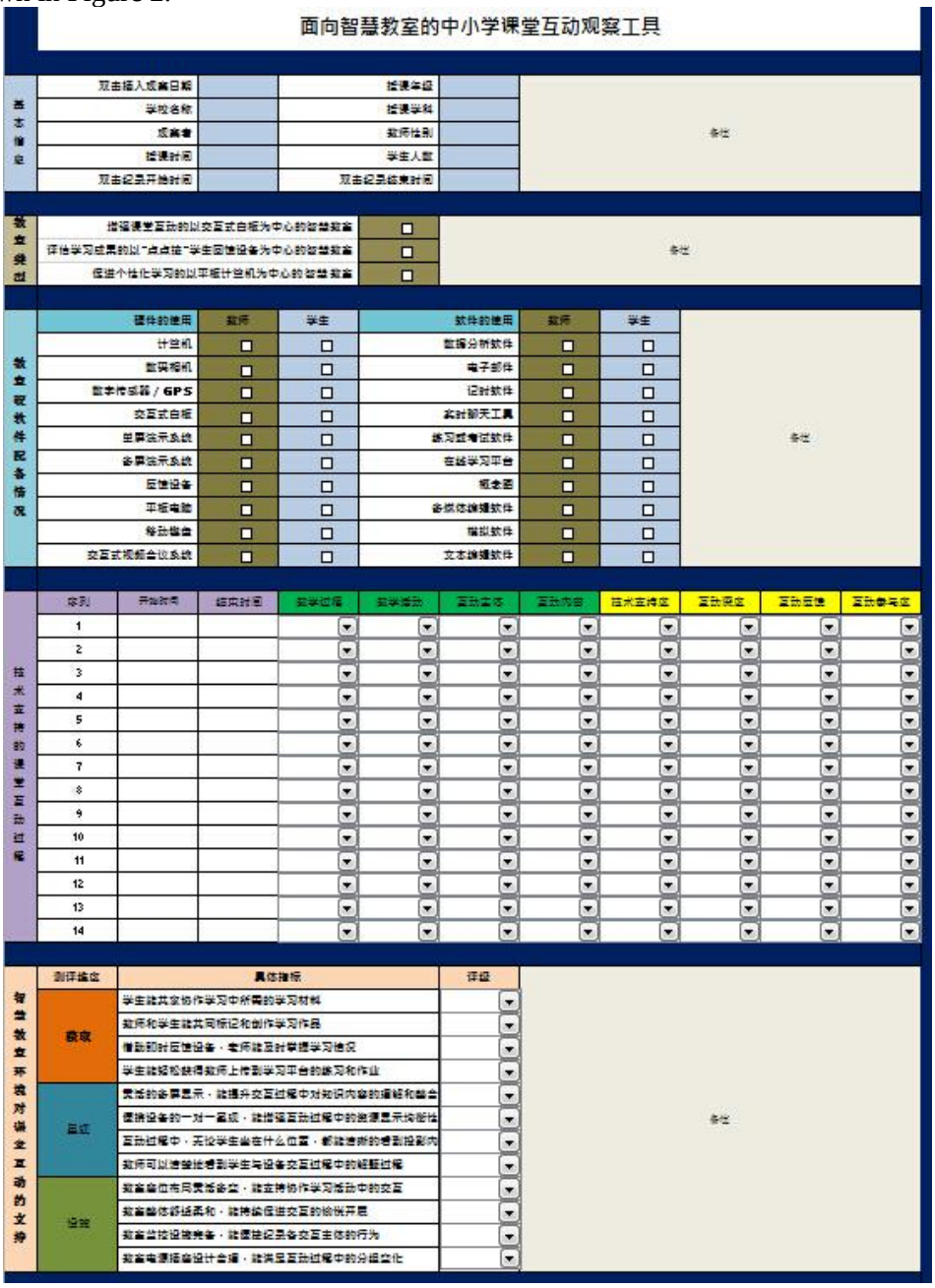
NO.	Factor	Indicators
1	Object	Teacher-student, Student-student, Student-content, Student-device
2	Content	Cognitive interaction, Emotional interaction, Operative interaction
3	Technical support	0---Could be achieve quality interaction without technology; 1---Technology does not play its due role; 2---Only as the tool of presentation and demonstration 3---Obviously improve the participation and efficacy
4	Depth	1---accidental, indistinct 2---messy, impassiveness 3---multivariate, unitary
5	Feedback	1--- No feedback or just an answer; 2---Provide an answer and encouragement in time; 3---Provide not only answer, but also inspiration and encouragement
6	Participation	1---Almost are absent-minded, some are general involvement, few are engaged; 2---Almost are general involvement, few are engaged; 3---Almost are engaged

3. Development of classroom interaction observation tool

3.1 Classroom observation recording tool

The interaction observation tool in K-12 smart classroom (IOTSC), which reference to the ICOT, was developed to help recording interactions in smart classroom. With the help of IOTSC, observers merely need to click the mouse. The tool contains five parts, which are basic information, the type of classroom, the software and hardware equipment, interaction process in technology-rich classroom and the environment support towards interaction.

Basic information emphasizes observation data, school's name, the time of class, teachers' gender, grade and subject of class, the number of students; The type of classroom is divided into three types: the interactive whiteboard classroom, the student response system classroom and the tablet computer classroom. The equipment of hardware and software includes computer, digital camera, data analysis software, timing tool, online learning platform etc. Interaction process and the environment support towards interaction in smart classroom could be recorded based on Table1 and Table 2. Part of the IOTSC is shown in Figure 2.


面向智慧教室的中小学课堂互动观察工具

基本信息

双击插入或离日期		授课年级	
学校名称		授课学科	
观课者		教师性别	
授课时间		学生人数	
双击记录开始时间		双击记录结束时间	

备注

教室类型

增强课堂互动的以交互式白板为中心的智慧教室	☐
评估学习成果的以"点点通"学生回馈设备为中心的智慧教室	☐
促进个性化学习的以平板计算机为中心的智慧教室	☐

备注

教室软件配备情况

硬件的使用	教师	学生	软件的使用	教师	学生
计算机	☐	☐	数据分析软件	☐	☐
数码相机	☐	☐	电子邮件	☐	☐
数字传感器 / GPS	☐	☐	记时软件	☐	☐
交互式白板	☐	☐	实时聊天工具	☐	☐
单屏投示系统	☐	☐	练习或考试软件	☐	☐
多屏投示系统	☐	☐	在线学习平台	☐	☐
反馈设备	☐	☐	概念图	☐	☐
平板电脑	☐	☐	多媒体编辑软件	☐	☐
移动摄像	☐	☐	模拟软件	☐	☐
交互式视频会议系统	☐	☐	文本编辑软件	☐	☐

备注

技术支持的课堂互动过程

序列	开始时间	结束时间	教学过程	教学活动	互动主体	互动内容	技术支持类	互动模式	互动目标	互动参与度
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										

智慧教室环境对课堂互动的支持

测评维度	具体指标	评级
获取	学生能共享协作学习中所需的学习材料	
	教师和学生能共同标记和创作学习作品	
	借助即时反馈设备，老师能及时掌握学习情况	
	学生能轻松获得教师上传到学习平台的练习和作业	
互动	灵活的多屏显示，能提升交互过程中对知识内容的理解和整合	
	便携设备的一对一配备，能增强互动过程中的资源显示灵活性	
	互动过程中，无论学生坐在什么位置，都能清晰的看到投影内	
	教师可以清楚地看到学生与设备交互过程中的经验过程	
设施	教室座位布局灵活多变，能支持协作学习活动中的交互	
	教室整体舒适柔和，能持续促进交互的愉悦开展	
	教室各设备齐全，能便捷记录各交互主体的行为	
	教室电源插座设计合理，能满足互动过程中的分组变化	

备注

Figure 2. Part of the IOTSC.

At the same time, we developed the instruction manual, including (1) the notes for use, including the environment requirement, personnel training, staffing, equipment etc.; (2) the connotation of indicators; (3) the scope of application; and (4) the proposed data analysis techniques and methods.

3.2 Pilot use and refinement of the tool

IOTSC has been piloted in 14 selected primary and secondary schools in Hong Kong, Beijing and Shenzhen. The tool has been revised eight times after thirty times of in-class observation and ten times

of video observation. The lessons observed covered normal curriculum from primary school grade 1 to middle school grade 2, including the subjects English, Chinese, mathematics and information technology. After each round of trial, the relevant observers were asked to list the tool's shortcoming and then suggest the relevant revision. More than 30 problems and revisions were put forward; with examples shown in Table 3.

Table 3 Examples of problems and revisions

round	Problems	Revisions
1st	It is not conducive to the data analysis if not invoice the interaction content	Divide into cognitive interaction, emotional interaction and operative interaction
2nd	Did not have score standard, different observers score the same interactive behavior with great difference.	Increase the rating criteria, such as technical support degree 2 represents " the technology is used, but it does not play its due role"
……	……	……
8th	Different observers have different records of the starting and ending time of each interaction.	After analyzing the process, the difference is no effect on data analysis and could be neglected.

3.3 Data obtain from the tool analysis

With the aid of IOTSC, researchers could acquire related interaction data for analysis according to the study requirements: (1) Recording equipment of smart classroom; (2) Understanding the subject, content, depth, feedback, Technical support and participation of interaction in smart classroom; (3) Evaluating the impact of accessing, showing and physical setup in smart classroom on interaction; (4) Analyzing the difference of interaction among three types of smart classroom; (5) Analyzing the difference of interaction depth, feedback, technical support and participation based on learning process, learning activities, subject and content of interaction; (6) Analyzing the relevance between interaction indicators and smart learning environment indicators.

3.4 Limitation of the study

The design of IOTSC fully considered characteristics of technology-rich classroom, although there is still room for improvement; such as (1) the tool cannot record student-content and student-device interaction completely; (2) the tool cannot analyze the data automatically; 3) the tool cannot record the details such as the gesture and frequency in student-device interaction.

4. Evaluation of the IOTSC

In order to test the effectiveness of IOTSC, we invited relevant practitioners to evaluate the tool in the dimensions of function, usability and data processing. The assessment questions are shown in Table 4. A total of 50 practitioners took part in the assessment, which consisted of 5 experts of Educational Technology, 10 K-12 teachers, and 35 observers. Because of the largely different backgrounds of the raters, we analyzed the Kendall synergistic coefficient firstly to ensure the assessment coherence. The Kendall synergistic coefficient W=0.471, Sig.=-0.000 indicated that the assessment coherence was highly acceptable. The results show that the experts and the potential users set a high value evaluation on IOTSC. The average scores were 4.10 in overall, 4.47 in function, 3.98 in data processing, 3.94 in usability.

Table 4. Assessment questions of IOTSC.

Dimensions	Questions	Score
Function	1-1 Have certain theoretical and practical significance	4.42
	1-2 Clearly reflect the core problem of smart classroom interaction	4.44
	1-3 Structure and the relationship among different dimensions are reasonable.	4.60
	1-4 Observation indicators well reflect the design of the structure	4.42
Usability	2-1 Relevant instructions clearly explain the special using requirements	4.38
	2-2 Easy to use, and relevant personnel can carry out after short-term training	3.48
	2-3 Observation records options are clear, easy to understand and record	3.82
	2-4 Observers can easily record and modify in class	3.68

Data processing	3-1 Measured data match the research without overlapping problem	3.76
	3-2 Measured data list orderly, and easy for viewing and extraction	3.52
	3-3 Measured data is easy for processing and inference	4.66

5. Conclusion

The smart classrooms for K-12 fully meet the requirements of strong interaction for new generation learners. The interaction observation tool in this study is consistent with the interactive behavior characteristic in smart classroom environment. It has good reliability and validity and provides a solid foundation of technical support for the research on classroom interaction. In the future, we will carry out large-scale classroom interaction observation experiments based on the tool, explore the classroom interaction rules, and construct the interaction mode. At the same time, we will analyze learning style and interactive behavior characteristic of university classroom, and develop interactive observation tool for university classroom environment.

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