# Optimizing Classroom Environment to Support Technology Enhanced Learning

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**Abstract.** Researchers have found that classroom environment has close relationship to students' learning performance. When considering technology enriched classroom environment, researches are mainly on the psychological environment and the measurement of the environment. While as technology integrated in classroom, the physical classroom environment should be investigated to facilitate students' effective and engaged learning. First we carry out a survey on the current technology enriched classroom, after that we sample the Technology Involved Classroom (TIC) and Technology Uninvolved Classroom (TUC) to compare the differences between the two kinds of classroom; then we do the classroom observation and interview with teachers; finally based on the analysis of these data, we propose some solutions for optimizing the classroom environment to facilitate technology enriched learning in China.

**Keywords:** class environment, classroom environment, technology enriched classroom, flipped classroom, technology enhanced learning.

## 1 Introduction

Over the past four decades, the study of classroom environments has received increased attention by researchers, teachers, school administrators and administrators of school systems [1]. Research on the classroom environment has shown that the physical arrangement can affect the behavior of both students and teachers [2], and that a well-structured classroom tends to improve student academic and behavioral outcomes [3]. The nature of the learning environment is judged based on students' perceptual consensus about the educational, psychological, social, and physical aspects of the environment [4]. Generally, the physical, social and psychological aspects are the three dimensions of evaluating classroom environment, and there are direct associations between psychosocial environment and physical environment [5] [6]. Some well-validated and robust classroom environment instruments to measure students‟ perceptions are developed to measure the psychological environment in class, like Learning Environment Inventory (LEI) [7], Constructivist Learning Environment Scale (CLES) [8], What Is Happening In this Class? (WIHIC) questionnaire [9].

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While as technology evolve dramatically, technology enriched learning environment can range from simple computer classrooms to extravagantly appointed classrooms equipped with computers, projectors, Internet access, and communications technology allowing for distance and real time access to a vast array of resources [10]. The use of computer and relevant digital devices has the potential to change physical and psychosocial classroom environments in either negative or positive ways. Many research have been done on the measurement of technology enriched classroom environment, and instruments like Constructivist Multimedia Learning Environment Survey (CMLES), New Classroom Environment Instrument (NCEI), and Technology-rich Outcomes-focused Learning Environment Inventory (TROFLEI), the Technology Integrated Classroom Inventory (TICI) are proposed and validated [11].

Although these researches and instruments could help to understand the physical and psychological classroom environment, they could not indicate how to construct and equip a classroom to facilitate effective and engaged learning and cultivate students' 21st survival skills. Especially in mainland China, there is few research concerning how to optimize today's classroom environment to match the needs of the new generation students from the perspective of effective teaching and learning. So in this research we try to carry out a survey on the current technology enriched classroom and then propose some solutions for optimizing the classroom environment to facilitate technology enriched learning.

## 2 Literature Review

In the age of information, both the physical classroom environment and the psychological classroom environment could be optimized through equipping "right" ICT and fusing "right" pedagogy.

In recent years, policy makers, institutions and researchers have realized the priority of classroom environment changing and they have initiated some projects on the improvements of classroom environment and the construction of future classroom. MIT initiated Technology Enhanced Active Learning (TEAL) project in 2000 to involve media-rich software for simulation and visualization in freshman physics carried out in a specially redesigned classroom to facilitate group interaction [12]. The student-centered activities for large enrollment undergraduate programs (SCALE-UP) project was initiated in North Carolina State University, with the aim to establish a highly collaborative, hands-on, computer-rich, interactive learning environment for large, introductory college courses [13] Kansas State in America initiated Technology Rich Classrooms project, and after the project Ault and Niileksela (2009) found that including technology in a classroom, training teachers how to use the technology, and providing support for technology use may change many aspects of learning [14]. Though these projects were able to demonstrate that the combination of newly designed classrooms and active learning approaches contributed to improving student learning achievements, but their research were lack of evidence for the findings because few of them isolated the relative effects of either space or pedagogy in research design.

According to Chinese scholar, the connotation of the classroom consists of three levels: (1) classroom is the physical environment (2) classroom is teaching activities, (3) classroom is integration of curriculum and teaching activities [15]. The classroom is not only a physical environment but also should provide support for carrying out various teaching and learning activities. From the late 90s, China started education information infrastructure construction in large-scale. After more than 10 years of construction, educational informatization has made remarkable achievements and the understanding of e-education has enhanced more than before [16]. Most teachings in class have transformed from the original "blackboard + chalk" mode to the "computer + projection" mode, but the teaching mode has not changed as we expected yet [17]. In some ways, the classroom and facilities have evolved dramatically, but in many ways they remain mired in the past. Wu (1998) indicated that the classrooms are mostly using the traditional seating layout [18]; Li (2006) expressed the functional advantages of the technology enriched classroom are not fully realized [19].

## 3 Research Method

This research involved a combination of a variety of methods. Whereas the classroom environment was surveyed with a questionnaire developed by the researchers, the class are observed with a classroom observation tool ICOT, the teachers was interviewed through an interview protocol.

### 3.1 Procedures

In this research we are trying to find the challenges in today's technology enriched learning environment, and then propose solutions to optimize the classroom environment. The procedure of this research can be divided into four steps as follows, as shown in Fig.1.

(1) Conduct a large scale survey on classroom environment from the perspective of teachers
(2) Use the sampling rules to select TIC and TUC. Technology Involved Class (TIC) refer to the class, in which internet is available and digital resources can be accessed conveniently, and digital technologies contribute to facilitate teaching and learning. Technology Uninvolved Class (TUC) refer to the traditional class in which internet is unavailable or digital resources could not be accessed conveniently, and technologies could not contribute to facilitate teaching and learning.
(3) Compare the differences between TIC and TUC.
(4) Go to classroom to observe the teaching practice in TIC and TUC, and after class to have an interview with teachers.

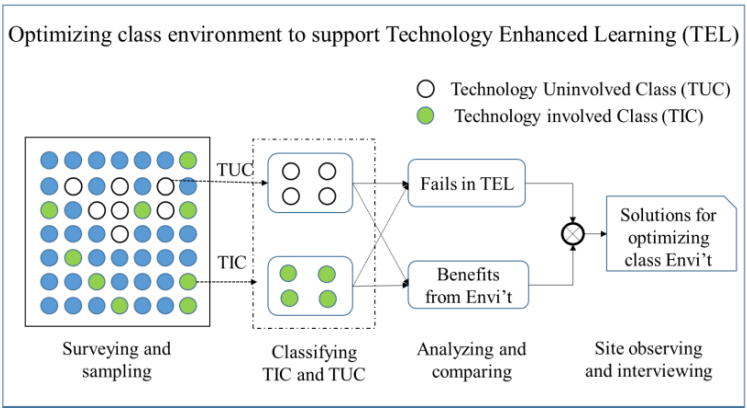


**Fig. 1.** Procedures of this research

### 3.2 Research Tools

Data was collected by ISTE Classroom Observation Tool (ICOT), and the Classroom Environment Questionnaire (CEQ) and the Focus Group Interview Protocol (FGIP) designed by ourselves.

The **ISTE Classroom Observation Tool** [20] is a computer-based rubric designed to help observers assess the nature and extent of technology integration in classroom, which is developed by International Society for Technology in Education (ISTE).

The **Classroom Environment Questionnaire** (CEQ) was developed based on the SMART classroom model proposed by Huang et. al. (2012) [21], as shown in Fig. 2.

***Showing of learning and instructional content*** concern with the teaching and learning material's presenting capabilities in classroom. Not only should the learning contents be seen clearly, but also it should be suitable to learners 'cognitive characteristics. ***Managing of physical environment/instructional materials/students behavior*** represents diverse layouts and the convenience of management of the classroom. The equipment, systems, resources of classroom should be easy managed, including layout of the classroom, equipment, physical environment, electrical safety, network, etc. ***Accessing to digital resources*** represents convenience of digital resources and equipment accessing in the classroom, which includes resource selection, content distribution and access speed.

***Real-time* interaction *and supporting technologies*** represents the ability to support the teaching/learning interaction and human-computer interaction of the classroom, which involves convenient operation, smooth interaction and interactive tracking. ***Tracking learning process/ environment*** represents tracking of the physical environment, instructional process and learning behavior in classroom.

According to the SMART classroom model, we developed the CEQ which consists of 65 questions, including the 11 questions about basic information and 54 questions on the dimensions of classroom environment. We use "content validity ratio" (CVR) to do the validity test of the questionnaire. Five experts (outstanding teachers and experts on subjects) are invited to give scores on the validity of the questionnaire. After collecting their scores and excluding some items that are not qualified, we finally use the **48** items with CVR over 0.7, as shown in Table 1.

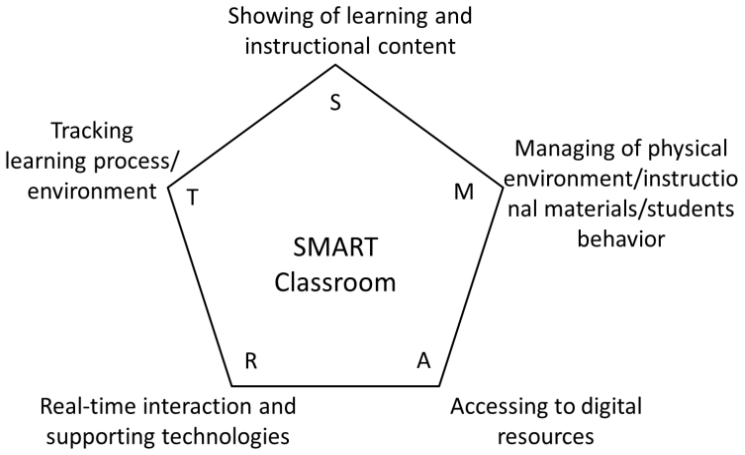


**Fig. 2.** SMART classroom model

**Table 1.** Dimensions and Items of CEQ

| Dimensions | Items | Numbers of Items |
|---|---|---|
| Showing of learning and instructional content | Instructional showing, Learning showing, Audio effects | 12 |
| Managing of physical environment/instructional materials/students behavior | Physical environment, Instructional materials, students behavior and action | 10 |
| Accessing to digital resources | Internet, Instructional resources, Learning resources | 9 |
| Real-time interaction and supporting technologies | Instructor-students interaction, students-students interaction, Human-computer interaction | 9 |
| Tracking learning process/ environment | Instructional process, leaning behavior, other environmental factors | 8 |

10 respondents are selected to fill in the same questionnaire again after a week to the test the reliability of the questionnaire, which results in the correlation coefficients ranging from 0.89 to 0.99.

Focus group interviews are a multi-faceted instrument that can be used alone, or in conjunction with other research methods allowing the researcher to delve more deeply into the study of a phenomenon and provide enhanced understanding to the research [22]. The FGIP consists of five parts which include showing content, managing environment, accessing resources, real-time interacting and tracking environment derived from the S.M.A.R.T. classroom model.

# 4 Sampling, Interview and Data Analysis

In order to sample a region effectively, we first calculated the overall teachers in each grade in the 11 cities in Zhejiang province, and then we decided to cover about 1/4 of all teachers in each grade. Finally about 21,397 teachers in Zhejiang province China including primary schools and middle schools have taken part in the survey, and we collected 21,397 questionnaires on classroom environment. 6 teachers in TIC and 6 teachers in TUC (7 Female and 5 Male) are involved in the classroom observation and focus interview.

## 4.1 Sampling

From the data collected, we found teachers' perception of classroom environment and technology involved in classroom varies. **In order to find out the reason for these differences, we select the TIC and TUC to compare the perception of classroom environment and the technology involved differences, which will enlighten us some solutions on optimizing classroom environment to support technology enhanced learning.** The sampling rules are: (1) Computer(s) and relevant digital devices are available in classroom; (2) Internet are available in classroom; (3) Digital resources are easy to access in classroom; (4) ICT are used to dispatch and collect learning materials frequently in class; (5) Students' works could be presented by using ICT in class frequently.

## 4.2 Comparison of TIC and TUC

Finally, 4046 out of 21,397 are selected as TIC (account for 18.9% of total), and 3376 are selected as TUC (account for 15.8% of total). From the comparison of TIC and TUC, we found:

(1) For classroom seating layout, 80.5% teachers in TIC express that the layout are conventional straight row layout, and 89.2% teachers in TUC express that. Teachers in TIC have adopted more U and O seating arrangements. 15.2% of teachers in TIC compared with 8.4% of teachers in TUC adopt U seating arrangement and 4.2% compared with 2.4% adopt O seating arrangement. Teachers in TIC change the classroom seating layout more often according to the pedagogy the use in class.
(2) For teaching console, 43.0% of teachers in TIC compared with 12.6% of teachers in TUC often change the place of teaching console and the classroom seating layout in order to carry out different teaching activities.42.7% of TIC compared with 59.2% of TUC would like to change the place of teaching console, but they con not because the console is fixed in front of the classroom.
(3) For showing content, 73.7% of teachers in TIC express that students could see clearly the showing content on the projection screen, while only 52.4% of teachers in TUC express this. 97.3% of teachers in TIC and 91.8% of teachers in TUC express PPT courseware could facilitate students' effective learning. For the reason why PPT courseware could not facilitate student's effective learning, most teachers express that "no time and no skill to do PPT" is the common reason.

31.1% of teachers in TUC express that the PPT is not good for student's digesting knowledge, while only 20.6% TIC think this.

(4) For technology enhanced interaction, we find TIC are more positive in "Students always learn collaboratively to finish the assignments in class", "Group students always learn together via interaction", "Students have more opportunities to discuss issues with the teacher", "Student have more opportunities to discuss with each other". These four questions are rating items using a five-point likert scale (5=Strongly Agree, 1=Strongly Disagree). 1.78, 1.81, 1.83, 1.84 are the four results in TIC; 2.39, 2.47, 2.65, 2.68 are the four results in TUC

(5) There are more senior teachers in TIC. Senior teachers take account 40.3% of teachers in TIC, but only 24.5% in TUC. In china, only a teacher have good pedagogy knowledge, domain knowledge and research ability could qualify himself to be a senior teacher. When consider the age of teaching and the degree or diploma, there is no significant difference.

Generally speaking, **the results are following**: (1) the seating layout is mainly conventional straight row layout and fixed; (2) the teaching console where the teaching computer and control system are located, is normally fixed in front of the classroom; (3) there are a larger proportion of teachers in TIC think students could see clearly the showing content on the projector screen than TUC; (4) Generally teachers' attitudes are positive to PPT courseware's effects on student's effective learning; (5) the deeper technology integration into classroom, the more collaborative learning strategy and digital technology are uses to facilitate interactions between teachers and students; (6) technology integration in classroom requires pedagogy knowledge, domain knowledge and research ability.

From the comparison, we find that the **physical classroom environment has a significant influence on teacher's teaching methods adoption,** which inspires us to think if the physical classroom environment could be improved to better facilitate teacher's teaching. So we went into classroom to do site observation in 6 TICs and 6 TUCs, and after that we carried out an interview with the teacher.

### 4.3 Site Observation and Interviews

In order to deeply understand the differences and to investigate the influences of physical environment on teacher's teaching, we first go into 6 TICs (2 Math, 2 English, 2 Chinese) and 6 TUCs (2 Math, 2 English, 2 Chinese) to observe the detail in-class behaviors, and then conduct interviews with the 12 teachers (4 Math, 4 English, 4 Chinese). All TIC are equipped with computers, projectors, wireless internet, interactive white board, Apple TV and other relevant digital technologies, while most TUC are traditional classroom with basic computers and projectors.

After the observation, focus group interview were carried out separately on 6 teachers in TIC and 6 teachers in TUC. The focus group interview protocol is based on the five dimensions of classroom environment. From the observation and interview, we find the following issues categorized into the five dimensions of classroom environment.

(1) **For showing content.** Most teachers , no matter in TIC or TUC express that because there is no curtain in classroom and the light from outside is so strong, some students could not see the content on the projector screen. When talking about the PPT usage, some teachers in TIC say they doubt whether students have enough time to take notes or digest knowledge before teachers change to the next slide, and some teachers in TUC are afraid of using PPT because it will distract student's attention.
(2) **For managing environment.** Almost all teachers express they are willing to adopt different teaching strategies to meet the teaching objects and students' needs, but they feel it a little difficult to conduct collaborative learning because of the conventional straight row layout, so they always want to change the seating layout to U shape. Teachers in TIC also express the inconvenience of the teaching console, which is evidenced from the observation that most teachers stay before the teaching console to manage computers for most time of the class. Teachers in TUC always complain the breakdown of computers and projectors.
(3) **For accessing resource.** Some teachers in TIC express they have built the website for sharing digital resources with students, and students could access to resources in class, which make it easier to adopt multiple teaching strategies, such as inquiry learning, collaborative learning, self-directed learning, etc. Students in TUC could not get access to digital resources. Teachers adopt more student-centered teaching method in TIC than in TUC, and students are more engaged in TIC than in TUC.
(4) **For real-time interaction.** Questions, discussion in peers, retell, role play, model, etc. are used to promote interactions between teachers and student. Students always show their learning outcome in TIC via airplay devices, while students seldom have opportunities to show the learning outcome in TUC. Interactive white board, interactive courseware and synchronous communication tools are used to promote communication between teachers and students in TIC.
(5) **For tracking environment.** Teachers both in TIC and TUC think it is necessary to record and analyze students learning behavior and teachers teaching behavior. From the interview, teachers have mentioned that the students' behavior should be recorded from the time students engaged, the time students take part in activities, the time students do practice, etc., and the teacher's behavior could be recorded and analyzed from the language in class, the teaching content, the activities conducted, the time using technology, etc.

The observation of TIC and TUC tell us some impressive results. In TIC, teachers often divided the class into several groups and conducted collaborative learning; while in TUC teachers always talk and students always listen and take notes. In TIC class, teacher use different kinds of technologies, but sometimes it seems the teachers is a little busy on technology; while in TUC class, teachers seldom use technology except for the projector for showing content.

## 5 Conclusion

The overall context for discussing our results reflects four important points based on the survey, observation and interview.

First, classrooms equipped with computers and projectors is the basic configuration of a technology rich classroom currently in mainland China, and some classrooms in top K-12 schools are equipped with different kinds of technology to facilitate teaching and learning, such as Apple TV, IPads, Interactive White Board, etc.

Second, from the schools participated in the research, we found technology may facilitate learning in case the technology enriched classroom was designed based on the pedagogy in association with "right" learning resources, "right" seating layout, place of teaching console and projector screen, etc.

Third, the five dimensions, such as showing content, managing environment, accessing resources, real-time interaction, tracking environment, can be taken into consideration in optimizing classroom environment.

Fourth, it is necessary for teachers to be aware of the potential risks for using slides. The teachers will perform better in technology enriched classroom if they have a fully understanding of the new generation students' learning needs, and have more technological knowledge and pedagogical knowledge. This results is coincided with Mishra and Koehler's TPACK model [23].

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