*Research Article*

# Analysis of Teachers' Tablet Teaching Adoption Process[*]

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## Abstract

Teachers play a very important role in providing children with a technology-supported learning environment. They are often challenged by the use of the tools and the effort required for planning pedagogical activities in technology integration. This study explored teachers' adoption process in tablet teaching (teaching with tablets). The purposes of the study were to study: (1) the processes teachers experienced for adopting tablets teaching, (2) the inspirations from children's learning reactions, and (3) challenges and strengths of the integration of tablet teaching. A phenomenological approach was used in this study. Three stages were involved in the data collection and analysis: (I) document analysis from online activity records and project reports, (II) interviews with 17 teachers, and (III) inductive analysis of various data resources. Analyses from various sources revealed that teachers' adoption process for tablet teaching includes: building basic knowledge of the new device, exploring different interests, modifying and redefining integration, and on-going tryouts. They were challenged with technology, pedagogical concerns, policy support, and community support. From the adoption process, teachers were inspired by children's motivation and learning engagement. In future implementation, scaffolding skills, exploratory opportunities, collaborative approach among teachers, open sharing of knowledge were suggested in tablet teaching.

## Keywords

Tablet teaching • Technology integration • Teaching strategy • Pedagogical knowledge

Teachers' adoption of technology plays a significant role in providing children with a technology-supported learning environment (Ifenthaler & Schweinbenz, 2013). With the advances in tablet technology, students are offered with new learning opportunities to explore world of knowledge (Kim & Kim, 2017). However, integrating technology into classrooms for reaching new education goals often challenges teachers with potential difficulties when there is limited policy and pedagogical support (Hew & Brush, 2007; Kumbargoudar, 2013; Laferrière, Hamel, & Searson, 2013). Various factors might impact on teachers' adoption process of tablet teaching. Other than external factors (support, technology, and environmental influences), internal factors (such as personal beliefs in the use of technology, capability in management, and perceived professional development) also influence teachers' adoption of technology in different school settings. Issues related to teachers' decisions regarding technology integration have been extensively discussed in prior studies (Blackwell, 2013; Chiu & Churchill, 2016; Hew & Brush, 2007; Liaw & Huang, 2015; Peterson, 2011; Phiri, Foko, & Mahwai, 2014; Polly & Orrill, 2016). These discussions underline the importance of teachers' attitudes, expectations, and facilitation conditions in the adoption process of tablet teaching. Teacher's attitude and knowledge toward technology integration might change as they gain more experiences from and insights in the adoptions processes (Ifenthal & Schweinbenz, 2013). The analysis of teachers' adoption processes is important to identify how teachers react to the facilitation conditions, including: technology, supports and environmental influences (Figure 1). These reactions might have impact on the change of knowledge and attitudes in integration of teaching with tablets. It is proposed that along with the diffusion process of teaching with tablets, teachers experience changes in knowledge and attitudes in their teaching integration practice (Figure 1). Facilitation conditions in the adoption process are important. Children's curiosity and motivation to use new media for learning might also have a potential impact on teachers' adoption of tablets in teaching (Binsaleh & Binsaleh, 2013; Castek & Beach, 2013; Ruyter, 2014).
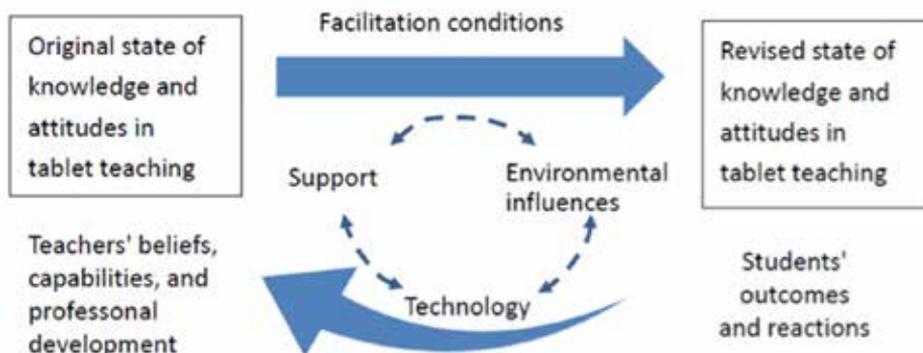


*Figure 1.* Proposed teachers' knowledge change from tablet teaching.

*Note.* Facilitation conditions and students' learning outcomes might foster the cyclic processes involved in changes of teachers' knowledge and attitude in tablet teaching.

## Change in Pedagogical Knowledge

In tablet teaching, teachers' change in pedagogy involves restructuring classroom activities in accordance with careful considerations of the personalized, learner centered, situated, and ubiquitous features of the learning tool (Osakwe, Dlodlo, & Jere, 2017). Diffusion of tablet teaching entails innovative instructional strategies for planning learning activities to trigger children's curiosity to learn, and motivation to search, explore, use, and communicate with diverse electronic media (Binsaleh & Binsaleh, 2013; Castek & Beach, 2013; Ciampa, 2014). Various approaches to fostering knowledge acquisition have an influence on teachers and children's perceptions in the adoption of tablets in teaching and learning (Binsaleh & Binsaleh, 2013; Blackwell, 2103).

Meaningful learning experiences with tablets are enhanced by teachers' pedagogical management of various situated learning activities with adaptive supports from the learning system (Glackin, 2017; Jeng, Wu, Huang, Tan, & Yang, 2010). Creating opportunities for children to experience the richness of contemporary learning in the digital era and preparing children for future learning, teachers also learn to cope with various barriers that might be experienced in technology adoption, including changing beliefs and attitudes, and learning new skills in planning pedagogy aligned with teaching practices (Chiu & Churchill, 2016; Collier, Burkholder, & Branum, 2013).

## Activities for Integration

Tablet learning movements have created a transformative impact on classroom learning among teachers by offering a context in which students can engage in open and active learning settings based on their preferred learning styles (Cummings & Hill, 2015; Sahin Izmirli & Kabakçi Yurdakul, 2014). However, incorporating tablet technology into students' learning also increases the complexity of, and creates additional challenges and anxieties for managing classroom settings. These challenges and anxieties regarding teachers' adoption might result in rejection of the technology (Moats, 2015).

In the study of technology integration, the TAM (technology acceptance model) and TPACK (technological pedagogical content knowledge) models have been widely used to explore teachers' perceived usefulness and ease of use of technology, and the interrelated factors of knowledge of the technology, teaching contents, and pedagogy (e.g., Adam, 2016; Davis, 1989; Koh, Chai, Benjamin, & Hong, 2015). Many existing studies (Bissell, 2015; Cowan & Butler, 2013; Joo, Lim, & Kim, 2016; Land & Zimmerman, 2015; Liaw & Huang, 2015) have theorized the integration of mobile technologies in the framework of activity theory. However, there are limitations to the use of the TPACK framework in explaining the dynamic nature of teachers' knowledge construction and experiences of practice in technology-

rich environments (Koehler, Mishra, Kereluik, Shin, & Graham, 2014; Koehler, Greenhalgh, Rosenberg, & Keenan, 2017; Olofson, Swallow, & Neumann, 2016).

## Knowledge Construction through Diffusion

Roger (2003) argues that the process of adoption of new technology entails a series of communication channels over a period of time. Four main elements influence technology integration: the innovation itself, communication channels, time, and the social system (Roger, 2003). The five stages of adoption include: awareness, interest, evaluation, trial, and adoption (p. 79). To bridge the use of tablets with students' authentic learning environment, teachers need to be aware of the ubiquitous ownership of tablet learning, and design activities to encourage students to tackle real-world problems and to challenge themselves with the given tasks (Burden & Kearney, 2016). Teachers' adoption processes start with an awareness of and interest in the new technology and innovative pedagogical strategies for encouraging a learner-centered learning context. Along with the adoption process, teachers have to construct new knowledge, and change their teaching style by transforming lessons in accordance with the advantages tablet computers can offer (Montrieux, Vanderlinde, Schellens, & De Marez, 2015).

According to Rogers (2003), adoption of technology involves various adoption processes at both the individual and social level. The diffusion process involves interactions in the innovative learning context. Successful technology adoption in classroom settings entails long-term employment of innovative strategies and sharable experiences among the community members. The innovation-decision processes are defined as "information-seeking" and "information-processing" activities (p. 172) to decrease the uncertainty about the innovation (p. 219) which involves various stages (knowledge, persuasion, decision, implementation, and confirmation), as defined by Rogers (2003).

The contextual influences on teachers' construction of technological pedagogical content knowledge in the adoption of technology are critical in examining their use of digital technologies (Koehler et al., 2014; Taber, 2017). Olofson et al. (2016) suggest that teachers' adoption process of technology integration is ongoing and is dependent on the change of context and experiences, as well as on their knowledge of teaching practice. With this understanding, teachers' change in their own pedagogical content knowledge is an evolving process in tablet teaching practice. The contextual realities imply that teachers need to manage and prioritize the various demands of classroom integration (Koehler et al., 2014; Laurillard, 2013). Teachers' tablet teaching strategies reflect their knowledge of pedagogy, teaching content, understanding of students' characteristics in the use of the technology, and the context of the teaching and learning environment.

Since teachers' knowledge and experience in the adoption of tablet teaching is evolving and differs over time, it is the process which the teachers have experienced that is of interest. In our study, we analyzed data from cases in which teachers experienced and engaged in this knowledge construction. We looked for how they constructed their knowledge through experiencing tablet teaching. In this study, the approaches adopted for teaching with tablets were studied. The research questions are as follows:

1. What were the processes the teachers experienced for adopting tablet teaching?

2. How were the teachers inspired by children in the processes of adoption?

3. What were the challenges and strengths of the integration of tablet teaching?

## Method

### Research Design

In this study, a phenomenological approach was used to analyze qualitative data from teachers' tablet teaching adoption processes. The phenomenology places emphasis on the meaning, not only the textual data but also the actions involved and interpretations in reposing to that data (Salice & Schmid, 2016). Purposeful sampling from multiples resources of documents as well as responses from teachers who had actually experience in tablet teaching were used in the study. The research aimed to observe the phenomena from teachers' experiences in teaching through the use of tablets and their teaching innovations integrated in both formal and informal learning among children.

### Settings

The sample for this study consisted of school teachers with experience of tablet teaching in Taiwan. Due to the limited funding and support available for schools, many schools have searched for donations of tablet PCs. A charity foundation donated tablet PCs to 32 schools (many of which are in rural areas) across two academic years, and included the Windows 8 and Android platforms). To apply for and fulfill the requirements of the tablet donation, the schools were obliged to submit their proposals and final reports and to share the children's learning status as a result of the implementation. To network these teachers from diverse locations so as to promote mobile teaching, the teachers were encouraged to participate in online interactions on a shared platform, "Mobile Teaching & Reading" (http://tablet.project.lins.fju.edu.tw/). A framework to organize and structure both pedagogical and technical support was established.

## Data Collection

In this study, research data were gathered from multiple sources for analysis, including: online activity records, project reports, and interview responses from teachers. For ethical concerns, all the data used for the study obtained permission from the respondents. Three stages were involved in the data collection and analysis: (Stage I) collection of online activity records and project reports for document analysis, (Stage II) interviews with 17 teachers, and (Stage III) inductive analysis of various data resources (Figure 2). The interview guide used for collecting in-depth responses from the teachers is listed in Table 1. Among these 17 teachers, 15 were teaching in elementary schools, and 2 in secondary schools. These teachers had 5-10 year of teaching experiences and 1-2 years of experience in teaching with tablets. These teachers taught diverse subjects, including: math, language, nature and science, information technology, environment education and literature. All interviews were held on a one-to-one basis. A portion of the data is cited for the explanation of specific phenomena. To preserve anonymity, documents used for analysis were labeled with a special code. The data resources and descriptions of the citation codes are listed in Table 2.

Table 1

*Data Gathered from the Interview Questions*

| Issue for study | Interview questions |
|---|---|
| Research Question 1 Pedagogy and activities | What are the features for tablet integration in specific subject areas in your school? |
| Research Question 2 Involvement of teachers and children | How did you implement tablet teaching and learning in teaching? How were the children involved in learning? |
| Research Question 3 Challenges and strengths | What were the barriers and strengths to the implementation of tablet teaching? |
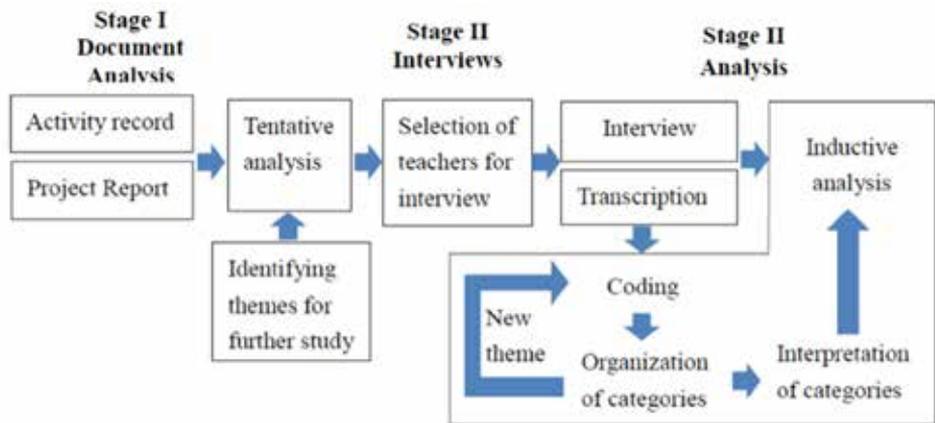


*Figure 2*. Procedure for data collection and analysis.

*Note*. Three stages were involved in the data collection and analysis: (I) collection of online activity records and project reports for document analysis, (II) interviews with 17 teachers, and ( III) inductive analysis of various data resources.

Table 2
*Use of Different Data Sources*

| Data source | Citation code | Total | Example and description |
|---|---|---|---|
| Activity record* | ACT School ID - No. | 206 | ACTB -003 (Activity No. 003 for School B ) |
| Project Report | DOC School ID | 32 | DOC-B (Report for School B) |
| Interview | T ID: Line No. | 17 | T(Teacher ID No.: Line No. of transcribed document) |

*Activity records and Project Report were used at the Stage I, Document Analysis

## Data Analysis

In this study, the phenomenon observed is teachers' tablet teaching adoption process. The research data were gathered from multiple sources including: online activity records, project reports (shared at http://tablet.project.lins.fju.edu.tw/), and interview responses. In processing the research data, the data were analyzed and organized into specific categories based on the phenomenon under observation. Characteristics from the lived experiences of the phenomenon were identified and discussed (Cibangu & Hepworth, 2016; Kinnunen & Simon, 2012; Marton, 1981, 1986). In this approach, important statements, sentences, themes and interpretations were emphasized. Activity records and project reports were first used at Stage I document analysis for observing the approaches of tablet teaching employed by teachers. Through the process, relevant issues for tablet teaching were identified for further study. Interviews with the teachers followed for collecting in-depth information. The constant comparative method was used to analyze the data when summarizing the themes observed from the data (Creswell, 2013). Inductive analysis of the interview data started with open coding, followed by organizing themes and recoding data if new themes were observed (Figure 2).

## Reliability and Validity

In qualitative research, the use of a coding process to generate a description of settings and participants as well as the categories or themes for analysis is important (Denzin & Lincoln, 2011). The adequacy of the data is an important criterion for validity (Elo et al., 2014). The researcher was the coordinator of the tablet donation project and so collected the data as an insider. An important aspect of a researcher being insider is having a greater understanding of the culture being studied. Multiple perspectives provided by the data could be meaningfully interpreted from the context. However, greater familiarity might also lead to subjectivity. An explicit awareness of the possible effects of perceived bias on data collection and analysis, and respect on the ethical issues related to the anonymity is needed (Unluer, 2012).

The study used multiple resources across two academic years for interpreting the observed themes. In terms of credibility, the self-awareness of the researcher is essential (Clayton & Thorne, 2000; Wellington, 2015). The analysis of the document

contents in Stage I was used to identify the key process of the approach, and to gain awareness for the follow-up interviews and analysis. The various stages of analysis conducted for redefining new themes are summarized in Figure 2. To improve the validity of the data, interviews were elicited from experienced respondents (teachers with more than one year of experience in tablet teaching). The transcriptions of interview data were confirmed by respondents. To ensure the reliability of the data, multiple resources were triangulated to interpret the phenomena observed. Also, in the categorizing process of data analysis, another expert (in the field of tablet teaching) was invited to perform inter-coding. The reliability of consensus for the two inter-coders was: 85% for Question 1, 90% for Question 2, and 87% for Question 3.

## Results

Teachers' pedagogical and technology knowledge and attitudes toward tablet teaching could be interpreted as a dynamic learning process influenced by various conditions within the community, and would change over time through on-going tryouts of new approaches, and continuous modifying and redefining of pedagogy and teaching practice (Figure 1). Children's learning reactions and the challenges perceived by the teachers were influential conditions for teachers' adoption. These themes are described as follows.

### Processes for Adoption of Tablet Teaching

Activities were reported on the shared online platform. A total of 206 records reported from 32 different schools were tentatively analyzed for identifying the strategies employed by teachers for tablet teaching. For example, in School G and P, teachers started with training student TAs ( teaching assistants) from the class to help their classmates in use of tablets (ACTP-001; ACTG-001), then followed by various approaches, including: search for Internet resources (ACTG-003), anatomy learning (ACTG-004), reading (ACTG-006), photo-taking and video-shooting (ACTP-004), field trip for ecological observation (ACTP-014), and etc. From the document analysis, approaches for tablet teaching strategies were summarized. In addition to implementation in their own schools, these teachers also shared their experiences with other schools. Followed-interviews continued to gain insights into teachers' thinking, and more in-depth data were integrated into the data analysis process.

From the inductive analysis, the adoption processes of tablet teaching employed by the teachers were categorized into different stages: (1) Building knowledge for the use and management of the new devices in the classroom, (2) Exploring different interests that were shared by the community (teachers from their own schools or other schools), (3) Modifying and redefining the use of tablets for encouraging meaningful learning, and (4) On-going tryouts of new approaches. Interview data collected from

the 17 teachers reflected that the teachers changed their knowledge and attitudes along with the process of adoption. The themes observed from the sample data are listed in Table 3.

In the stages of (1) building basic knowledge for new devices, and (2) exploring different interests, teachers often started with small groups to try out the new devices. Learning and sharing among teachers and children (such as training workshops, and exploratory learning activities) were observed among these schools. Show-and-tell and downloading various applications were commonly used in the classrooms and after-school activities. Several platforms were adapted to facilitate electronic interactive teaching and learning processes. Mobile learning with the tablets was an exciting experience for most children.

> The children loved to use the tablets to search for learning materials. They also enjoyed sharing and discussing with me the information they got from the Internet. They were much more interested in the subject than they had ever been before (T1: 201-204).

In addition to in-class activities, the tablets were also used for after-class activities, such as remedial instruction, club activities, and preparation for various competitions. Most teachers considered exploring mobile learning different from traditional approaches to teaching, and this experience introduced multidimensional learning by both the children and teachers.

> In the remedial instruction, the children were teamed up. Search tasks were assigned for science exploration with the tablets (T1: 199-200).

> The children used the tablets in various out-of-class activities such as science club and international chat (T13: 12-13).

> In the information club, the children and I explored the setting up of AP using Linux. We tried to see whether it worked (T17: 75-76).

> We appreciated the opportunity for us to learn and explore. Without these tablets, we would not have had this achievement (DOC-7).

In stage (3), modifying and redefining integration, the teachers modified and redefined their approaches to tablet teaching. They employed tablet teaching from dynamic approaches that were integrated into the children's real-life experiences. Tablets were used as a management or planning tool for work and study (DOC-B), a creation tool for the development of applications (teaching children to design simple mobile applications) (DOC-A), or as a documenting tool for self-review of show-and-tell activities (DOC-G; DOC-J; DOC-U). More meaningful learning approaches were integrated in pedagogy planning with teaching content and technology use. These approaches employed a student-centered learning approach which included project-based learning in science

(DOC-B, DOC-P; DOC-U), scenario-based learning (with YouTube movies) (DOC-O; DOC-N; DOC-A1; DOC-P), and game-based learning (online mathematics problems, Pagamo, Kahoot, etc.) (DOC-H; DOC-W; DOC-X; DOC-Z).

The integrated activities with tablets involved advanced exploration by the teachers and children who shared a mutual interest in the learning space provided by the tablets. A tied connection among learning contents, pedagogy, and tablet technology was observed. Club activities for science, information technology, international exchange and local culture were furthered explored by the teachers and children. The tablets were also used for documenting various important events for these activities. For example, in culture-related research projects, the tablets' photo-taking and note-taking tools (using Evernote) were used for documenting visual information. Video-recording was also used for collecting interview data from informants (DOC-P, DOC-S). In the GreenMech contest (for engineering creation), the tablets were used as an analysis tool for group creations. Through documenting the procedures of their created works in various stages, the children developed critical thinking skills in the creation process, especially for prospective and retrospective analysis of their creative works. The tablets became a tool to identify "key-turning points" in the creation process (DOC-H).

> To prepare for the GreenMech contest, the tablets were used to record the procedure for the construction of the final products (engineering designs). The photos taken with the tablets helped the children analyze what needed to be improved in the construction process (T11: 99-102)

> We attended various contests, such as an environmental contest, a culture contest, and a traffic-safety contest. ... The tablets were used for collecting data and gathering needed information (T14: 22-23; 35-37)

> In the Veterans' Home, the children used the tablets to search for literature about the history of local veterans. The tablets were also used to record interviews in the project (T3: 253-256)

In stage (4), on-going tryouts, new approaches of interest were adopted by the teachers. A cyclic process was carried out for modifications and redefining teaching practices. In the process of full adoption, interactions among the members of the tablet teaching community were frequent (weekly or monthly for sharing and discussions among team members). These teachers shared their experiences with others and gained new insight from others. They often sat in others' classes to learn from each other (DOC-A; DOC-O; DOC-H; DOC-J;DOC-P; DOC-U; DOC-X) .

> Supportive team members in the community pushed us to move forward. We discussed, designed teaching plans and solved the problems together. Learning together within the context, we were able to think from students' perspectives, and helped them develop problem-solving capability in real life settings (DOC-U).

Table 3
*Themes of the Adoption Process Observed from the Sample Data*

| Stage | Theme | Description significant events | Example |
|---|---|---|---|
| Building basic knowledge of the new device | Exploring the features of the new devices | Basic operations of the tablet device (touching, tapping, tracking, I/O, use of browser) and the use of its peripheral devices were explored | ACTY-001 |
| | Tryout by teachers | A teacher training workshop was held in a school. A tablet teaching community was formed | ACTA1-003; ACTY-004 |
| | Tryout with a small group of students | A small group of children tried out the tablets. They were going to help other children in the classroom. | ACTP-001 |
| Exploring different interests | Classroom activities with diverse applications | Tablet teaching was used for different learning contents, including practicing with Junyi (Chinese language), reading instruction, mathematics, English, social science, and natural science | ACTU-003; ACTB1-001; ACTW-001; ACTZ-001; ACTX-001; ACTS-004 |
| | Remedial learning | Tablets were used for after-school learning by low-achievement students. | Used in every schools |
| | Preparing for competitions | Tablets were used for practicing and preparing for specific school competitions | ACTA1-006 |
| | Learning through playing | Tablets were used for learning with specific games, English songs, YouTube movies, Staria and GPS | ACTF1-014; ACTP-013; ACTE1-001; ACTG-012 |
| Modifying and Redefining of integration | Integrated learning approach | Tablets were used for student-centered learning projects such as planning a graduation trip. | ACTG-047 |
| | Eliciting learning and learning reflection | Show-and-tell activities were recorded for review of progress and self-directed learning | ACTH-011 |
| | Data collection for research projects | Tablets were used as data collection tools by children in a group science project | ACTP-013 |
| On-going tryouts | Adoption of new approaches from other teachers | Tablets were used in new approaches shared by other teachers. | ACTP-017; ACTH-034 |
| | Sharing of innovative approaches | Brand new approaches to tablet teaching were tried and shared with other teachers | ACTP-017; ACTH-034 |

## Children's Learning as an Inspiration

The tablets provided opportunities for new learning. The children's interest in learning from the tablets was inspiring for the teachers. The children's achievements included: learning the basics about tablets, more focus on learning, meaningful learning, and self-exploratory learning (Table 4). The teachers were willing to change their attitudes and perceptions of teaching. With openness to a new teaching approach, they learned together with the children. They also overcame the obstacles and barriers to technology integration, and learned to accommodate themselves to the new way of teaching.

Through tablet teaching, hands-on skills for operating tablets were first provided to the children. From experimenting and practicing, children were more focused

Table 4

*Themes for Children's Learning from Teachers' Tablet Teaching Approach*

| Theme | Key concept | Responses from teachers |
|---|---|---|
| Learning the basics about tablets | Practice for learning content | At the novice level, it is inevitable that one will face a trial and error phase. But over time, less time would be spent troubleshooting, there would be fewer barriers, and then we could put more effort into knowledge content and teaching. (T13: 190-191) |
| | Mastery learning | When the students had mastered tablet learning, the teaching role gradually faded out. They would teach each other and even solve things on their own. The students had great potential to accommodate new ways of learning and assimilation of knowledge. (T14: 61-64) |
| | | I found that these students (special students with difficulty in mastering fine motor skills) seemed to benefit from this learning environment. They seemed to know how to manipulate the tablets, and were more active and engaged than when asked to do paper and pencil learning tasks. (T16: 33-36) |
| More focus on learning | Getting attention | The tablets attracted the students' attention. For example, when the children responded to the questions in the system, the instant feedback like the pop-up "Congratulations, you are right!" with cute graphics really attracted the children's interest in learning. (T6: 325-326) |
| | More learning engagement | The children's engagement was significantly enhanced. They used to pay less attention during class hours. Even for a simple task, such as counting, it could not be handled successfully. Since starting to use the tablets during the past six months, they would be able to focus on learning. I was really amazed by their outcomes. (T15: 58-60). |
| | Scaffolding for thinking processes | The tablets provided scaffolding which was helpful for the children's thinking processes. Sixth graders were encouraged to focus on the Internet information needed for accomplishing the task sheet assigned in class. (T12: 52-55) |
| Meaningful learning | Alternative approach to understanding | I introduced an app called "Staria" (for astrology learning) to the class. The children practiced with the app and compared the application with what they had learned in the textbook. ….I guided them to look up Polaris through Staria, and then asked them to measure the distance between stars. After the exercise, I took them outside the classroom, and looked up to the sky to see those stars in a real context. (T1: 161-165). |
| | Observing and documenting | Before implementing tablets in the laboratory observation, my teaching approach was mainly traditional lecturing. This semester we started implementing tablets in the microbiology lab class. "Smart Microscope" was used for laboratory observation. "Evernote" (a note-taking app) was used to take notes. I found these (elementary) students were so engaged in the science class. (T14: 44-46) |
| | Synthesizing knowledge | The children learned to use GPS to identify location, and Staria for astronomy observation. Knowledge of science, such as earth science, and the life cycle of butterflies together with the use of mobile tools for supporting data collection were learned from project tasks. Synthesizing information and data from various media were observed. (T1: 160-164) |
| | Briefing and reflection | After 5-6 weeks of practicing summarizing with the app, the students knew what an "abstract" was, and how to make a summary of an article. In the next step, I taught them how to raise questions. Through questioning each other, they reflected on what was learned. (T6: 173-174) |
| Self-exploratory learning | Exploring thinking tools | I didn't spend too much time teaching them about these apps. They enjoyed exploring individually and collaboratively with their peers. They were often excited about discovering new features by themselves. For example (in using the concept mapping tool), one student discovered how to insert graphs (into the concept map), and another found out how to change a template. (T2: 70-73). |
| | Exploring language tools | The children were motivated to search for immediate language help from the online dictionary. (T13: 11-12) The children enjoyed learning English by singing songs with YouTube. (T13: 24-25) The children gradually developed interest and confidence in learning English. (T13: 33-34) |
| | Inspiring experiences | Through inquiry based learning, the students explored the Internet through tablets. I supervised their discussion, and talked to them for further exploration. The tablets offered inspiring teaching and learning opportunities for us. (T1: 142-149) |

on learning, and engaged more in meaningful interpretation and self-exploration of knowledge from their learning experience. The children enjoyed a wide variety of tablet learning opportunities provided by the teachers. Even learning the basics of tablet operation was an exciting experience for them. They also loved to share what they had discovered with their peers.

The use of the tablets also made the children engaged in multidimensional ways of thinking and learning, which totally differed from what they had experienced before. One of the most interesting aspects of the use of the tablets was exploring the diversity of applications. Some of these applications were powerful tools for specific subject learning, for example, Staria for learning astrology, Smart Microscopic for learning biology, and Evernote for note-taking. With these tools, the children were able to interpret knowledge with meaningful representations. Even the children with special needs felt comfortable with the interface for assisting their learning. For the teachers, the adaptation process entailed their openness, accommodation and willingness to learn with the children. The children were inspired to explore new features and new ideas when trying out the tablets and applications.

## Challenges and Strengths in Adaptation

Tablet teaching invited the teachers to pedagogically restructure the school digital learning space. Many teachers experienced the value of exploration in the integration of the tablets into their classroom and out-of-class activities. However, there were challenges and barriers when the teachers implemented the tablets in their classrooms. Examples of the teachers' responses regarding these challenges and barriers are listed in Table 5. The challenges include: technology, pedagogy, policy support, and community. Teachers with limited technology skills might feel reluctant regarding the integration due to the barriers of the mobile devices. Moreover, management issues related to having tablets well placed and power-charged for classroom use were also problems that the teachers had to deal with in their daily teaching practice with the devices.

From the pedagogical aspect, much preparation and planning needed to be managed before the class hours. Connectivity problems were always one of the major barriers mentioned by teachers. For successful implementation of mobile teaching, the teachers needed more support from the community, including government policy and funding support, the information industry (for the teaching platforms), and members within the community. For example, some teachers mentioned that temporary support from industry or uncertainty about government policies might hinder their integration of tablets into their teaching. These issues should be well considered in order to create an inviting and inspiring atmosphere for inviting technology integration.

Table 5
*Challenges of Integrating Tablets into Teaching and Learning*

| Challenges | Key concept | Example |
|---|---|---|
| Technology | Fluency in use | The students were also unfamiliar with this device at the beginning. Many times we were stuck for 10 minutes on just a tiny little problem. For the first time use, both students and teachers need to get used to mastering this device. Especially for teachers, we need to have the capability of handling issues like that right away on site. (T11: 114-115) |
| | Management | I was in charge of these devices. The management issues gave me a headache. (T12: 75) |
| | WIFI connectivity | It is quite frustrating if there is no WIFI connectivity while conducting tablet learning activities. (T1: 117) The biggest challenge to me is not about the shortage of tablets but the WIFI connectivity. (T12: 29-30) |
| Pedagogy | Time and effort needed | Time and effort were required to learn and get familiar with the tablets. There were curricula objectives and progress that teachers needed to achieve on a weekly basis. Therefore, not many teachers were willing to participate in the pilot run. (T12: 85-86) |
| | Accommodation for trial and error | After this first semester of trial and error, I discovered that tablet teaching among teachers was more challenging than tablet learning among children. The children had more potential to accommodate the new devices than the teachers. (T13: 63-64) |
| Policy support | Limited funding | There was no funding support for purchasing tablets for the use of mobile teaching and learning. (T3: 8-9) The Ministry of Education only supported funding for setting up the classroom environment for mobile teaching and learning. (T7: 90-101) |
| | Uncertainty about policy | At the very beginning, I hesitated to apply for implementation (of tablet teaching). I was not so certain about the policy. (T1: 82-83) |
| Community | Colleagues and atmosphere in the school | In my case, I could not find any peers around. I had nobody to exchange my experience with. (T15: 96) Most teachers were reluctant adopters. Working with tablet teaching would bring them a great deal of pressure in the class). (T13: 74-75) |
| | Uncertainty about supportive community | There were some uncertainties to work with the information industry (for the teaching platform). They might provide free support for the first year, but requested you to pay for the following years. (T3: 232-233) |
| | Concerns of parents | Parents were concerned about children playing games with the tablet… and too much use of tablets would cause vision problems. (T11: 120-121) |

Although there were challenges, the teachers gave positive and promising comments regarding the tablet teaching approach. Examples of the teachers' responses concerning the strength of integration are listed in Table 6. These positive responses to their tablet teaching experiences include: growth with the community, peer collaboration, inspiration from teaching, and support from the community. Some teachers participating in the teacher community, "mobile-teaching-interest group", highly valued the experiences shared by members from other schools. They also cherished the relationships built from monthly meetings for the pioneering use of tablet teaching in the classroom. Their innovative approaches inspired other teachers to try. Since the children were highly motivated to engage in various learning activities with tablets, more active and meaningful learning was involved. The children's motivation and achievement in learning also encouraged the teachers to try out with the devices in their teaching. Along with the process of integration, support from the authorities was also important.

With authority support from their schools and from the government, the teachers were more willing to face the challenges of tablet teaching.

Table 6
*Strengths of Implementation*

| Strength | Key concept | Teachers' Responses |
|---|---|---|
| Growth with the community | Learning from others | Participation in the teaching community helped me a lot. I learned a great deal from my peers, and built up competence in tablet teaching. (T1: 127-129) |
| | Sharing of expertise | When I came to this teaching community, I realized that I was not alone, everyone from different schools all confronted WIFI connectivity issues. Since it was a common issue, I felt I could share my expertise to solve this problem. (T17: 183-186) |
| | Stimulation from others | Teachers who were promoting tablet teaching stimulated others. There were only two teachers willing to try out tablet teaching at the beginning. Ten teachers joined the group and are engaged in tablet teaching now. (T12: 87-89) |
| Peer collaboration | Building partnerships | My teaching partner helped me a lot. He was technology savvy. I always turned to him when I had technical problems. His generous tutoring and sharing boosted my tablet teaching confidence. (T16: 126-128) |
| | Bridging the gaps in campus | New generation teachers lead us to explore new ways of teaching. I really appreciated their help. And our principal also supported our transformation. (T14: 72-74) |
| Inspiration from teaching | Enjoyment of the children | The children were excited to work with the interactions of tapping and sliding the touchscreen on the tablets. (T9: 62-63) |
| | Children's attitude and learning | The children's attitudes toward learning changed. They became active learners. They came to me with questions and discussion. (T1: 105-108) |
| | Achievement from teaching | Now I really enjoy teaching. With these tablets, I was thrilled by the students' learning potential. I also learned a great deal while teaching. (T15: 106-107) We saw students' transformation from passive learning to active learning. It was worthwhile for us to face more challenges. (T13: 77-78) |
| Support from the community | Support from authority | Having the principal's support made it possible to promote tablet learning. (T17:178) The challenges we faced before are now turning into strengths. Issues we have encountered are discussed among the higher authority of the school. They were planning budgets to build up the WIFI infrastructure next semester. We are turning the challenges into opportunities. (T12: 78-80) |
| | Support from information industry | The County Government collaborated with Chunghwa Telecom to set up the cloud server and needed connections. Teachers and children could benefit from the facility support. (T9: 23-26) |

## Suggestions for Future Implementation

Experiences from tablet teaching offered schools opportunities for pedagogical restructuring of the learning activities, which encouraged the children to learn diverse knowledge with up-to-date mobile technology. Many teachers provided comments for future implementation of pedagogies including: scaffolding of operation skills, more exploratory opportunities, team approach, synthesizing knowledge, use of instant feedback, and a diversified integration approach (Table 7). The tablets offered opportunities for learning exploration. Teachers' planning and design of tablet activities also took into consideration the needs of culture and life in the community. Skills and knowledge relevant to the children's real life experience would motivate them to learn.

To help the development of information literacy in the use of tablets, scaffolding children with basic operation skills was suggested. Children also required guidance in learning subjects with available software applications. The use of the instant feedback with tablets was considered effective in helping students focus on the learning content and in encouraging active responses. In pedagogical planning for specific subject

Table 7
*Suggestions for Future Implementation*

| Suggestions | Key concept | Responses |
|---|---|---|
| Scaffolding of operation skills | Basics for starting up | In the beginning, the introduction to the use of apps was essential. The skills of downloading were applied in other tasks. (T2: 66-67) |
| | | At first, we acquainted them with the hardware; later on, we led them to think about how to use the tablet PCs in learning. For in-depth subject knowledge construction, I would suggest implementing it at a later stage. (T13: 37-39) |
| | Guidance for skills development | Narrowing down their searches from the Internet required re-defining the use of keywords. Guidance for them to explore more relevant information was needed. (T3: 110-111) |
| More exploratory opportunity | Free exploration | As long as students were provided with time and space, they could explore by themselves. ...With a good exploration tool such as a tablet PC, they would explore more than you ask for. (T17: 127-128) |
| | Guided exploration | Movie clips about landslides downloaded onto tablets would be a good starting point for learning earth science. A task sheet was designed for further exploration of the issue. (T5: 43-46) |
| Team approach | Team duty | From group exploration, children learned to share duties, discuss with others, and accomplish tasks through collaborative learning. (T12: 43-44) |
| | Team reflections | The children were teamed up to play Q&A for reflective learning in the lessons. The tablets were used for recording their reflections. (T1: 49-51) |
| Synthesizing knowledge | Training of thinking-aloud | I used a sharing teaching approach. I asked students to be teachers; they needed to prepare teaching materials, and they would teach on stage. At the beginning they might seem to be immature in teaching; I would facilitate their teaching, provide supplementary information, and give them advice for next time. (T11: 71-73) |
| | Project-based learning | The children enjoyed active learning with extended activities, such as research projects or international exchange. The tablets were used as a tool for documenting data. (T13: 36-37) |
| Class engagement | Instant feedback | We knew when the students confronted learning problems because they responded right away. Through instant feedback, their engagement was maintained. The tablets helped individuals and groups actively think and respond. (T12: 52-53) |
| | Frequent interactions | The tablets facilitated interactive learning and instant feedback in the class. The tablets did better than the teachers, especially when the students were having difficulty expressing their ideas orally. …The children found it helpful and felt acknowledged in the process of response-and-feedback. (T16: 27-29) |
| Diversified integration approach | Teaching with apps in various subjects | I suggest using tablet PCs to teach Chinese, math and information literacy. For other subjects taught by different teachers such as social studies, natural science, health, humanities and art, I would encourage those teachers to integrate tablet PCs into their classroom teaching with the use of various apps via tablets with assigned problems. (T11: 87-89) |
| | E-reading | I suggested developing their habit of looking for information via the tablets, and cultivating their interest in e-reading. I would ask the children to reflect on what they had learned with the tools. (T2: 47-48) |
| | Entertainment | When the students finished their assignments, I rewarded them with the use of a tablet (with a headset). They so longed to listen to pop songs on the tablets. The children enjoyed visiting YouTube and playing their favorite songs. (T16: 106-108) |

domains, employing inquiry-based learning would create an atmosphere of knowledge acquisition. The approach also stimulated the children's curiosity and encouraged them to explore new knowledge. The children teamed up with their peers, which encouraged them to share duties and reflections on their learning. They also experienced collaborative learning opportunities for the co-construction of knowledge.

For teaching development in the future, teachers experienced the mutual learning opportunities provided within the community. Most of the teachers who experienced tablet teaching gradually overcame some of the barriers encountered during the process. They also developed capability in the design of tablet teaching activities which facilitated students' transformation from passive learning to active learning. The teachers also strongly suggested connecting with other peers with the same interests, and participating in various workshops for mobile teaching.

## Discussion

In this study, the process of adopting tablet teaching is summarized in Figure 3. Themes together with the process of teachers' adoption of tablet teaching were developed from the observed data. Tablets are appealing to many children, and are considered to have the potential to enhance the emergent literacy skills of the young generation (Neumann & Neumann 2014; Phiri et al., 2014). From this study, it was observed that teachers experienced the use of the new device and a learner-centered paradigm shift in tablet teaching. Teachers' adoption process was summarized as: building basic knowledge for the new device, exploring different interests, modifying and redefining integration, and on-going tryouts. As the teachers became more involved in tablet teaching, the repeated process of "on-going tryouts" and "modifying and redefining" made them gain more pedagogical knowledge of tablet teaching. From a constructivist perspective in TPCK, teachers were offered with opportunities to enact curriculum through pedagogic approaches with on-going try-outs of new technologies (Koehler & Mishra, 2009; Taber, 2017).

The adoption process summarized in this study is in accordance with the concepts derived from Rogers' works (Rogers, 2003) which addressed five stages of diffusion (awareness, interest, evaluation, trial, and adoption (p. 79) (Rogers, 2003). From the adoption process, teachers changed in their knowledge (of technology, pedagogy, and teaching content) in their technology adoption through interactions with other members of the community (teachers, students, and other community members). Additional interpretations regarding the epistemology of TPCK also discuss technology and its relationship to *content*, *pedagogy*, and *learners*, and explain how teachers use the affordances of technology to transform content and pedagogy for learners (Angeli & Valanides, 2009; Engeström, Miettinen, & Punamäki, 1999; Liaw & Huang, 2015; Rozario, Ortlieb, & Rennie, 2016).

Integrating new technology into teaching involves conceptual change of knowledge and beliefs perceived by teachers, and processes of familiarization, utilization, integration, re-orientation, and evolution (Al-Senaidi et al., 2009; Ducate & Lomicka, 2013).

Decisions to include activity-based exploratory opportunities in tablet teaching encourage teachers to develop diverse thinking and problem-solving skills, and construct new pedagogical knowledge in tablet teaching settings (Fabian & MacLean, 2014; Gerard, Knott, & Lederman, 2012). Our study concluded that a successful integration process encouraged teachers to try out more new innovative approaches, to accommodate new ideas, and to modify their strategies to cope with problems encountered. These processes empowered the teachers with knowledge of managing pedagogy, technology, and learning content. Teachers' integration experiences reflect diverse approaches to their use in various subject areas and extended activities. The use of tablets became an integral part of their knowledge of teaching. Many teachers changed their understanding of and attitudes toward the use of tablets in teaching.
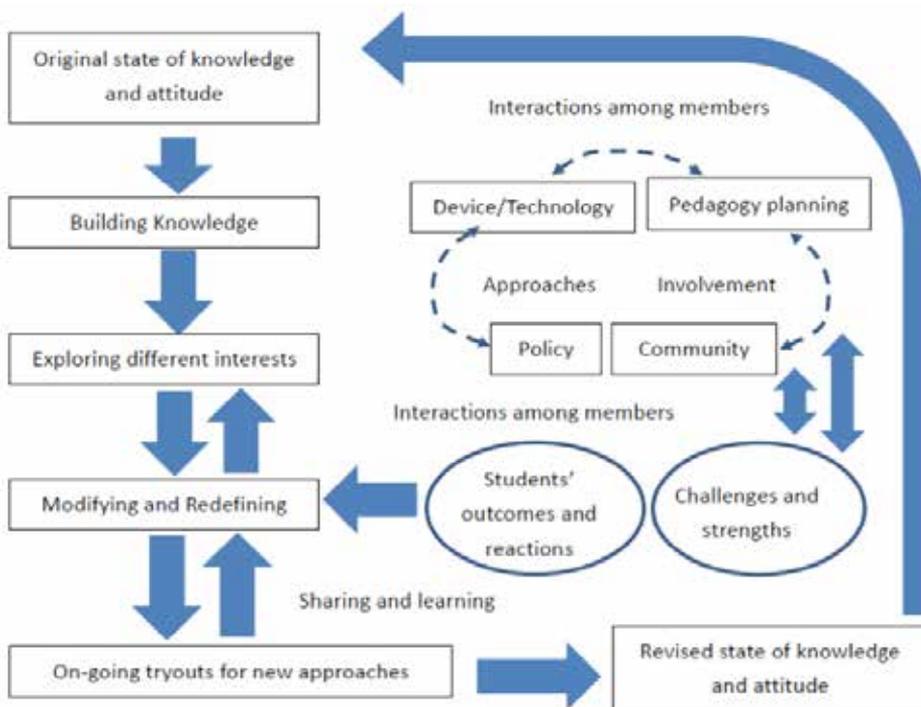


*Figure 3*. Adoption processes for tablet teaching among teachers.

*Note*. Teachers' adoption in tablet teaching was summarized as a cyclic process of building basic knowledge for the new device, exploring different interests, modifying and redefining integration, and on-going tryouts. Within this process, interactions among the community members are important for teachers' construction of knowledge in tablet teaching.

According to the teachers' responses, the use of tablets made the children more focused on multidimensional ways of thinking and learning, which totally differed from what they had experienced before. Much literature has addressed that both teachers and students share the interactive learning space supported by tablets in the learning context (ChanLin, 2016; Kumbargoudar, 2013; Schlicht, 2013). Issues related to providing scaffolding for instructional, social, technical, and managerial approaches contribute to a connective tablet teaching and learning environment (ChanLin, Chou, & Hung, 2015; Kabanda, 2014; Ozan, 2013). The children enjoyed the use of tablets to explore the diversity of applications. Observed by the teachers, the children learned the basic operations of the tablets, were more focused on their learning, and experienced meaningful interpretations of knowledge and self-exploratory processes. The children's learning and achievement were inspiring to the teachers who integrated tablets into their teaching.

There were challenges and barriers encountered by the teachers. A summary of the challenges faced by the teachers includes: tablet technology, pedagogical concerns about using tablets, policy support, and community support. Teachers changed pedagogical decisions, and shifted their mindset to more student-centered philosophies in the integration of tablet teaching approaches (Blackwell, 2013; Chui & Churchill, 2016; Peterson, 2011; Taber, 2017). In our study, the teachers greatly valued the chance for the children to experience the latest technology. Although there were barriers and challenges in its implementation, they tried their best to overcome the problems. The strengths regarding the implementation of tablet teaching summarized in this study include: growth with the community, peer collaboration, inspiration from teaching, and support from the community. The teachers cherished the relationships built in their community. They were inspired by the children's achievements, and were willing to influence other teachers in the same schools.

For future implementation, suggestions made by the teachers include: scaffolding of operation skills, more exploratory opportunities, a team approach, active expression and synthesis of knowledge, active responding, and a diversified integration approach. Prior research has suggested the use of applications with tablets to support children's development strategies for representing problems, constructing arguments, solving problems, and building a self-monitoring learning process (Beggs, Shields, Telfer, & Bernard, 2015; Chen & Law, 2015). More effort in the fields of information sciences for exchange of new ideas in a meaningful way would be helpful for creating an inviting environment for teaching and learning (Conejar, Kim, & Lee, 2016). In the implementation of tablet teaching, pedagogical planning for encouraging motivation to learn with tools as well as inquiry learning in specific subject areas are both essential. Creating an atmosphere of knowledge acquisition in inquiry-based learning stimulated the children's curiosity to learn in specific domains. Advancing pedagogy to encourage active and self-monitoring knowledge acquisition was also suggested by teachers in future tablet teaching practice.

## Conclusion

According to TPCK, teachers' knowledge in integrating tablet teaching entails reflection and experimentation, and collaboration with others. The TPCK also emphasizes connecting technology and its relationship to content, pedagogy, and learners. In this study, teachers' tablet teaching adoption processes were studied. The culture of tablet integration among the members with dynamic characteristics in the community was also observed. The teachers' and students' participation in cultural communities was focused on. Various approaches were employed by the teachers, most of whom considered tablets as an ideal tool for the integration of active thinking and expression. To encourage the children's use of tablets as a learning tool, the teachers' knowledge of the pedagogical planning of learning activities and of the use of tablets in advanced activities was enhanced. Through openness of tryouts among teachers, the capabilities embedded in the tablets were explored. The children were offered opportunities to explore the tool in their free time, and to integrate the use of tablets in diverse learning contents they were interested in. The teachers and children shared the learning space within the community. The children's learning motivation and sense of achievement from using the tablets became an inevitable power that propelled the trend of tablet teaching and learning. Along with the process of integration, support from the community was also important to encourage teachers to devote their time and effort to implementing tablet teaching in their classes.

For future studies, it would be worth exploring the specific innovative approaches of these experienced teachers, or identifying the barrier factors faced by teachers in the implementation of tablet teaching. Strategies for supporting children with special needs in various communities are also necessary for understanding tablet teaching and learning in diverse settings. The impact on tablet learning adoption by children within and outside of the formal curriculum should also be studied in the future.

This research is preliminary and is limited to certain schools. Further research on different learning settings may shed light on developing further guidelines for tablet teaching implementation and application.

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