Implementation and Evaluation of Three Learning Activity Levels in Wireless Learning Environment

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Abstract

With the emergence of information technology, wireless communication and mobile devices are the newest applications in education. The wireless technology enhanced classroom (WiTEC) integrates wireless local area network, mobile learning devices, and client-server architecture to support instruction and learning activities in classroom. This paper introduces the framework of three learning activity levels, namely learning function, learning episode, and learning flow, as the basis to design and develop an integrated system to support various kinds of learning activities in WiTEC. A teacher can use the system to form new learning flows before class and to implement them in class. A two-stage evaluation was conducted in three elementary classes to investigate the usability and feasibility of the proposed system. The participated teachers indicated that the integrity mechanism of three learning activity levels eases the burden of preparing, implementing, and reviewing instruction and learning.

1. Introduction

In the last decades, lots of innovations tried to be applied in the classroom, such as radio, television, film, video, and the computers. Besides of the computers, most of the media technologies, which are all in the form of one-way communication, have had only isolated, marginal effects on how and what children learn in school, despite early champions of their revolutionary educational potential [11]. Even the computer still could not cause intrinsic impact in classrooms due to the heavy weight, messy wires, and keyboard and mouse based operation. It is important to understand where it is going before jumping into the specifics of the educational changes that technology will cause [12]. Most applications of wireless and mobile devices in learning are using small size display devices, such as personal digital assistant [2][3][7] and portable computer [1], to support outdoor or mobile learning. Those show that ubiquitous educational technologies can greatly expand the range of activities that students can undertake [12].

Our early work focused on the development of Wireless Technology Enhanced Classroom (WiTEC) that integrates wireless LAN, mobile learning devices (MLD), an electronic whiteboard, a resource and class management server, and an interactive classroom server to support everyday activities unobtrusively and seamlessly in classroom contexts. Among these devices, interactive learning center, installed on MLD, supports learner's interactions with peers, instructor and their own interactions within content-rich contexts without barrier. The interactive instruction center, operated through electronic whiteboard, assists teacher to play the role of mediator, supporter, facilitator or guider during everyday classes. The resource and class management server manages teaching and learning resources, activity content, students' learning and teacher's teaching; and the interactive classroom server keeps track of individual operating processes as well as coordinates interactions between teacher-student and among students. In contrast with traditional classrooms, the WiTEC enhances productive interactions of teacher-students and peers [9], enables the teacher and students to concentrate on teaching and learning itself rather than spend too much time and efforts on tedious tasks. It helps the teacher to easily monitor each student's learning status for further gudiance, to engage students in learning activities, to facilitate students' group collaboration and to empower the teacher and students to apply technologies to a variety of traditional and innovative learning and teaching activtities [10]. These features of WiTEC can effectively support and enhance the teacher and students to carry out many instructional and learning activities that are difficult to be implemented in ordinary classrooms, such as Jigsaw model and project-based learning [9][10].

Gay et al. (2001) noted that 'not every teaching activity or learning community can or should successfully

integrate mobile computing applications' [5]. Tuckman also stated that 'The nature of the instructional model is the critical element in technology-enhanced instruction' [13]. The WiTEC has been established and tested in practical classroom settings, but some issues remain to be further explored. Different structures of classes, learning contents, and pedagogical models all influence the productivity of learning and instructional activities in WiTEC. Therefore, it is necessary to consider if other innovative learning approaches are appropriate for the WiTEC. Besides, whether or not the WiTEC can achieve its anticipated capabilities and facilitate students' learning effectively depends on how the teacher and students use it. Hence, it is important to guide class members appropriately using the device and to immerse these technologies with everyday teaching and learning activities [8]. In addition, developing appropriate guiding tools for effective implementation is the key for the WiTEC to progress from the research stage to practical use.

This paper is to propose a framework of three learning activity levels, namely learning flow, learning episode, and learning function, to support designing and implementing instruction and learning activities in wireless learning environment. An integrated system, which comprises instruction supporting subsystem, learning supporting subsystem, and collaboration mechanism supported by learning functions, was developed by adopting the framework to support teaching and learning activities in WiTEC. The system not only provides flexibility of activity design that enables the teacher to arrange and implement learning activities, but also provides extensibility of system functions that enables the system developer to add new features based on practical needs. For investigating the usability and feasibility of WiTEC with learning flow, a two-stage evaluation of three sixth grade classes, based on collaborative learning, using the proposed system was conducted.

2. Three Learning Activity Levels

Learning activities in classroom could be designed, analyzed, and evaluated from three levels of different scale units: learning flow, learning episode, and learning function. Therefore, the progression of a learning activity could be presented by a learning flow, which is composed of several learning episodes supported by many learning functions. A learning function is a specialized mechanism for facilitating learning activities, such as content presentation and content transmission. A learning function could be defined by three elements: *action*, *content*, and *participants*. For an example, content presentation function allows a teacher to present content to students. The action in this example is "to present" and participants are the teacher and students. A learning episode is the basic unit of a learning activity while performing specific instruction and learning, such as lecturing, group discussion, and creating reports. Each episode is supported by a small set of learning functions. For an example, "teacher's lecturing" episode requires content presentation and annotation functions for the teacher to present content and take annotations on presented content. A function may support several learning episode; for instance, content presentation function supports both teacher's lecturing and students' group work presentation episodes. A learning flow is a collection of learning episodes with sequences to perform a completely set of learning activity. For an instance, a learning flow may be composed of four episodes: teacher's lecturing, students' group work co-construction, students' group work presentation, and students' peer voting. For fitting different students' status, a learning flow may have branches to skip or switch some episodes. Different combinations and sequence of learning episodes can produce various learning flows for realizing diverse instructional strategies or for particular students.

The WiTEC greatly supports many learning functions, facilitates various learning episodes and learning flows, and increases efficiency or convenience of activity. That is, the teacher can select learning functions to compose specific learning episode and organize learning episodes to create appropriate learning flow for particular learning method or instruction strategy.

By adopting the framework of three learning activity levels into WiTEC, system developers can freely add new learning functions into the system based on practical needs to extend the applications in classroom. The well arranged learning episodes could be used to implement specific instruction strategies and shared with other teachers. In addition, learning flows let a teacher pre-think about instruction procedures before class, guide both instruction and learning in class, and facilitate the teacher to review students' learning portfolios after class.

3. System Description

Learning and teaching in WiTEC make students and teacher enjoy the benefits of ubiquitous computing. This paper applies the framework of three learning activity levels to establish an integrated system to support instruction and learning in WiTEC. The integrated system includes an instruction supporting subsystem for teachers, a learning supporting subsystem for students, and a collaboration mechanism supported by learning functions. It provides tools for not only supporting in-class instruction and learning, but also before-class preparation and after-class reviewing.

3.1 Instruction Supporting Subsystem

In the WiTEC, instruction supporting subsystem combines interactive instruction center and resource and class management server to support teachers for preparing and implementing instruction. The teacher uses interactive instruction center to control the pace of instruction, to monitor students' status, and to perform activities. Learning functions of the instruction supporting subsystem are listed in table 1. Every learning function associates action, content, and participants. The "voting" function, for example, lets whole class students (participants) to vote (action) for a question (content). The teacher can setup question type, number of options, and statistical graphic type to collect responses from students and instantly display statistical result on the form of numerical data together with graphics on the frame of interactive instruction center.

Table 1. Summary of learning functions in the instruction supporting subsystem

Function	Content	Participants	Description
content transmission	transmitted document	individual student, group, or whole class	transmit content to individual student, group members, or whole class
co-construction of quiz	quiz file	group member	compose items to form a quiz
co-construction of report	report file	group member	compose pages to form a group report
display quiz	items	whole class	whole class based simultaneous test, display statistics of items and whole quiz
group work presentation	presentation file	group member	retrieve presentation file and display
replay annotations	annotations	teacher	replay annotations on different speed
replay learning records	learning records	individual student	replay individual student's annotations on a specific material
student mapping & control	interactive learning center statuses	whole class	display students' statuses, interface for retrieving learning records
teaching notes	e-book file or webpage	teacher	annotations on e-book or webpage
voting	question	whole class	collect responses and display statistics

Functions in the instruction supporting subsystem not only support teacher-oriented activities but also support student-oriented ones. For example, 'annotation' and 'content transmission' are teacher-oriented functions which let a teacher lecture to whole class on the electronic whiteboard and transmit related materials, such as annotations on e-book, to students. On the other hand, 'co-construction of report' and 'display quiz' are student-oriented activities. Group members are automatically logged into resource and class management server to edit their own group report. They discuss details face-to-face to complete the group report by modifying page content, arranging page sequences, inserting and/or deleting pages.

There is a learning flow editing tool in the instruction supporting subsystem for teachers to arrange their own learning flow before class. Figure 1 shows a snapshot of editing a learning flow. A teacher can create a learning flow by firstly giving a label and then add new learning episodes in it. Once a learning episode is generated, the teacher can choose learning functions s/he needs from the function list and add them into the learning episode. Each learning function automatically contains related materials so that the teacher does not need to choose further. In addition, the teacher can implement an existed learning flow in class anytime s/he wants.

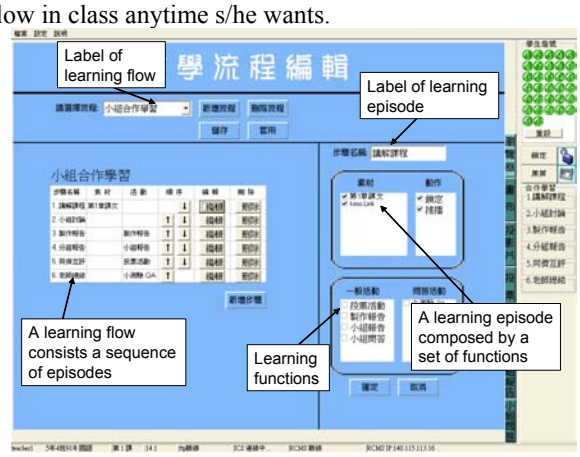

Figure 1. Teacher uses the learning flow editing tool to arrange activities before class

For example, the teacher can generate a learning flow, named "collaborative project-based learning", including six learning episodes which are 1. "introductory discussion", 2. "group discussion and information gathering", 3. "co-constructing group product", 4. "group presentations", 5. "peer-evaluations among groups", and 6. "discussion and conclusion". The "introductory discussion" episode may contain two learning functions which are "annotation" and "content transmission". The "co-constructing group product" episode may contain two learning functions which are "co-construction of report" and "co-construction of quiz".

Figure 2 shows a frame while implementing the learning episode of "introductory discussion" in the classroom. The teacher firstly clicks the learning function labeled "annotation" in the learning flow area and the associated e-book file would be automatically displayed on the content area of the frame. The teacher can use annotation tools to annotate on the e-book. After completing annotations, the teacher clicks the learning function labeled "content transmission" and the e-book together with annotations on it would be transmitted to whole class students' MLD. The learning flow lists at

right hand side of the frame. While the teacher clicking on one of the episodes of the learning flow, function list of the episode will be extended within the menu. Furthermore, all students' MLD statuses are displayed on the right upper corner. It lets the teacher instantly monitor the progress of activity students performed. This area, furthermore, is also the interface for retrieving individual student's learning records while performing the learning function of "replay learning records".

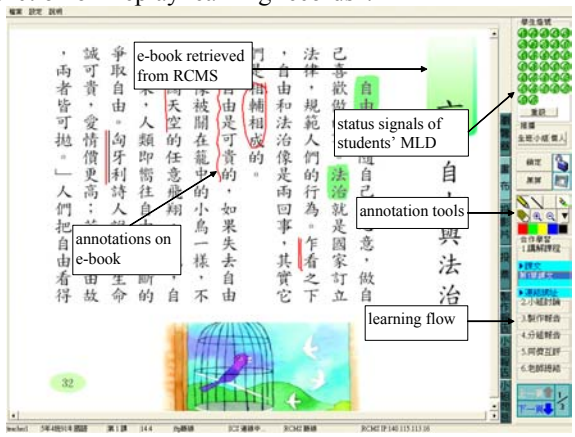

Figure 2. A snapshot while implementing the learning function of "annotation"

WiTEC, which adopts client-server architecture, provides the flexibility to add, delete, and organize learning functions for instruction. Before class, the teacher arranges the learning flow in interactive instruction center and the learning flow would be stored in resource and class management server. In class, the teacher retrieves well arranged learning flow from resource and class management server and then performs each learning function in interactive instruction center. After class, the teacher and students can retrieve instruction and learning records from resource and class management server.

3.2 Learning Supporting Subsystem

There are several functions corresponding to instruction supporting subsystem in learning supporting subsystem for students. For example, once the teacher performing the learning function of "voting", every student's interactive learning center would automatically activate the corresponding "vote to question" function by the command of instruction supporting subsystem. A number pad will pop up on the frame of each student's MLD to wait for response. After the student clicks on one of the number buttons, the response would be sent back to instruction supporting subsystem and the statistical results would be shown on the frame instantly. Besides corresponding functions with the instruction supporting subsystem, there are isolated-execution functions in learning supporting subsystem such as 'notebook' and 'note on MLD'. Table 2 lists the learning functions of learning supporting subsystem.

The learning supporting subsystem combines interactive learning center and resource and class management server. Resource and class management server stores learning materials, student profiles, and group setting. Once a MLD boots up, it would be automatically logged into resource and class management server to join the group it belongs. The memory of MLD stores temporary data only. After completing an operation of a learning function, temporary storage of the MLD would be stored in the corresponding area of resource and class management server. In addition, the group based products of a collaborative learning function are stored in the group area of resource and class management server.

Table 2. Summary of learning functions in the learning supporting subsystem

Function	Content	Participants	Description
construction of report	report file	group member	edit pages of the report
construction of quiz	quiz file	group member	edit items of the quiz
content receiving	received document	individual student, group member, whole class	receive material sent from instruction supporting subsystem
learning notes	e-book file or webpages	individual student	annotations on e-book or notebook
notebook	notebook file	individual student	sketches on notebook
respond quiz	items	whole class	respond to items in the quiz
vote to question	question	whole class	respond to question and transmit to instruction supporting subsystem

3.3 Collaboration Mechanism Supported by Learning Functions

Most of collaborative learning activities rely on learners to construct material about courses and to make it accessible to other learners [4]. Such kind of collaborative activities let students sharing each other's sentences, pictures, notes, or any other constructed materials generally via a web-based interface [6]. Pupils are loosely coupled during the learning process. However, there still are many kinds of instruction and learning activities, especially group based simultaneous activities, can not be implemented in this manner.

Besides of collaborative learning, lots of instruction and learning activities also need collaborative mechanism. The collaborative mechanism supported by learning functions is based on the two servers which are resource and class management server and interactive classroom

server. Resource and class management server, basically, is a web-based collaborative activity center which provides shared working area for peers within a group while they are co-constructing group products. In addition, interactive classroom server coordinates not only actions but also contents of learning functions. For example, the teacher transmits a project guideline to the designated group by performing the "content transmission" function. Interactive instruction center firstly retrieves group setting information from resource and class management server and then transmits the guideline to all members of the group through interactive classroom server. That is, interactive classroom server is a synchronous collaborative activity coordinator that supports activities which need to be real-time processed or responded.

Figure 3 illustrates the operating mechanism between interactive instruction center, interactive learning center, and interactive classroom server. There are seven modules, which are categorized to three blocks, in interactive classroom server. The daemon block comprises the daemon and protocol-parsing module. The connection management block comprises connection management and authentication module. In addition, the activity control block comprises message delivery, response control, and broadcast control module. The daemon block receives, transmits, and parses highly interactive protocols. The connection management block authenticates logins from interactive learning center and interactive instruction center, handles the connection of all interactive learning centers in the classroom under wireless communication, and detects the connection status of each interactive learning center as well as to recover the disconnect one. The activity control block processes both synchronous and asynchronous activity protocols. All of the synchronous activity protocols are processed by the broadcast control module and response control module while asynchronous activity protocols are processed by the message delivery module.

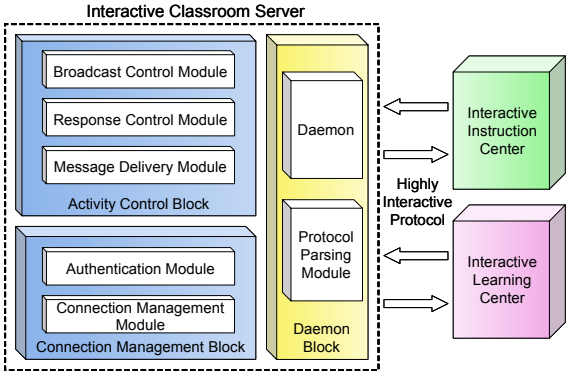

Figure 3. Seven modules in the interactive classroom server to support collaboration in WiTEC

For example, once interactive instruction center performing the "voting" function, it sends the corresponding highly interactive protocol to the daemon of interactive classroom server. The protocol-parsing module parses the received protocol and then passes it to the response control module. After processing the protocol, the responded protocol would be generated and then sent to all interactive learning centers through daemon to activate the "vote to question" function of interactive learning center. On the interactive learning center side, the activated "vote to question" function waits for the student's response and the responded data would be encapsulated as a protocol and sent back to interactive classroom server through the daemon, parsed by the protocol parsing module, and then the response control module sends the response to interactive instruction center. The final result of the "voting" function would be displayed on interactive instruction center by collecting all the responses from interactive learning centers.

Asynchronous activities are also coordinated by interactive classroom server. Once an interactive learning center activating an asynchronous activity, such as "construction of report", it communicates with interactive classroom server and would be authenticated and automatically logged into the corresponding working area of resource and class management server which belongs to its group. Consequent operations would be directly processed between interactive learning center and resource and class management server.

4. Evaluation

To evaluate the usability of the integrated system and the feasibility of the learning flow, this study conducts a two-stage evaluation. The first-stage evaluation focuses on the teachers' opinions about applying learning functions or that are not integrated by the instructor as the learning flow in the class. The second-stage evaluation focuses on the teachers' opinions of applying the learning flow in the class and whether WiTEC affects the instruction through the learning flow. The subjects of the two evaluations are the three teachers in Nan-Hu Elementary School, Taipei, Taiwan who have participated in the experimental project. Each Student uses a webpad, which equipped 10.4 inches TFT-LCD with touch panel and running Windows CE as well as learning subsystem, as MLD. Teachers use 72 inches electronic whiteboard, which connected to a PC and running Windows 98 as well as instructional subsystem, to implement their instruction in classroom.

4.1 Stage 1 Evaluation

From May 2002 to January 2003, three participating classes have adopted the first version of the WiTEC systems, in which the learning flow was not developed and only a variety of learning functions are provided for the teachers and students to select. Furthermore, we have conducted an interview with the three participating

teachers on January 2003. The results of the interview with the three teachers (whose first names are abbreviated as C, H, and J) are summarized as follows:

The complexity of WiTEC:

- The system interface seems to be user-friendly – only two or three hours needed to familiarize the operation of the entire system. (C, J)
- Less frequently used functions still need to be reviewed before formal usage – this is not due to the unclear descriptions of the functions, but owing to the large number and complexity of the functions that makes it difficult to memorize. (H)

Frequently-used functions of WiTEC and the whys:

- **Content transmission & annotation:** these functions help me present and broadcast the prepared digital materials to the students quickly. When using text materials in the class before, many students often could not find the contents or follow the teacher's pace. After using this function, this situation has been improved a lot. (J,H)
- **Voting & quiz:** these functions enable the teachers and students to immediately know the results and scores of answering, which avoids inconvenience and saves much time. (C, H)
- **Co-construction of report:** this function is also used frequently. 'If I plan to let the students carry out group discussion and reporting, I will arrange the assignment and questions before class, and broadcast the assignment or questions to each group for group discussion and report activities during the class.' (H)

Favorite functions:

- 'I select appropriate function according to the course needs, and have no specific preference.' (J)
- **Replay learning records function** is useful for sharing the learning results to the whole class and enables the teacher to know the students' learning status immediately. (C)
- **Co-construction of report:** In-group members can use this function to co-create, share, or revise the contents of group reports. (H)

Functions that want to be added

- The functions of the system are plentiful and useful, thus the teachers often need to consider what to do for next steps and which functions they should use, which explicitly increases their burden. Some functions are suggested to add in order to facilitate the teacher in applying various functions to the preparation before class or in-class instruction. (C, H, J)
- Adding the calculator function or providing blank space for calculation. (C)

In sum, the participating teachers basically held a positive attitude toward the system functions, but they still have some expectation on the usability and convenience of the system. On the one hand, all of the teachers felt that various functions of WiTEC are very useful. They also, furthermore, considered that various functions of the system may bring burdens on using it. This dilemma confronted by WiTEC's users still waits to be solved.

4.2 Stage 2 Evaluation

From January 2003 to May 2003, the three participating classes have adopted the second version of the WiTEC systems, which provide the basic functions similar to the first version, but further add the integrity functionality to the learning flow. The present evaluation procedures include: the teachers first apply the learning flow to a four-week collaborative learning class, after four weeks they are interviewed, and finally the interview results are analyzed. They are described as follows:

4.2.1. Applying learning flow to implement collaborative learning

Preparation Phase

The teacher uses the function of students' score management in the resource and class management server in class computer to set the fundamental score of each student and divide students into heterogeneous groups according to their past learning performances. In addition, the teacher uses the function of resource and class management server to design different project-based learning for every group and search for various information.

Execution Phase (implementing learning flow)

We design a collaborative learning flow, as shown in figure 4, for the teachers used in the execution phase. It includes six learning episodes which depicted in sec 3.1.

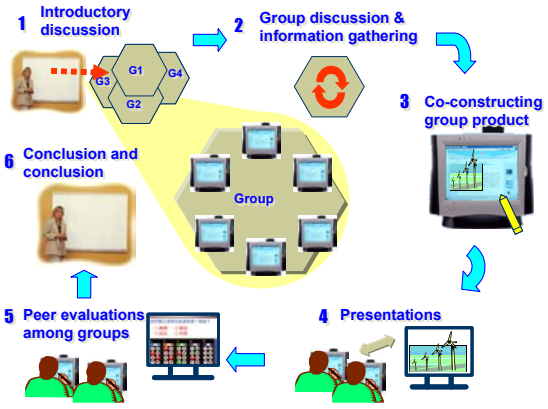

Figure 4. Collaborative learning flow used in the execution phase

Follow-up Phase (Using the products of learning flow)

1. **Recognition.** According to the results of self-evaluation and peer evaluation, the system can calculate improved individual performances and group achievement. Then, the teacher may display the score of each group on the electronic whiteboard and hold

recognition activities.

2. **Revising, sharing, and grading.** Each group revises their own project based on the other students' suggestions. After revision, these groups record the completed project as a specific file in resource and class management server for further reference. Besides, the teacher can retrieve the projects and each student's learning portfolio from resource and class management server, and then grade them on the interactive instruction center.

4.2.2. Results of the interview analysis

Preparation Phase

- **Comprehensive instruction procedure and easy operation:** the learning flow mechanism enables the teachers to use WiTEC more structurally and systematically. The teachers only need to follow the instructional objectives and the contents of the activity step by step to arrange the instructional materials that corresponds to the system functions. Teacher H and J thought that the learning flow enables them to follow easy and clear procedures to prepare instruction.
- **Pre-thinking about instruction procedures:** when the teachers are mapping out the learning flow, they are also clarifying the steps and contents of an instruction activity. They almost go over the entire instruction process again. For instance, Teacher C felt that "using the learning flow to draw up instructional materials and activities helps the teachers think over the instruction process."

Execution Phase

- **Guiding both learning and instruction:** In using the learning flow in class, the digital instruction materials and system functions required by every instruction procedure can be shown in order, so the learning flow can guide the teacher's instruction. For instance, Teacher H felt that "sometimes I may forget what to do for the next step during the class. When I use this system, I can exactly know the next instruction activity." Teacher C remarked that "when I employ unfamiliar instruction procedures, I usually preview the lesson again by myself but unavoidably forget something during the class. Through the support of this system, the teacher can know where we are, and the students can know what to do for next steps."
- **Saving time and reducing cognitive loading:** when the teachers apply the learning flow to in-class instruction, what they need to do is to click on certain procedure at proper time. This both saves the teachers' time and reduce their cognitive loading in searching for and presenting the materials. Teacher J indicated that "when I use information technology to teach, what I really worry about is that I cannot make sure when to use which function and present which digital instruction materials. Pre-editing the instruction procedures prevents me from going through the class disorderly, and I can save the time and make efforts on students' learning."

Follow-up Phase

- **Integrating students' learning process and instruction activities:** even though the first version of the system can also record students' learning process, it is often difficult to judge which portfolio is implemented and accomplished from which activity because there are too many portfolios. Therefore, more efforts are needed to be made for after class. This version of the system can organize and sort the students' learning portfolios according to the sequence of the learning flow, which helps the teacher review the contexts of the students' portfolios clearly. Teacher H noted that "reviewing and evaluating students' in-class works according to the sequence of the learning flow enables me to review the students' in-class works while thinking about the instruction activities in which they are doing in-class works. This allows me to evaluate the students' works more deeply on the one hand, and reflect my instruction process on the other hand."
- **Facilitating the teachers' revising and utilizing once again:** As Teacher C noted, "when I use information technology in teaching before, students' portfolios are often dispersed in different files and it is difficult for me to make so much efforts to review and correct each of them. The design of the learning flow enables me to review the entire instruction in order. If a student's portfolio needs correction, I can go to the editing part to do some correction immediately." Teacher J remarked that "when using information technology in teaching before, I found that managing portfolios is not easy. When I apply to another class next year, I don't know either where the portfolios are or what the entire process is. This problem may be overcome after using the learning flow."

4.3 Synthetic discussion of the two-stage evaluation results

According to the two-stage evaluation results, before applying the learning flow, even though the three participating teachers regarded the various functions in the WiTEC as helpful to teaching, the large number and complexity of the system functions increase the teachers' burden in using the system. After applying the learning flow, the teachers thought that the integrity mechanism of the learning flow enables them to design WiTEC-based instruction activities through detailed guideline and easy operation before class. This process helps them pre-think about the instruction procedures. During the instruction, the learning flow not only guides both the teacher and

students to an instruction and learning activity, but also saves time and reduces cognitive loadings. After the instruction activity is ended, the learning flow provides the context for the teachers to review the students' learning portfolios following the process of the instruction activity, and facilitates the teachers' revising of the instruction procedures and contents for further usage. In sum, the design of the learning flow solves the dilemma of using WiTEC before, and allows the teachers to use various functions of the WiTEC anytime during the process of instruction with fewer burdens and more convenience.

5. Conclusion

This paper presents the framework of three learning activity levels, including learning function, learning episode, and learning flow, to provide an effective and efficient way for arranging learning activities to solve the problem of complexity of instruction and learning in WiTEC. Learning flow is a series of learning episodes composed by learning functions. Learning episode is the basic unit of an instruction and learning activity. The needed learning functions could be added into the system to form a new learning episode. Once a teacher wants to perform a specific learning activity, s/he can compose proper learning episodes to form the needed learning flow and then implement it. That is, a learning function could be added in different learning episodes and a learning episode could be arranged in different learning flow also. A system developer can add new learning functions into the system to support the teacher and students implementing new forms of instruction and learning. Teachers can exchange their learning activity design in the form of learning episode. In addition, learning flow provides an efficient and effective way for teachers to prepare and implement their instruction. By adopting the framework of three learning activity levels, we develop an integrated system that could be used in WiTEC.

The WiTEC and the integrated system were installed in three elementary classrooms in Taipei City to conduct a two-stage evaluation. From the interview results of the three participated teachers, they thought that the mechanism of learning flow makes them pre-think about instruction procedures as well as provides comprehensive instruction procedure and easy operation before class. In using the learning flow in class, it is not only guiding both learning and instruction, but also saving time and reducing cognitive loading. Furthermore, it helps the teacher integrate students' learning process and instruction activities as well as facilitates the teachers' revising and utilizing once again after class. In sum, the framework of three learning activity levels enhances the usability and feasibility of using WiTEC.

Acknowledgements

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