Applying Wireless and Mobile Technology to Promote Productive Interaction

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Abstract

Productive interactions can enhance meaningful learning. Through applying computer technology appropriately, classroom interactions can be proceeded more effectively and productively. In view of this, this study presents and applies the WiTEC, a learning environment that adopts ubiquitous computing and wireless learning devices with various interaction-supporting functions, to promote productive interaction between members in the classroom. This study first clarifies the definition and critical factors of productive interaction and illustrates the interrelationship between WiTEC and productive interaction. Then, seven WiTEC-enhanced interaction modes that integrate the features of WiTEC are identified. Furthermore, the features and modes are summarized to reveal how using WiTEC can promote productive interaction.

Keywords: Productive interaction, Wireless technology, Mobile learning.

1. Introduction

According to Vygotsky, "learning awakens a variety of internal developmental processes that are able to operate only when the child is interacting with people in his environment and with his peer." [1] In light of this perspective, social interaction plays a crucial role in the process of learning.

Wertsch and Stone noted that "the process of knowledge internalization is not the transferal of an external activity to a preexisting internal 'plane of consciousness'; it is the process in which this plane is formed." [2] Knowledge could not be transmitted directly. Rather, the concepts of external world could be gradually internalized into one's cognitive structure through communicating between individuals and continuous negotiation and mutual meaning making.

The classroom is a complex situation of interaction for learning, where teacher-student and student-student interactions frequently occur. These interactions serve as the basis of students' knowledge construction. But several factors obstruct teacher-student and peer interactions in classroom contexts, such as seating arrangement, limited time for instruction, lack of effective assessment. Hence, further studies regarding how to make in-class interactions more effective and productive are needed.

A few studies have suggested that technology can facilitate learners' collaboration/cooperation and communication in classrooms. [3][4] Each type of technology has its advantages and limitations, but no one can achieve all instructional goals alone. [4]

The Research Center for Science and Technology of Learning at National Central University has integrated mobile devices, wireless communication, and network technologies to construct a wireless technology enhanced classroom (WiTEC), which potentially supports various types of interaction. [4] This study seeks to explore how to apply WiTEC to affect and promote productive interaction in classroom contexts. At first, this paper identifies and clarifies the definition of productive interaction and critical factors of promoting productive interaction. Then, the features of WiTEC are analyzed to reveal how to apply WiTEC to can enhance productive interaction. Furthermore, seven WiTEC-enhanced interaction models that integrate several WiTEC's functions are illustrated. Finally, this study summarizes the features and models to uncover the relationship between WiTEC and productive interaction.

2. Productive Interaction

2.1 What is productive interaction

Productive interactions, different from the popular claims on the definition of interaction, provide mechanisms for enhancing higher-order thinking. [5] The higher order cognitive process involves concentration, logical thinking, conceptions forming, analyzing, reasoning, and evaluating, and is not merely memorizing or understanding. [6] Such process needs not only individual active participation, but also dynamic construction of meanings.

"Meaning", as Volosinov/Bakhtin argues, is like an electric spark that occurs only when two different terminals are hooked together. [7] Based on this view, construction of meanings during interactions is not just making interlocutors express their ideas or respond to others, but also possesses "dialogical" features. [8] The "dynamic construction of meanings" described above possesses the features of "productivity", [9] which refers to the impetus to spark the interlocutors' thinking. The forming of productivity is based on mutual understanding of meanings actively constructed by the two interlocutors. Consequently, what the interlocutor produced can serve as his/her "thinking device" that further "sparks" mutual thinking and accommodates existed experiences and concepts. The perceived and interpreted contents of

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interaction are regarded as the basis for continually developing new thinking. The ongoing of this process will constantly change individual's cognitive structure, keep sparking mutual intellects, and further promote individual higher order cognitive development.

In sum, productive interaction is referred to that the thinking of different interlocutors is sparked through the negotiation process with continuous understanding, interpretation, and responding, thus more enriched meanings and implications can be generated.

2.2. Critical factors of promoting productive interaction

According to this prerequisite, several critical factors of promoting productive interaction that teachers can take account in the classroom context are identified based on relevant literatures. [6] [7]

1. Motivating students' participation: Through posing appropriate and meaningful questions, the teacher can trigger the learner's disequilibrium, which motivates them to inquire, and enhance the need of collaboration. In summary, motivating students to actively engage in classroom discussion is the first step to elicit learners' participation in interactions.

2. Focusing students' attention: The students may be deviated from the focus during the process of interaction owing to the change of intention. Therefore, how to help students retain their focus has become an important task in classroom interaction.

3. Externalizing internal thinking: "Thinking does not 'express' itself through them but rather comes into being in their use." [9] The intended meanings constructed by individuals are represented through various signs and tools. This process not only elaborates learners' cognitive structure during creating of works, but also serves as a basis of instructional evaluation and decision-making.

4. Maintaining the status of preparation: The process of thinking is "dialogical" in character [8], and constantly constructs the interconnection between intrapersonal and interpersonal thinking. When a learner is thinking which urges him/her to continually reconstruct external messages and revise his own cognitive schema. Therefore, if the learners maintain the status of continual thinking, envision the other's thoughts, and keep the status of preparing to communicate, the interaction will proceed more productively.

5. Constructing mutual understanding: The interlocutor' intention changes constantly before, during, and after the process of interaction, which affects how he/she expresses thinking and responds to the others. With the difference of intentions, individuals may only respond to the other's action that fits with their expectation. Therefore, how to build mutual understanding is one of the keys to achieving successful and productive interaction.

6. **Sustaining interactive productivity:** Productivity will not emerge after interaction, but comes into being through continuous sparking and incubating. To promote productivity that makes the interaction last and create the sparking of thought mutually, the process needs to elicit richer implications and motivation of participation. In brief, only sustained productivity can make interaction more constructive.

3. The application of WiTEC to enhance productive interaction

WiTEC, the abbreviation of "Wireless Technology Enhanced Classroom," is essentially a classroom environment that integrates wireless network and mobile learning devices and combines various types of interaction, such as human-computer interaction (HCI), computer-mediated communication (CMC), and face-to-face interaction. [3][4]

The e-whiteboard can either display communal learning frame or broadcast shared learning materials to individual's mobile learning device. Basically, the mobile learning device held by each student is a portable handheld computer, such as WebPed or a tablet PC, with hand-writing input and the short-distance wireless communication capability.

With wireless networking, all class members are enabled to employ the e-whiteboard and their own learning device to deliver or exchange materials or messages for in-class discussion. The whole process and contents of in-class interaction will be recorded and reserved in the server for further retrieving and analysis. The learning environment of WiTEC is shown as Figure1.

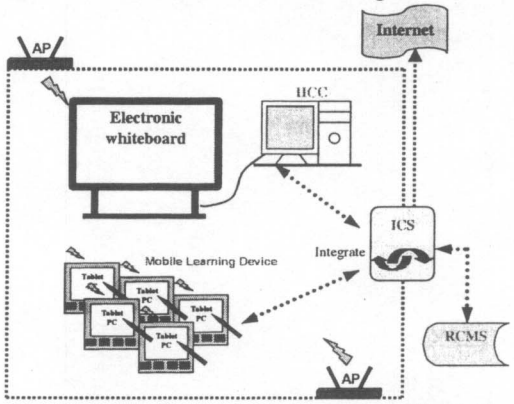

Figure 1. Learning Environment of WiTEC

In the following section, the fundamental functions of WiTEC are identified and the relationship between the functions and how they can be used to facilitate productive interaction is discussed.

(1) **Display:** The learning devices in the WiTEC can be used to display a variety of learning materials. Applying two types of display flexibly based on different instructional situations helps ***focus students' attention*** on the interaction:

a. **Display to whole-class:** The teacher displays the learning contents that need further discussion to the whole class through the e-whiteboard.

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b. **Display to individuals**: The learning contents can be displayed to student's devices (tablet PCs), which help students read and discuss with peers conveniently.

(2) **Broadcast**: All materials and messages can be broadcast through relevant devices in the WiTEC. Broadcasting discussed contents to others can ***elicit communication*** between the interlocutors. The broadcast can be distinguished into two categories:

a. ***Uni-cast:*** This refers to transmitting data to a specific participant at one time. This function supports the exchange of personal information between interlocutors.

b. ***Multi-cast:*** This function enables simultaneous transmission of the same materials to many students. Either the e-whiteboard or personal learning device can be used to support simultaneous interaction with different participants.

(3) Edit: Each device in the WiTEC has the editing function for the teacher to note and mark the learning materials through the e-whiteboard, and for the students to create works. This process helps the teacher and students to ***externalize their thinking*** through the representation of words and signs, which facilitates mutual understanding of the interlocutors' intentions.

(4) Aggregate: This function is separated into two steps – "data gathering" and "immediate statistics." In the WiTEC, the teacher can gather the works uploaded by all learners through the e-whiteboard. For instance, after the students answer multiple-choice questions, the teacher can use the e-whiteboard to display the results of immediate statistics, show the distribution of different answers, and lead the students who have selected different answers to further discuss their ideas. This process will keep each student on the status of preparing to participate in discussion, and thus ***motivating students to effectively participate*** in discussion.

(5) Assign and combine□When group members co-work on a group report, this function facilitates the assignment of the work and review of other's work. Because all members' work will be immediately combined at last through this function, each member needs to understand other's progress during group work in order to make the final report smooth and clear, which effectively ***facilitates mutual understanding*** between in-group members.

(6) Record: All data during the process of learning and interaction can be immediately recorded for teachers to retrieve at any time for further evaluating and decision-making. The recording and feedback of the entire learning process provides ***effective evaluation*** for the interactive instruction.

(7) Networking: Through wireless networks, the students can collect online resources or discuss with virtual communities. This type of interaction ***expands and extends*** students' learning, which breaks through the barrier of the classroom.

(8) Embed: The learning devices in the WiTEC are all user-friendly. The features of the WiTEC can be ***freely and flexibly embedded into*** the classroom context so that the gap between the technology and users can be minimized and the learners do not need to accommodate themselves to the adapted technology and change their habits of interacting with others.

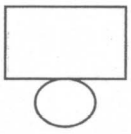
4. Seven WiTEC-enhanced interaction modes

Based on the seven fundamental functions of WiTEC, this section further identifies seven WiTEC-enhanced interaction modes constituted by different fundamental functions, and interprets how teacher apply these modes to enhance productive interaction in the classroom context.

4.1 Student-initiated interaction

The major purposes of this type of interaction is to increase the opportunities of classroom interaction, to clarify the interlocutors' intention and the representation of meanings through sustained refining and reorganizing of leaning contents, and to promote the construction of mutual understanding and ultimately achieve productive interaction.

Mode 1: Human-computer interaction

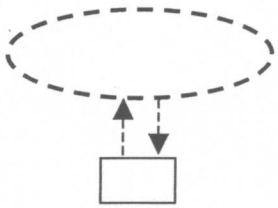


(a) ***Interlocutors:*** individual students vs. mobile learning device and/or learning materials

(b) ***Mode description:*** Each student uses his/her learning device to implement individual learning activities, such as writing, reading learning materials, taking personal notes, and revising their works.

(c) ***Its impact on classroom interaction:*** This interaction mode helps the students construct their understandings on the learning contents and develop their thinking or product for further communicating with others in the classroom.

Mode 2: Online learning



(a) ***Interlocutors:*** the teacher or students vs. communities outside the school and/or online resources

(b) ***Mode description:*** Through wireless networks, the teacher and students can access the Internet to search for online resources or interact with communities outside the school.

(c) ***Its impact on classroom interaction:*** As the teacher's course arrangement requires, the students access online resources through wireless networks and interact with communities outside the school. This mode helps to expand and extend students' vision of learning, and provide enriched implications for the process of knowledge building.

Mode3: Multiple-participants Interaction

(a) ***Interlocutors:*** students vs. students

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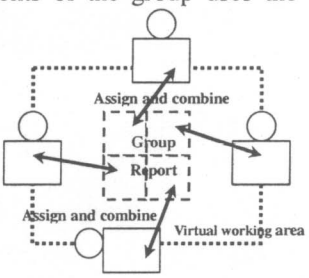
(b) ***Mode description:*** The students use their mobile learning devices to exchange learning resources and share the leaning results with one another synchronously and asynchronously.

(c) ***Its impact on classroom interaction:*** This mode promotes the opportunity of communication with one another. The broadcasted contents will become the thinking device of these interlocutors, which enable them to respond purposefully and have better understanding of mutual intention.

Mode 4: Group co-operation mode

(a) ***Interlocutors:*** the students within the same group

(b) ***Mode description:*** Students of the group uses the assign and combine function to co-edit a group report. All group members can review other's work and progress at any time during the process. Finally the system will automatically combine and organize all members' work as PowerPoint format.



(c) ***Its impact on classroom interaction:*** This mode leads group members to be engaged in cooperative activities, and through immediate review of other's work, they can check other's contents and progress at any time, understand the relevance of each member's work, discuss and negotiate about the contents of the report, and then enhance mutual understanding.

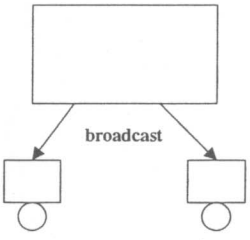
4. 2 Teacher-initiated interaction

Teachers are regarded as the major role in these modes. The major interface is e-whiteboard, which combines various functions of WiTEC for the teacher and students to carry out a variety of interactive learning and instructional activities.

Mode 5: Broadcasting mode

(a) ***Interlocutors:*** the teacher vs. individual students or all students

(b) ***Mode description:*** The teacher can flexibly broadcast learning contents either to all students' mobile learning devices, depending on instructional needs.



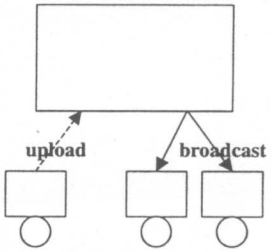
(c) ***Its impact on classroom interaction:*** When teachers apply this mode to classroom contexts, they can save much time for distributing instructional materials. This mode makes the interaction process more smoothly.

Mode 6: Teacher-mediated mode

(a) ***Interlocutors:*** the teacher vs. individual students or all students

(b) ***Mode description:*** The teacher intervenes by clicking a specific student's product and directly broadcast it to all students in order to develop and expand the interaction.

(c) ***Its impact on classroom interaction:*** As a mediated evaluator, the teacher needs to determine which materials can facilitate in-class discussion according to instructional objectives and then broadcasts the contents to each student through the "broadcast to many" function. This process makes the students focus on the discussed subject and leads them to effectively put purpose-rich activities into practice.

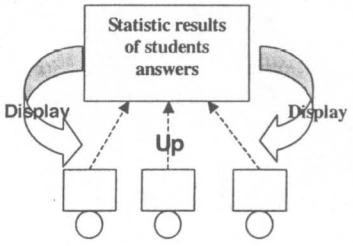


Mode 7: Response-integrated mode

(a) ***Interlocutors:*** the teacher vs. all students

(b) ***Mode description:*** As the teacher poses a multiple-choice answer, the students enter answers through their learning devices. After that, the teacher displays the chart of "immediate statistics" to present the students' opinions and picks some students with different answers to initiate discussion in order to clarify the relevant concepts.

(c) ***Its impact on classroom interaction:*** Through the process of selecting some students with different perspectives to initiate discussion, the students are allowed to compare, authenticate, and clarify their own ideas. Because the students need to explain the reason for their answers, all of which have been collected and shown in the statistic result, they are motivated to actively engage in the discussion.



The table 1 summarizes the relationship among the types of interaction models, the different interaction modes supported by WiTEC, the fundamental functions of WiTEC, and the critical factors of promoting productive interaction..

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Table 1: Comparison of the features in the Interaction Mode

Modes of Interaction \ Functions and support of WiTEC		Focusing attention		Initiating communication		Externalizing thinking	Promoting participation		Facilitating mutual understanding	Effective Evaluation	Expanding and extending	Freely and flexibly
		Display to Whole-Class	Display to One	Multi-cast	Uni-cast	Edit contents	Gather students' works	Immediate statistic	Assign and combine	Record process	Connect to Internet	Move flexibly
Student-Initiated interaction	Human-computer Interaction									●		●
	Online Learning									●	●	●
	Multiple-participants interaction									●		●
	Group co-operation								●	●		●
Teacher-Initiated interaction	Broadcasting									●		●
	Teacher-Mediated									●		●
	Integrating responses									●		●

5. Conclusion

In classroom practice, students keep on negotiation of meanings through the process of reflecting, clarifying, expanding, evaluating, and integrating mutual perspectives while the teacher manages to orchestrate the multiple voice of the classroom. [10] One of the challenges that researches have sought to overcome is how to support in-class members to achieve the goal of productive interaction and the higher order thinking.

Thinking is subordinated to, and informed by, the demands of communication. [8] WiTEC has potential to support teachers and students to promote communication and yield more chances of sparking the thought between interlocutors under the basis of mutual understading. WiTEC is not used to replace or override face-to-face interaction in the classroom, but to support classroom interactions to be proceeded more effectively. It provides effective support for productive interaction in classroom contexts, but it does not promise to achieve it. The teacher in the WiTEC needs to understand "interaction is not equal to productive interaction" and how to effectively apply various support functions of WiTEC and promote richer and meaningful interaction in the classroom. Take the braodcasting materials mode for example, when the teacher broadcast the learning material to all students, if he/she does not provide appropriate questions and motivate them to inquire and discuss, this mode can only lead to the transmission of instructional materials, rather than promote more in-depth verbal interactions.

So far, our research team is conducting empirical experiments in Wang-Fang, Nan-Hu and Si-Men Elementary School in Taipei, combining and applying different interaction modes to classroom instruction to find out how such instruction modes can promote the learning and quality of interactions.

Acknowledges: The authors would like to thank all members involved in the Learning Technology project, as well as the Bureau of Educational Administration of Taipei City Government and National Science Council. The Learning Technology project is supported by a grant from the Ministry of Education, No. 89-H-FA07-1-4.

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