Embedding EduClick in Classroom to Enhance Interaction

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Abstract: This study develops a specific interactive response system (IRS), called EduClick II, to overcome or alleviate obstacles of classroom interactions. Particularly, several interaction-supporting modes of EduClick are flexibly combined and applied to in-class instruction and learning activities. More than 800 elementary teachers in Taiwan have used EduClick and, in this study, some of the participating teachers were surveyed through questionnaires and interviews. Evaluation results of the application indicate that using EduClick during instruction and learning can increase the utility rate and time of classroom computer, enhance students' motivation and attention, as well as promote teaching quality.

Introduction

Oral questioning and answering is the most common way for a teacher and students to interact in the classroom. The teacher asks students questions to keep them actively involved in lessons, giving them opportunities to express their ideas and thoughts, to evaluate their learning, and to revise the instructional method (Morgan & Saxton, 1991). Gange et al. also stated that students' responses are important in learning because they provide a means for the teacher to provide informative feedback to students to help them know what to do next (Gange, Yekovich, & Yekovich, 1993). However, in conventional classrooms there are many obstacles of teacher-students' interaction, such as the time for which a teacher is in contact with students is very limited (VanDeGrift, 2002), and students' opportunities to interact with their teacher are often determined by their seating arrangement (Roth et al., 1999) or achievements (Shachar & Sharan, 1994).

The same limitations still exist in a classroom today, because few changes have been made in typical classrooms over the last decade. Even though computers have been brought into classrooms, they do not help to alleviate the limitations a lot (Huang et al., 2001). Since simply bringing a computer into a classroom cannot remove limitations on interaction, relevant accessories are needed to build an appropriate interactive environment. Based upon the above considerations, the major purposes of this research include the following. First, this study develops an interactive response system (IRS), called EduClick II, in which the design, software features, and how to application during instruction are highlighted. Second, the elementary teachers who use EduClick and teach various subjects are surveyed and interviewed to determine the efficiency of EduClick. Finally, we summarize the results of this study in the conclusion and suggest issues for further study.

The System of EduClick II

EduClick Hardware

Our research team designed and created the EduClick I in 1999 (Liang et al., 2001). From 1999 to 2002, we cooperated with a group of teachers to conduct field studies in the classroom and obtained suggestions for improvements. According to the feedback from the participants, we developed the EduClick II in 2002. Just as other

IRSs, such as Student Response System (Horowitz, 1988), Classroom Communication System (Abrahamson, 1999), Personal Response System (Cue, 1998) and Classroom Performance System (CPS) (eInstruction, 2002), EduClick II is a technology-enabled learning environment for enhancing learning interactivity by transferring, collecting, processing, and displaying students' responses in an ordinary classroom. The EduClick II hardware consists of **a set of signal transmitters** and **a response signal receiver** connected to **a classroom computer** via a RS-232 serial cable. **A large display** is connected to the classroom computer to broadcast content and processed information to all participants. The signal transmitter is an infrared remote controller. Every remote controller is assigned a unique ID, from 0 to 255, so that EduClick II can distinguish which student presses which button. Infrared, the communication technology used by EduClick II, is an inexpensive wireless technology. EduClick II uses one-way infrared transmission from the signal transmitters to the response signal receiver.

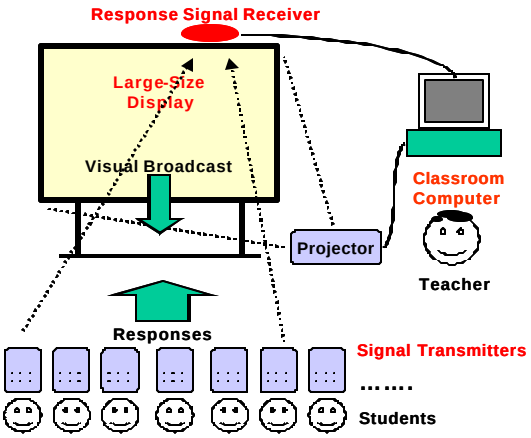

Figure 1: Typical IRS configuration in classroom

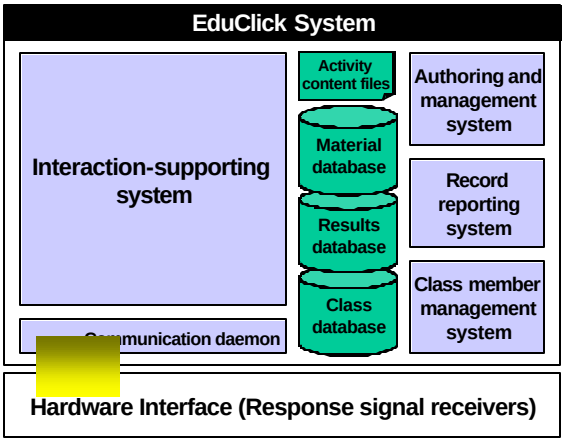

Figure 2: System architecture of EduClick II

Architecture of EduClick II Software

The software of EduClick II included five major subsystems - a class member management system, an authoring and management system, a communication daemon, an interaction-supporting system, and a record-reporting system. Figure 2 presents the system architecture.

- **Class member management system:** This subsystem is designed to help teachers manage class members, maintain a class database that includes each student's ID, mapping information and personal data, as well as group information, and the teacher's own notes on each class. Thus, EduClick II can identify students' signal transmitter IDs to record and analyze their responses.
- **Authoring and management system:** This subsystem has two primary functions: assisting the teacher in authoring instructional materials and, according to specific instructional requirements, reorganizing these instructional materials as an activity content file. These functions help the teacher conveniently author, edit and manage instructional materials.
- **Communication daemon:** After the classroom computer is started up, the communication daemon always waits to process data transferred from the response signal receiver, and then sends the corresponding messages to the foreground or designated program, such as the interaction-supporting system. This daemon also supports remote control by simulating the computer keypad function (i.e. cursor control), so that the teacher can carry the signal transmitter around the classroom.
- **Interaction-supporting system:** The major function of this subsystem is to support the teacher's instructional activities in the classroom context. The teacher can use this subsystem to load a prepared activity content file and present the material in this file on the large display. The teacher can only use the signal transmitter to control remotely the subsystem, such as changing materials and implementing an activity. The individual students' status lights on the large display notify the teacher and students of learning status - such as the green light for not responded yet, the red light for answered, and the blue one for giving a response. After the students' responses are collected, the subsystem counts responses under each option

and shows a frequency chart and pie chart. All response records, including raw data and statistical results, are stored in the results database to be retrieved by the record-reporting system or uploaded to servers through the intranet.

- **Record-reporting system:** The major function of this subsystem is to help the teacher retrieve and combine data from various databases after applying the interaction-supporting system. Using this subsystem, the teacher can review every student's responses to a specific question (including response time, option selected, and correctness), the distribution of responses to a specific question, every student's total score on a specific topic, every student's topics, and all students' average progress between topics. If necessary, the teacher can use this subsystem to retrieve the original questions and the students' responses for advanced discussion.

In summary, the five subsystems described above effectively facilitate teachers to manage class members who use EduClick II, prepare materials (i.e. questions) for EduClick II-supported instruction, perform in-class interactive instruction, and manage students' response data.

Interaction-supporting Modes of EduClick II

This study integrated the basic functions of EduClick II to develop two types of interaction-supporting modes - quiz modes and statistic modes. The former assists the teacher in conducting a quiz and the latter assists the teacher in summarizing and displaying the students' responses. The subsequent sections will introduce the rationale and functions of each mode, and provide some examples to illustrate how the two different types of modes can be combined to support an EduClick-embedded instructional activity.

Quiz Modes

The quiz modes provide the essential function of EduClick II. Each mode enables specific teachers' requirements to be achieved on the way of presenting the material or question's stem, the way of presenting the options in response to a question, the form of the questions, the order of the responses, and whether students use the transmitter (see Table 1). The following sections introduce the five quiz modes.

	The way of presenting the material or the question stem		The way of presenting the answer options		The form of the question		The sequence of responses	Whether students use the transmitter
	By system	Orally	By system	Orally	Single question	Set of questions		
Multiple-Choice-Quiz	?		?		?			?
Match-Up-Quiz	?		?			?		?
Competition-Quiz	?		?		?		?	?
Buzz-In-Quiz	?						?	?
Impromptu-Quiz		?		?	?			?

Table 1: Basic functions of each Quiz Mode

1. **Multiple-Choice Quiz**: In some cases, the teacher wants to know the students' opinions and misconceptions or whether students understand her/his instructions. This mode allows the teacher to present prepared questions or surveys on the display and allows students to make choices by pressing transmitter buttons. The teacher identifies the correct answer to each question. Also, EduClick II automatically scores every student and generates statistical charts instantly after students have transmitted their responses.
2. **Match-up Quiz:** Different from **Multiple-Choice Quiz**, the form of Match-up Quiz is a set of questions, not a single question. Each question is separated into two parts. The first part includes the question stem with a few blanks and the second part contains options only. Students must match up the options between these two parts. The answer to the question is a combination of numbers.
3. **Competition Quiz:** The teacher who wants can use this mode to make the classroom atmosphere livelier. Time is the key of this mode. After the question is presented, students must use their transmitters to respond. When the

correct answer is received, EduClick II will sound an alarm and show the students who responded correctly, in order of response time.

4. **Buzz-in Quiz:** Like the **Competition Quiz**, but the question is open-ended, not multiple-choice. The student who presses any button on his/her transmitter first has the right to answer the question orally. Points are awarded according to the teacher's judgment. If the first student who answers the question does not give the right answer, the other students have another chance to try again.
5. **Impromptu Quiz:** Like the **Multiple-Choice-Quiz**, does not need to no prepared materials are required. Questions or surveys are presented orally or by other traditional methods such as on paper or the blackboard. The IRS can display statistical charts, such as frequency charts, but cannot automatically determine the correctness of students' answers since it has no information on the correct answers.

Statistical Modes

The statistical mode is used to summarize students' responses. After the teacher has used a specific quiz mode to display materials (or questions) and students have transmitted their responses, the teacher can choose one or several suitable statistic modes immediately to display statistics concerning the students' responses. The statistical modes of EduClick II are as follows.

- **Show-All Responses**: This mode allows the teacher to present all transmitted responses on the large display. In this mode, both the teacher and the students can see each student's response. This mode is suitable for use after the Multiple-Choice Quiz, the Match-up-Quiz, and the Impromptu Quiz.
- **Show-Frequency Chart**: Using a bar chart, this mode allows the teacher to display the absolute frequency and percentage of the options chosen by the students. In this mode, both the teacher and the students can see how many students chose each option. Just like the Show-All Responses mode, this mode is appropriate for use after the Multiple-Choice Quiz, the Match-up-Quiz, and the Impromptu-Quiz.
- **Show-Correct Answer**: This mode allows the teacher to display which answer option is correct by changing its color. This mode is suited to use after the Multiple-Choice Quiz, the Match-up-Quiz, and the Competition Quiz.
- **Show-Scoreboard:** When the teacher gives students several questions and elicits their responses during instruction, he/she can use this mode to present the accumulated score of any group or each student at any stage during the quiz. This mode is suitable for use after the Multiple-Choice Quiz, and the Match-up Quiz.

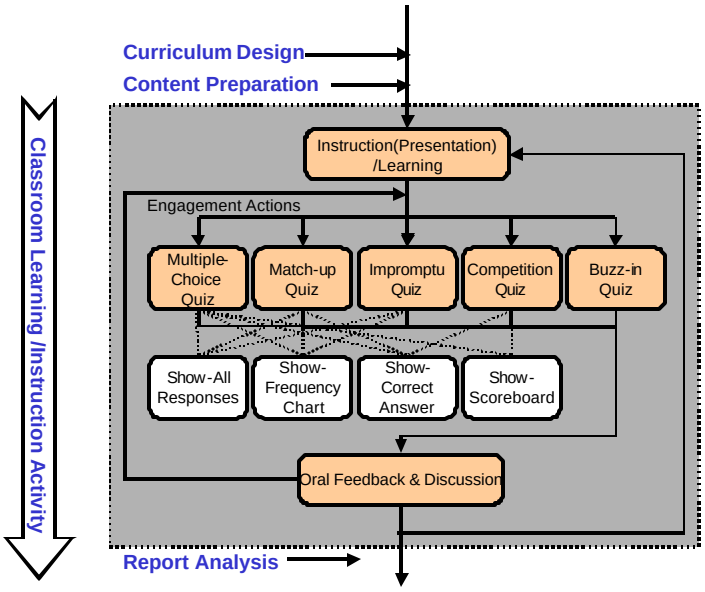

Figure 3: Learning/instruction activities using interaction-supported modes

Fig. 3 shows that during learning and instruction, teachers can flexibly combine various modes. The gray part in the figure refers to the instructional process in using EduClick II. For example, a teacher may first display prepared instructional materials on the large display. Then, she/he may select specific quiz mode to present questions and elicit students' responses. Afterwards she/he may select a particular statistical mode to display the results concerning the students' responses, before providing feedback and holding a discussion. This instructional process can be cyclic.

Application of the Interaction-supporting Modes during Instruction

Evaluating students' learning status, motivating students to learn, enhancing whole-class discussion, and supporting group discussion are instructional activities that teachers frequently perform in the classroom. However, in ordinary classrooms, implementing these activities is often obstructed. The following section illustrates how the teacher overcomes the obstacles and effectively proceeds with the activities through flexible combination and application of various interaction-supporting modes of EduClick II.

- **Understanding students' learning status.** To understand students' learning statuses at any time to support instructional decisions, the most common methods employed by teachers during instruction are paper-and-pen tests and oral Q&A. However, a paper-and-pen test takes a lot of instruction time while the teacher cannot immediately determine the results of the test. Oral Q&A allows only a few students to have opportunities to answer, raising difficulties for teachers in understanding all students' statuses, and the results of oral Q&A cannot be easily recorded. Applying EduClick II to Q&A activities can avoid these difficulties. During instruction, teachers can implement Q&A by selecting Multiple-Choice Quiz, Match-up Quiz, or Impromptu-Quiz mode to display various questions to students and then use the Show-All Responses and Show-Frequency Chart modes to present immediately the students' responses. Accordingly, the teacher can quickly observe individual's and the group's learning statuses, revise his or her curriculum, and further consider whether to offer remedial instruction.
- **Motivating students to learn.** Students' learning motivation is one of the major factors that affects students' learning results, and competition is an effective means of promoting students' motivation to learn. However, the inconvenience of grading and controversies over fairness (i.e. in determining which student was the first to raise his/her hand) often dissuades teachers from carrying out competitive activities in the classroom. The Buzz-in Quiz and the Competition Quiz modes of EduClick II enable teachers to avoid such problems and facilitate their implementation of competitive activities in the classroom. When a teacher applies these two modes to competitive activities, the criteria by which students' performance is evaluated are the correctness of the answers and the speed of the responses. Accordingly, the teacher must select easier questions or subjects with which students are familiar to ensure that all students have opportunities to participate. The authors' observations in the actual classroom revealed that the aforementioned competitive activities could most enhance students' learning motivation.
- **Enhancing whole-class discussion.** In such activities, the speed of response is not very important and a question does not necessarily have a correct answer. Instead, students' willingness and opportunities to fully express their opinions is key to learning. In large classes, teachers usually first pose a question to encourage whole-class discussion, ask students to express pro or con opinions by raising hands, encourage students with different answers to express themselves, and then ask all students to provide responses to different answer opinions. When teachers conduct such a discussion in ordinary classrooms, they often face some challenges. First, not all students are willing to raise their hands to express their opinion for or against an answer. Moreover, some students observe their classmates' hand-raising to determine whether or when to raise their own hands. Finally, since teachers cannot immediately record each student's hand-raising status, they tend to select one student, based on vague impressions of students' achievement, to explain why he/she chose his/her answer. Generally, a teacher can apply EduClick II to solve this problem. Firstly, the teacher may employ the Multiple-Choice Quiz or the Impromptu Quiz mode to present the prepared questions. In turn, each student uses a transmitter to express his/her opinions without knowing the responses of the others. Then, the teacher can use the Show-All Responses mode to determine each student's opinions and use Show-Frequency Chart mode to display the number and percentage of students who selected different options. Such information can help the teacher to understand how all students' opinions are distributed, and thus to determine which students should be selected to provide oral explanations.
- **Supporting group discussion.** Teachers often require students to conduct group discussions. However, teachers may have to confront the following difficulties in-group discussion. First, some participants in an in-group discussion may conceal their real ideas and submit to dominators of their group. Besides, when presenting the

results of the group's discussion, the representative sometimes cannot adequately present all the ideas of the group. Furthermore, the teacher cannot observe the changes of each student's ideas during the discussion. Effectively planned use of EduClick II will solve this problem faced by the teacher. When beginning to guide group discussions, teachers may use the Multiple-Choice Quiz mode to present the prepared questions and answer options, and ask all students to select answer(s) with their transmitters. The teacher then employs the Show-All Responses mode to demonstrate the response of each member of each group, and further encourage students to clarify the reasons of their responses during the group discussion. After all groups have finished their discussions, the teacher again asks all students to respond to the former questions by choosing appropriate options using their transmitters. The Show-All Responses mode enables teachers to see the changes in the responses of each student and group. Teachers can accordingly further encourage students to interpret the reasons for any changes.

Evaluation of Embedding EduClick in Classroom Instruction

Since 1999, over 800 classes of elementary schools in Taiwan have been using EduClick. Based on several features of EduClick discussed in previous sections, this study examines the feasibility of applying EduClick to classroom contexts, yielding the following assumptions. First, *EduClick can increase the utility time of the classroom computer*. Next, *EduClick can enhance the quality of teaching*. Finally, *EduClick can promote students' motivation and attention on learning*.

This evaluation involves quantitative and qualitative analyses of the above assumptions. In quantitative analysis, this study adopted single group pre- and post-test experimental designs. The participants were 42 primary school teachers who had used a classroom computer for at least one year preceding this study and who want to use EduClick in real classroom activities. This evaluation involves two questionnaires – one for pre-testing, focusing on the situation in which the teacher uses a classroom computer for teaching, and another is for post-testing, focusing on a situation in which the teacher uses EduClick. The quantitative analysis includes three phases. In phase one, the participants answered the pre-test questionnaire. In phase two, the participants applied EduClick in real classroom situations for six weeks. In phase three, the participants answered the post-questionnaire. 38 out of the total 42 participants took both the pre- and the post-tests and provided complete answers, so the finally statistical analysis relied on the data collected from the 38 teachers. For the qualitative analysis, this study sampled ten out of 38 participants and interviewed these participants based on the earlier quantitative analysis. The results of the quantitative and qualitative analyses are presented as follows.

Results of quantitative analysis

Does EduClick increase the utility time of class computers?

To answer this question, this study compares the average number of periods/ week during which the teachers used a classroom computer before and after the adoption of EduClick. The t-test method was used to analyze the data. Table 2 shows the statistical results.

		M	SD	Paired Difference				t
				M	SD	95%		
						Lower	Upper	
Average number of periods of using classroom computer in teaching	**After adoption of EduClick**	6.56	4.46	4.11 (0.79)	4.89	2.50	5.71	5.14***
	Before adoption of EduClick	2.46	2.99					

*** p<.001 (n=38)

Table 2: The t-test results of the number of periods/ week during which teachers used a classroom computer for teaching (n=38)

According to Table 2, the t-test analysis reveals significant differences between the use of the class of computer before and that after the adoption of EduClick ($t=5.14$, $p < .001$). The average number of periods/a week during

which a classroom computer was used was 2.46 before EduClick was adopted, and drastically higher, at 6.56 after EduClick was adopted. Above statistic results confirm that application of EduClick can significantly increase the number of periods that the teachers integrate information technology into teaching.

Does EduClick improve the quality of teaching and students' motivation and attention?

To answer this question, the pre-test questionnaire asks three questions to determine whether the "classroom computer" is helpful in improving the quality of teaching, motivating the students and attracting their attention. Another three questions in the post-test questionnaires ask the participants whether the "classroom computer with EduClick" is helpful in improving the quality of teaching, motivating the students, and attracting their attention. Each question includes a perception statement that indicates the degree of agreement or disagreement on a five-point Likert-type scale, with five representing strong agreement. Table 3 presents the statistical results of the t-test.

		M	SD	Paired Difference				t
				M	SD	95% Lower	95% Upper	
Promoting The Quality of Teaching	**After application of EduClick**	4.18	.83	.44 (.13)	.80	.19	.71	3.47***
	Before application of EduClick	3.74	.72					
Motivating Students to Learn	**After application of EduClick**	4.31	.84	.57 (.10)	.64	.37	.79	5.56***
	Before application of EduClick	3.74	.64					
Intensifying Students' Attention	**After application of EduClick**	4.39	.82	.58 (.10)	.64	.37	.79	5.56***
	Before application of EduClick	3.81	.69					

*** p<.001 (n=38)

Table 3: The impact of using classroom computer with and without EduClick

According to Table 3, the t-test analysis reveals significant differences between before vs. after application of EduClick on participants' perception of promoting the quality of teaching (t =3.47, p < .001), motivating students to learn (t =5.56, p < .001), and intensifying students' attention (t =3.47, p < .001). The above statistic results conform that application of EduClick can promote the quality of teaching, students' motivation, and attention.

Results of qualitative analysis

In addition to the above quantitative results, this study investigates which features or functions of EduClick cause these participants to think that application of EduClick can promote the utility time of classroom computers in the instruction, students' motivation and attention, and the quality of teaching. After arranging and analyzing the interview records, this study yields the following results. The summarized interview results are presented as the conclusion of this evaluation.

Why does using EduClick increase the utility rate and time of a classroom computer?

1. EduClick can be integrated with various instructional materials (i.e. films, pictures and audio recordings) and applied to facilitate teachers' instruction.
2. In the beginning of class, teachers can employ EduClick to perceive students' prior experiences and knowledge of a subject. During instruction, teachers can use EduClick to demonstrate students' answering statuses and provide further explanation or reflection. At the end of the class, teachers can use EduClick to conduct a summative evaluation. With the increases of teachers' use of EduClick, the utility rate of classroom computer also increases.
3. Adopting EduClick helps teachers to enhance students' learning during group cooperative learning and competitive games, and thus the teachers are more likely to use EduClick.

Why does using EduClick improve the quality of teaching?

1. Various application modes of EduClick enable teachers to design questions according to instructional goals, helping them to prepare for instructional activities more systematically.
2. EduClick enables teachers to ask questions at any time and allows students immediately to express their opinions, based on the instructional context, to deepen discussions and further activate classroom instruction.
3. The application modes of EduClick can enhance students' attentiveness to learning. As students interact with the teacher and their peers more frequently and effectively, the teacher will gain a sense of achievement that will help him or her to improve the quality of teaching.

Why does using EduClick enhance students' motivation and attentiveness?

1. Every member in the classroom is enabled to answer others' questions and provide his/her own opinions through EduClick, increasing their participation.
2. Teachers can use EduClick to understand the answering status of each student. The answering status of each student can be presented on the display so students are more likely to try their best to answer the questions.
3. Teachers can conduct competitions among groups by flexibly employing a variety of EduClick's features to heighten students' motivation and responsibility and further increase their attentiveness.

Conclusion

Our research team has applied the first version of EduClick II in a three-year field research to understand teachers' practical requirements in using EduClick II to determine modifications and improvements. Accordingly, the EduClick II includes the following features. First, to reduce the cost of the device, infrared communication techniques are used to enhance EduClick's delivery of information. Consequently, the system is not limited by classroom space and can effectively send and receive users' responses. Second, to enable teachers to "effectively" and "conveniently" integrate EduClick II into the instruction of each subject, five subsystems were designed to help teachers to (1) manage basic information about class members; (2) edit, re-classify and manage needed instructional materials used in EduClick-based instruction; (3) grasp easily the entire process of integrating EduClick II into instruction; (4) understand thoroughly students' learning statuses when using EduClick II; and (5) conclude and sort data on students' interactions into various useful data tables, which are helpful in managing students' response data and understand their answers. Finally, EduClick II has two types of interaction-supporting modes, quiz mode and statistical mode, to enable teachers "flexibly" to integrate EduClick II into "various" learning and instruction activities according to different needs. Teachers may flexibly combine various modes to overcome the obstacles in carrying out interactive activities in the classroom and effectively implement various interactive instructions and types of learning (elucidating students' learning statuses, arousing their motivation to learn and promoting whole-class and group discussion). According to the results of the survey and interviews conducted herein with teachers who had actually used EduClick II, the added features of EduClick II efficiently enhance the utility rate of the classroom computer and facilitate the integration of information technology into instruction, effectively improving students' attentiveness and motivation to learn, as well as the quality of the teachers' instruction.

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