ELEMENTARY SCHOOL TEACHERS' PERCEPTIONS TOWARD ICT: THE CASE OF USING MAGIC BOARD FOR TEACHING MATHEMATICS

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ABSTRACT
This study aims at investigating elementary school teachers' perceptions toward to the use of ICT. Magic Board, an interactive web-based environment which provides a set of virtual manipulatives for elementary mathematics, is used as the case of ICT. After participating in Magic Board workshops, 250 elementary school teachers in Taiwan responded to a researcher developed questionnaire to get teachers' perceptions toward the use of Magic Board. The study revealed that teachers rated high scores on perceived teaching assistance, perceived learning assistance, and perceived competence of technology integration. The correlation among the three subscales indicates that teachers had a higher score on one scale correlated with higher scores on the other two scales. Findings show no gender difference on perceptions toward Magic Board. However, teachers who have data projectors in their classrooms rated higher scores on perceived teaching assistance and perceived competence of technology integration than those without data projectors in their classrooms. Lastly, this study discusses implications for these results and recommendations for future research.
Keywords: virtual manipulatives; mathematics learning; Magic Board; perceptions toward ICT.

INTRODUCTION

Physical manipulatives and virtual manipulatives

Many elementary school teachers have experienced using physical objects (i.e. manipulatives), such as counters, Cuisenaire® rods, pattern blocks, geometric solids, and base-ten blocks, to introduce basic mathematic concepts to young children. Piaget (1952) proposed the concept that children need concrete experiences to supplement mathematical words and symbols. Consequently, using manipulatives in teaching mathematics has come to taken for granted as a method that will help children to learn mathematics in a more meaning way. In short, they provide experiences in helping students build clearer mental images and understanding mathematical ideas (Weiss, 2006). However, using manipulatives in teaching mathematics was not as expected in practice (Gilbert & Bush, 1988; Moyer, 2001). In Moyer's study, she examined 10 middle grades teachers' uses of manipulatives for teaching mathematics using interviews and observations to explore how and why the teachers used the manipulatives as they did (Moyer, 2001). Results showed that school teachers typically thought manipulatives were fun, but not necessary for teaching and learning mathematics. She further stated that manipulatives have problems associated with implementation in the elementary classroom. These problems include lack of suitable manipulatives, organization, use, and storage, as well as classroom control issues.

Recent research on "virtual manipulatives" has brought new perspectives into the use of manipulatives for mathematics instruction and learning. Virtual manipulatives are exact virtual replicas of concrete manipulatives placed on the internet in the form of computer applets for constructing mathematical knowledge (Moyer, Bolyard, & Spikell ,2002). Many researchers believed that virtual manipulatives have the potential to overcome some of the main drawbacks of implementing physical manipulatives (Clements & Sarama, 2005; Moyer, Niezgoda, & Stanley , 2005; Yuan, Lee, & Wang, 2010). They discussed many advantageous properties of virtual manipulatives, including the potential for alteration, interactivity, flexible representations, unlimited supply, and easy to clean. The National Council of Teachers of Mathematics (2000, pp. 26-27) indicated that work with virtual manipulatives allows young children to extend physical experience and to develop an initial understanding of sophisticated concepts such as the use of algorithms. Many studies have shown that virtual manipulatives offer unique advantages, and can be as or more effective than physical manipulatives, in supporting learning (Wright, 1994; Clements & Sarama, 1998; Suh & Moyer, 2007). Yuan, Lee, and Wang (2010) examined the performance difference between using physical manipulatives and virtual manipulatives in finding the number of polyominoes. They found students in the virtual environment paid much more attention to exploring the polyomino problem. New ideas, including using new symbols to record the results and considering the influence of symmetry and rotation on the figures, also occurred in the virtual manipulative group. Using virtual manipulatives during instruction seems to be a new trend for integrating technology into mathematics learning and teaching (Lee & Chen, 2009).

Teachers' beliefs toward classroom use of technology

Over the past two decades, research has demonstrated that personal belief systems exert a powerful influence on what teachers learn from reform initiatives and staff development programs, on their curricular decision-making, and on the instructional practices, they use in their classrooms (Nettle, 1998; Vacc & Bright, 1999). Many educational reform initiatives have failed because they had little impact on teachers' beliefs or practice (Czerniak &Lumpe, 1996; Cohen & Ball, 1990), particularly, introducing educational technology into the classroom. Scholars have argued that providing a technology infrastructure will change teachers' practice (David, 1994; Sheingold, 1991) and technology can support using constructivist approaches to the teaching and learning advocated by the current reform movement (Linn, 1998; Sandholtz, Ringstaff, & Dwyer, 1997). However, the current level of technology integration has not yet reached a critical mass (Scrimshaw, 2004) and there is tension between the input of enthusiastic forerunners and the reality of a more widespread implementation (Watson, 2006).

The gap between innovation objectives and the current level of technology integration is due to the mismatch between the meanings attached to innovation by those involved in the instructional process (van den Berg, Vandenberghe, & Sleegers, 1999). In this respect, the personal willingness of teachers to adopt and integrate innovations into their classroom practice seems to be of crucial importance (Ghaith & Yaghi, 1997). Previous evidence has suggested that, if treating technology as an instructional innovation, beliefs will play a significant role in whether or how it is adopted and implemented (Czerniak & Lumpe, 1996). For example, Niederhauser and Stoddart (2001) suggested that teachers use technology in ways that are consistent with their personal beliefs about curriculum and instructional practice. Zhao, Pugh, Sheldon, and Byers (2002) reported that the further a new practice is from existing practice, the less likelihood of implementing it successfully. Given this, instructional technologists might consider introducing technology as a tool to accomplish what is already valued. Once the tool is valued, the emphasis can switch to its potential for accomplishing additional or new tasks, including those supported by broader or different beliefs (Ertmer, 2001).

Ertmer (2005) proposed the following three strategies for promoting change in teacher beliefs about technology integration.

1. Personal experience: self-efficacy literature (Schunk, 2000) highlights the importance of building a teacher's confidence through successful experiences with small instructional changes before attempting large changes. Particularly when technology is involved, starting with relatively simple uses may be a more productive path to achieving teacher change than expecting teachers to use technology, from the outset, to achieve high-end instructional goals.
2. Vicarious experiences: Zhao and Cziko (2001) found that observing successful others might increase teachers' perceived need for change as well as assure them that the required changes are not impossible. Therefore, models not only provide information about how to enact specific classroom strategies, but increase observers' confidence for generating the same behaviors.
3. Social-cultural influences: Zhao and Frank (2003) noted that change in teacher beliefs regarding the value of computers was more likely to occur when teachers were socialized by their peers to think differently about technology use. An innovation is less likely to be adopted if it deviates too greatly from prevailing values, pedagogical beliefs, and practices of teachers and administrators in the school. Teacher practice is more likely to change in professional communities that support technology integration.

Based on the above-described three strategies, Magic Board workshops provide elementary school teachers with hands-on design activities, model examples, and an on-line professional development community. Teachers can have successful personal experience in using Magic Board to design their teaching materials through hands-on activities. They can see model examples designed by other peers. Observing other similar others serves both informational and motivational functions. Teachers can register as a member of the Magic Board professional learning community, in which teachers jointly explore new teaching methods, tools, and beliefs, and support each other as they begin transforming classroom practice. The next section provides a brief introduction of Magic Board.

Magic Board

Numerous virtual manipulative websites are currently available worldwide, such as the National Council of Teachers of Mathematics Illuminations (http://illuminations.nctm.org/) and the National Library of Virtual Manipulatives (http://nlvm.usu.edu/en/nav/vlibrary.html). These resources are full of applets, and each applet is designed for teaching a specific topic. Virtual manipulatives in different applets cannot be used together within the same interface. This reduces the flexibility and the need for representing different concepts.

Different from these existing resources, Magic Board provides a collection of virtual objects that elementary teachers usually use to present mathematics concepts. Magic Board is a well-known web-based virtual-manipulative environment for teaching elementary mathematics in Taiwan, developed by Yuan (2005), and based on experiences for developing virtual manipulatives. Magic Board consists of three important components, namely Magic Board Software, a Problem Center, and an Instructional Material Center. When a user registers as a member of Magic Board, he (she) can use all the components to construct and to share his (her) problem posing materials through the Magic Board platform. A user can make use of the shared posing problems and adapt them to suit his (her) classes, which other members can subsequently share and re-use. Non-registered users (guests) can still open and utilize the Magic Board Software and can implement existing problem posing materials into their instruction. All parts and graphic files in Magic Board are directly downloadable for using in conjunction with related worksheets.

- Magic Board Software (MBS)

MBS can be accessed from the upper right corner of the website home page by clicking the "Try English version." button. MBS (See Figure 1) has the frequently used elementary mathematics manipulatives digitalized and componentized in the Toolbox, which allows teachers instant access during teaching. Teachers can drag these objects to the Display Area and a right-click allows access to property variation and operation. At the Function Button Area, the Text button allows one to enter text to pose story problems for explorations, and the Draw button can be used to scribble or mark anything which erases by clicking the Erase button. The Cheers button encourages students who are doing well or motivates students showing good efforts. The BK button allows for fast change of background and lastly, members can upload their designed materials onto the online database or download previously saved teaching materials. Clicking the Rubbish Bin located at the bottom right-hand corner clears all components from the Display Area. A user creates his/her problem on the Display Area, he/she can save the problem by clicking the Save/Upload button to save it on the web for other users to use or clicking the Load Locally button to save it in personal computer temporarily.

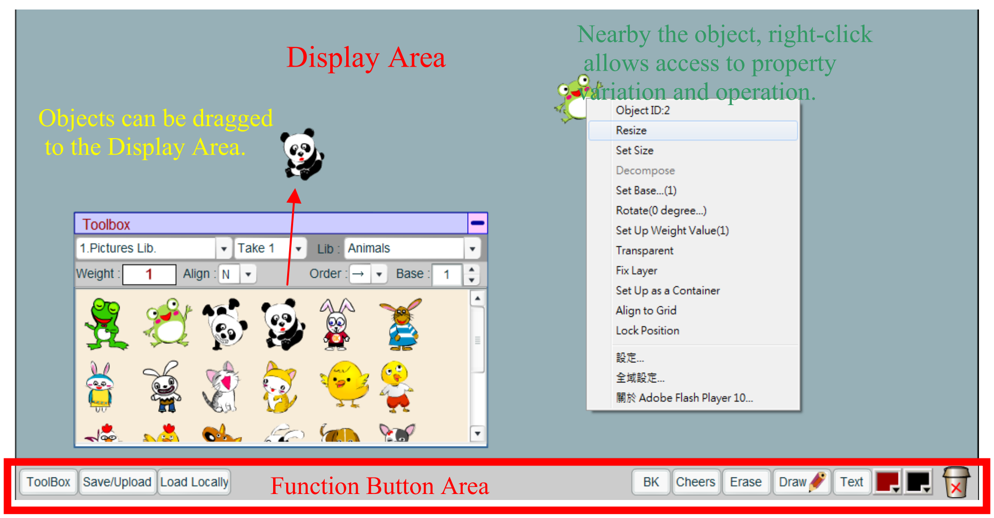

Figure 1: Magic Board software interface

- Problem Center (PC)

Users can log into the Magic Board platform to use resources from the PC. They can search for uploaded problems according to the level of their students and mathematical contents. The teaching materials can be saved and uploaded as users click on Save/Upload button on the Function Button Area, and from there follow the instruction to enter the grade of the target students and their content. Users can search for problems based on these pre-set search values. Clicking on Searching Problem on the top and selecting grade 1, measurement and length as the search values lists past problems uploaded by Magic Board members (see Figure 2).

Figure 2: Searching problems uploaded by pre-set search values

- Instructional Material Center (IMC)

By clicking on Organize Instructional Materials, users can browse through problems and choose suitable source materials, to personalize the instructional materials. Once users have entered Organize Instructional Materials (See Figure 3), searched, and clicked the problems, the right-hand column numbers the problems according to their picking order. Clicking on Finish button and entering the classification information of the instructional materials, completes the compilation. By clicking on Search Instructional Materials, users can look for shared instructional materials through classifications such as grades and mathematical concepts. Users can access and read the completed instructional materials at the IMC. Figure 4 is an instructional material presented in a story form that contains 12 problems (current screen demonstrates problem 4). Clicking on the arrow in the Function Buttons Area controls the presentation of instructional materials. As the components (such as the tables and chairs) on the screen all come from the Toolbox, they can therefore be easily shifted around to allow clearer demonstration of the texts as well as class discussion prior to problem solving.

Figure 3 : Operating interface of organizing instructional materials

Figure 4: An instructional material that contains 12 problems

Magic Board can be accessed at http://magicboard.cycu.edu.tw for free. Teachers only need to drag and copy to compile their own instructional materials, and subsequently upload them to share with other teachers. Teachers can edit and adopt instructional materials created by other teachers to an individual application. It is an all-in - one applet. Teachers can share the instructional materials they developed to save other teachers' time, and teachers can personalize instructional materials to adjust to their specific needs. Hatfield (1994) indicated that teacher competency of technology-integrated instruction is one major reason that elementary teachers decide not to use manipulatives in their classroom. Magic Board is designed to be a good assistant for elementary teachers in teaching mathematics.

THE PURPOSE OF THIS STUDY

Virtual manipulatives are one important element of mathematics teaching and learning as components of representational systems (Durmus & Karakirik, 2006). Mathematics classrooms are now using this relatively new technology with greater frequency. Therefore, this study developed a questionnaire to help understand elementary school teachers' perceptions toward ICT and the use of Magic Board is explored as a case of using ICT. A recent study indicated that male teachers showed more positive attitude toward integrating technology into instruction than female teachers on attitude and strategies used (Yuan & Lin, 2008). Therefore, an analysis of gender differences also included in the study. Generally speaking, accessibility of ICT equipment can create a significant problem for teachers' technology integration. However, a few studies indicated that increasing teachers' access to ICT dose not increase their desire to use ICT in class (Cuban, Kilpatrick & Peck, 2001; Wallace, 2004). In this study, classrooms with data projectors are investigated. With this equipment, instructional materials created by Magic Board can be easily and clearly demonstrated in front of the whole class. For this reason, this study also compared views of teachers who have data projectors with those who do not have in their classrooms.

METHODOLOGY

Instrument

To develop the Magic Board Questionnaire (MBQ), three subscales were constructed on elementary school teachers' perceptions toward Magic Board, i.e., perceived teaching assistance, perceived learning assistance, and perceived competence of technology integration. Based on the work of Lee (Lee & Chen, 2010; Lee & Yuan, 2010), and by consulting with experts in mathematics education, twenty-two items were chosen for the questionnaire. The questionnaire consisted of bipolar agree-disagree statements on a 4-1 Likert scale. All items were presented in the Chinese language. The following three statements are samples of the respective subscales.

1. Perceived teaching assistance scale (PT): An assessment of teachers' views that Magic Board assists teachers in mathematics teaching (e.g., "I feel that Magic Board is a good tool to assist teaching", see appendix PT3).
2. Perceived learning assistance (PL): An assessment of teachers' views that Magic Board aids students in mathematics learning (e.g., "I feel that using Magic Board for teaching improves students' mathematics achievement", see appendix PL5).
3. Perceived competence of technology integration (PC): An assessment of teachers' perceived competence of technology integration (e.g., "I have confidence in implementing technology integrated instruction in mathematics class", see appendix PC5).

Participants

Since the release of the Magic Board on the Internet, the study researcher has frequently been invited to host workshops in various counties and cities throughout Taiwan to promote the use of the Magic Board and gather participant feedback and opinions. If lectures are provided for explanation within relevant research and promotion activities, participants will only receive one-way functional information transmission without opportunities to actually use and operate the Magic Board. By increasing the learning or study time to 6 hours or more, the participating teachers can obtain a clearer understanding of the Magic Board's operational functions through practical applications and can have opportunities to actually complete problem posing and implement the teaching materials. Therefore, for this study, we selected 272 elementary school teachers who attended learning activities for 6 hours or more between 2007 and 2009 as the participants. The participants were recruited from Taoyuan County, Hsinchu City, Taichung City, and Kaohsiung City. Although the sample size of these teachers was relatively small, they represented different demographic backgrounds. The majority of the learning activities was provided by the Curriculum and Instruction Counselling Group for Mathematics in the four regions. Most of the participating teachers were school or teacher representatives for schools in the various cities and counties, and a number of them participated in the learning activities voluntarily.

After completing the learning activities, questionnaires were issued on-site and completed and collected. After excluding the incomplete questionnaires, we had a total of 250 valid questionnaires. Of the 250 participating teachers who completed valid questionnaires, 35 were men and 215 were women. The distribution of years of teaching experience was 53 teachers with 5 years or less, 84 teachers with 5 to 10 years, 60 teachers with 10 to 15 years, 36 teachers with 15 to 20 years, and 17 with over 20 years teaching experience. Regarding the age distribution, 52 participants were 30 years of age or younger, 141 participants were between 30 to 40 years of age, and 57 participants were older than 40 years of age. Background analysis of the teachers who received the questionnaires indicated that the majority of the teachers were women, had 5 to 10 years teaching experience, and were between 30 to 40 years of age. Detailed background information of the participants is listed in Table 1.

Table 1 : Demographics of Teachers in Study

	Taoyuan County	Hsinchu City	Taichung City	Kaohsiung City	Total
Number of teachers (*n*)	97	35	61	57	250
Gender					
Male	13	3	7	12	35
Female	84	32	54	45	215
Age					
□30 years of age	23	1	13	15	52
Between 30 to 40 years of age	56	19	38	28	141
> 40 years of age	18	15	10	14	57
Teaching Experience					
□5 years	27	2	15	9	53
5 to 10 years	35	13	21	15	84
10 to 15 years	22	7	17	14	60
> 15 years	13	13	8	19	53

Data Analysis

An exploratory factor analysis was applied to clarify the structure of item factors. Principle component analysis with varimax rotation to reveal the structure of MBQ was used. The MBQ response differences on some variables, such as gender and the data projector, analyzed by a series of independent t-tests, were investigated further.

Results

KMO and Bartlett's Test were used to examine the appropriateness of conducting factor analysis. From table 2, we can interpret that there is no error in 92.8 % of the sample, and the observed significance level is less than .001. These indicate that a factor analysis of the variables is a good idea.

Table 2: Result of KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.928
Bartlett's Test of Sphericity	Approx. Chi-Square	2502.761
	Df	136
	Sig.	.000

The MBQ revealed three factors, as expected. A questionnaire item was retained only when it loaded greater than 0.50 on the relevant factor, and less than 0.50 on the non-relevant factor. As a result, the initial twenty-two items were reduced to sixteen items. Table 3 shows that the eigenvalues of the three factors (perceived teaching assistance – 6 items, perceived competence of technology integration– 5 items, and perceived learning assistance– 5 items) from the principle component analysis were all greater than one: 8.13, 1.59, and 1.03, respectively. These three factors accounted for 67.19% of the variance. Internal reliability, alpha coefficient, was satisfactory for the three subscales (0.89, 0.90, and 0.81, respectively).

Table 3: Results of principal component analysis

Item	Factor 1 PT	Factor 2 PC	Factor 3 PL
PT1	**.831**	.156	.179
PT2	**.801**	.222	.249
PT3	**.722**	.284	.222
PT4	**.717**	.237	.119
PT5	**.619**	.270	.387
PT6	**.617**	.234	.300
PC1	.206	**.842**	.217
PC2	.181	**.821**	.230
PC3	.184	**.816**	.171
PC4	.294	**.778**	.170
PC5	.424	**.665**	.020
PL1	.393	.307	**.716**
PL2	.051	-.016	**.675**
PL3	.355	.417	**.657**
PL4	.440	.305	**.641**
PL5	.445	.315	**.551**
Cronbach's α	.887	.896	.806
Eigenvalue	8.133	1.585	1.032
Cum. Variance explained (%)	26.144	50.489	67.187

Note. Overall Cronbach's α .927; PC: perceived competence of technology integration, PL: perceived learning assistance, PT: perceived teaching assistance.

Table 4 shows teachers' descriptive results on the three subscales. The questionnaire applied a 4-1 Likert scale, so the maximal mean item score is 4. The mean item score was 3.49 for perceived teaching assistance, 3.32 for perceived learning assistance, and 3.41 for perceived competence of technology integration. These results indicate that teachers believed Magic Board assists teachers in mathematics teaching and aids students in mathematics learning after finishing the Magic Board workshop program. In addition, teachers perceived more competence of technology integration.

Table 4: Teachers' scores on the three subscales (N=250)

Subscale	*Items*	*Mean of items*	*SD*
PT	*6*	*3.4920*	*.45886*
PL	*5*	*3.3184*	*.48336*
PC	*5*	*3.4056*	*.49036*

Note. PC: perceived competence of technology integration, PL: perceived learning assistance, PT: perceived teaching assistance.

Table 5 reveals that all three subscales positively correlated with the other two subscales. The more teachers believe that Magic Board is beneficial for teaching and learning assistance, the more they are willing to integrate technology into their instruction. This is consistent with Ertmer's (2005) findings that integration is better determined by observing the extent to which technology is used to facilitate teaching and learning. Thus, teachers' views about perceived teaching assistance and perceived learning assistance may play an important role in the technology adoption process.

Table 5: The correlations among PC, PL, and PT (n=250)

	PC	PL	PT
PC	1	.581**	.605**
PL	.581**	1	.700**
PT	.605**	.700**	1

Note. **p<.01; PC: perceived competence of technology integration, PL: perceived learning assistance, PT: perceived teaching assistance.

Table 6 presents an analysis of results by gender, indicating no significant difference in all three subscales when comparing the responses of male teachers and female teachers. The results suggest that male and female teachers had similar conceptions toward Magic Board.

Table 6: Teachers' scores on the three subscales, by gender (N=250)

Subscale	*Gender*	*Mean of items*	*SD*	*t*
PC	Male	3.4114	.51551	.076
	Female	3.4047	.48739	
PL	Male	3.4000	.51791	1.077
	Female	3.3051	.47746	
PT	Male	3.5810	.41297	1.238
	Female	3.4775	.46518	

Note. n=35 for males, n=215 for females. PC: perceived competence of technology integration, PL: perceived learning assistance, PT: perceived teaching assistance.

Table 7 shows the results based on the possession of data projectors in teachers' classrooms, with significant differences on the subscales of PC and PT (p<.05). Teachers with data projectors in their classrooms showed significant more agreement in their perspectives on the perceived competence of technology integration and perceived teaching assistance than did those without data projectors in their classrooms. The results indicate that accessibility of ICT equipment can create a significant problem for teachers' technology integration (Means & Olson, 1997). Magic Board is an interactive web-based environment. With a data projector, instructional materials created by Magic Board can be easily and clearly demonstrated in front of the whole class. This might be a reason to get these differences between the two groups.

Table 7: Teachers' scores on the three subscales, by data projector (N=250)

Subscale	*Data Projector*	*Mean of items*	*SD*	*t*
PC	*yes*	*3.4881*	*.46743*	*2.544**
	no	*3.3318*	*.50028*	
PL	*yes*	*3.3593*	*.47900*	*1.267*
	no	*3.2818*	*.48612*	
PT	*yes*	*3.5579*	*.42499*	*2.163**
	no	*3.4331*	*.48114*	

Note. n=118 for having data projectors in their classrooms, n=132 for having no digital projectors in their classrooms. * p<.05; PC: perceived competence of technology integration, PL: perceived learning assistance, PT: perceived teaching assistance.

DISCUSSION AND CONCLUSIONS

This study presents a convenient tool to assess elementary school teachers' perceptions toward Magic Board based on perceived teaching assistance, perceived learning assistance, and perceived competence of technology integration. Using this tool, teacher educators and researchers can deeply explore the role of elementary school teachers' views about Magic Board (In the questionnaire, Magic Board can be changed into any technology tools that suit your need, such as Virtual Manipulatives).

After finishing training in the Magic Board workshop, teachers rated high scores on PT, PL, and PC. Apparently, hands-on design activities make teachers perceive the ease of using Magic Board and that model examples enable teachers to perceive the usefulness of Magic Board in the real classroom. Based on the Technology Acceptance Model (Bagozzi, Davis, & Warshaw, 1992), the greater the perceived usefulness and ease of use of an innovation, the greater likelihood of adopting the innovation. Therefore, teachers may have more confidence in technology integration after training in the Magic Board workshop. The results may imply personal and vicarious experiences, as well as social and culture norms, having some potential for altering teachers' beliefs. Moreover, teachers may become motivated to make changes in their instructional practices (Millsaps, 2000), and have an impact on their students (Patterson & Norwood, 2004). Future research needs to verify their relative impact. Furthermore, the correlation among the three subscales indicates that teachers had a higher score on PC correlated with higher scores on PT and PL. This is consistent with Ertmer's (2005) findings that integration is better determined by observing the extent to which technology is used to facilitate teaching and learning. Thus, teachers' views about perceived teaching assistance and perceived learning assistance may play an important role in the technology adoption process.

The result shows that no gender difference was found in all three subscales when comparing the responses of male teachers and female teachers. However, previous studies (e.g., van Braak, Tondeur, & Valcke, 2004) found that female teachers reported significantly lower levels of educational computer use than their male counterparts did. The training in the Magic Board workshop seemingly reduced the gender gap of teachers' conceptions toward Magic Board. With a user-friendly feature, teachers only need to possess the most fundamental computer skills to operate Magic Board. This might provide female teachers with more confidence in using Magic Board to teach mathematics.

This study reveals that access to data projectors in teachers' classrooms has an influence on teachers' perspectives about perceived teaching assistance and these teachers seemed to perceive competence of technology integration. Hennessy, Deaney, & Ruthven (2005) claimed that limited access to technology and insufficient technological support are some of the reasons why teachers might not take advantage of the educational power of technology. Although the barriers related to equipment support can cause significant problems for technology integration, teachers may solve these problems through hand-me-downs, grants, and private donations.

The results of this study support another way to promote technology adoption among teachers at different levels. Researchers need to develop easy-to-use tools so that the teacher does not need to spend extra time and energy learning to use the technology. Since Magic board is designed to support a wide range of teaching approaches, it does not require a teacher to change his pedagogy in order to use technology. Moreover, it uses a common graphic-interface web browser, making it easy to learn and use because many pre- and in-service elementary school teachers have already had experience with such software.

Future research should examine how teachers' perceptions toward Magic Board influence their choice of how and when to use it in instruction. For instance, it is important to determine if this group of teachers, influenced by the training of Magic Board workshop, are the only teachers using virtual manipulatives in ways central to their mathematics lessons or if other teachers are using manipulatives in the same ways. Further examinations, using in-depth interviews with teachers and observations of classroom implementation, have the potential to reveal additional insights into these results.

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Appendix: The questionnaire used in the study

PT1: In the proper mathematical topics, I will be enthusiastic about using Magic board to design learning materials and to integrate them into my class.
PT2: I will use Magic Board for mathematics teaching.
PT3: I feel that Magic Board is a good tool to assist teaching.
PT4: I feel that conveniently using and storing Magic Board in the classroom can save a lot of teaching time.
PT5: I feel that using Magic Board can remedy the lack of physical manipulatives.
PT6: I feel that Magic Board is easy to demonstrate and convenient for big group teaching in the classroom.
PC1: I can present teaching materials clearly by integrating technology into mathematics instruction.
PC2: I can understand the meaning of technology-integrated mathematics instruction.
PC3: I can make abstract teaching materials easy to understand by integrating technology into mathematics instruction.
PC4: It is easy for me to implement technology integrated mathematics instruction.
PC5: I have confidence in implementing technology-integrated instruction in mathematics class.
PL1: I feel that using Magic Board for teaching can help students express mathematical ideas.
PL2: I feel that using Magic Board for teaching can improve students' interest in mathematics learning.
PL3: I feel that the functions of various components in Magic Board can help students link the mathematics concept.
PL4: I hope that students can use Magic Board to learn mathematics.
PL5: I feel that using Magic Board for teaching can improve students' mathematics achievements.