A Case Study of Interactive Tabletops in Education: Attitudes, Issues of Orientation and Asymmetric Collaboration

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Abstract. This paper is concerned with the exploration of an educational tabletop application designed to facilitate collaboration amongst young learners while they learn about the "Plants of Cyprus". The application was used by 28 third-graders during a scheduled visit at the Cyprus Center of Environmental Research and Education. We report empirical findings concerning the participants' interactions around the table as well as their attitudes regarding the activity. Findings demonstrated that the students collaborated intensively in completing the task and they were overwhelmingly positive about the experience. The paper discusses issues of orientation of the on-display learning artifacts, which encouraged learners to move at a new location around the table to "correct" the orientation. Also, the study raises concerns regarding asymmetrical forms of collaboration, where peers dominated the activity despite the equal access on the tabletop surface.

Keywords: Interactive Tabletops, Collaborative Learning, Interactions, Attitudes, Orientation, Asymmetric Collaboration.

1 Introduction

Multi-touch interactive tabletops have recently attracted the attention of the Human Computer Interaction and Educational Technology communities. A multi-touch interactive tabletop can handle multiple simultaneous touch inputs and can support collaboration by allowing different patterns of turn taking, negotiation and interaction [2][1]. As discussed by [4], multi-touch tabletops afford cooperative gestures which can enhance users' sense of teamwork. In this work, an educational tabletop application was designed to facilitate collaboration amongst young learners while they learn about the "Plants of Cyprus". The study sought to (1) explore the kinds of interactions evident around the tabletop and (2) examine students' attitudes toward the activity.

2 The "Plants of Cyprus" Application

The "Plants of Cyprus" aims to facilitate collaboration amongst young learners while they learn the different types of the plants growing in Cyprus and their uses in

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cooking, weaving, pharmacy and basketry. Two educators at the Cyprus Center of Environmental Research and Education were actively involved in the design process and pilot-testing of the application. The "Plants of Cyprus" runs on a TouchMagix table -- a multi-touch technology that supports multiple simultaneous users. The application is designed for four users (one at each side of the table) and is completed in two stages.

In Stage 1 (declarative knowledge), learners interact with the application to retrieve information through a series of videos concerning the various plants growing in Cyprus and their uses (see Fig. 1). In this stage, learners are advised to collect as much information as possible, before they proceed to Stage 2 of the application; Stage 1 is not accessible once learners proceed to Stage 2.

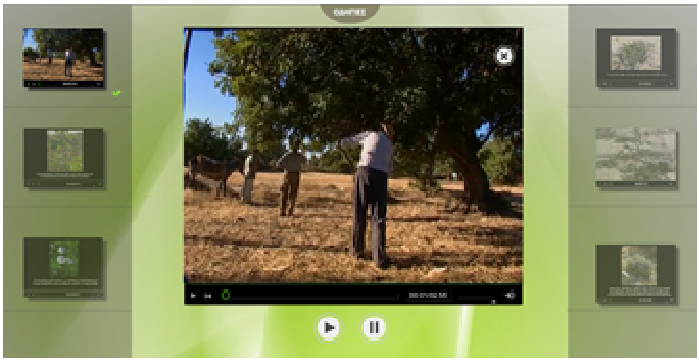

Fig. 1. "The Plants of Cyprus": Stage 1 – declarative knowledge

In Stage 2 (assessment), learners are asked to collaborate on a matching activity to assess their level of "recall" of declarative knowledge (see Fig. 2). The pictures of eight plants are presented and each one has to be linked to a category/use (cooking, weaving, pharmacy and basketry). Some indicative information about the plant is displayed to help learners recall the information from Stage 1. The application is collaboration-enforcing in the sense that learners have to discuss the information they recall from Stage 1 in order to match the plants to the correct category and complete the task successfully; students are allowed to try till they find the right solution.

Furthermore, the application is designed to promote symmetrical collaboration where all four learners have equal access to the tabletop and equal opportunity to match plants to categories. This is achieved through the design of a workspace for every user as shown in Fig. 2, as well as the restriction imposed by the application that each learner has to match exactly two plants. That is, a learner chooses two plants to link to the appropriate category; these plants cannot be reused by another learner.

3 Method

A convenience sample of 28, third-graders (8-9 years old) participated in this study during a scheduled visit at the Cyprus Center of Environmental Research and Education with their teachers (2 teachers).

Students worked in groups of four, formed by their teachers (i.e., 7 groups total). Groups, one after the other, were taken to a quiet place at the Center where they engaged with the "Plants of Cyprus". There were no time restrictions in completing the activity; all groups spent 25-30 minutes on task.

Students' interactions were videotaped for subsequent analysis. Also, a questionnaire was administered to the students at the end of the activity to assess their attitudes regarding the experience. The questionnaire included six items with a Likert-type response scale from 1: strongly disagree to 5: strongly agree in the form of smiley faces, appropriate for the age of the participants. Also, the questionnaire included an open-ended question regarding students' experience.

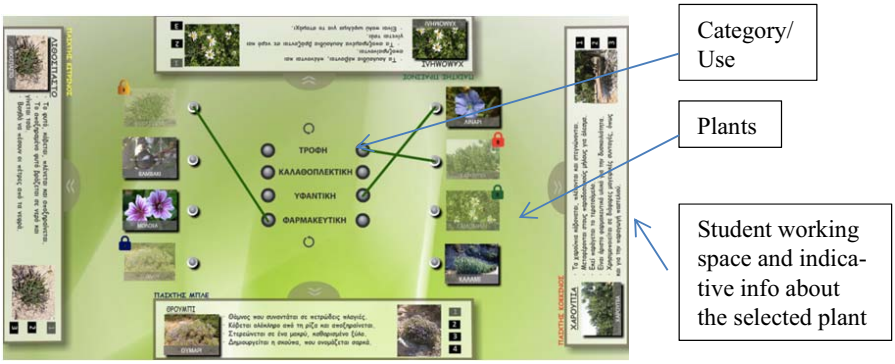

Fig. 2. "The Plants of Cyprus": Stage 2 - assessment

4 Analysis and Results

Video analysis was conducted first. Two researchers (coders), with professional backgrounds in educational technology considered the video in its entirety (approximately 3 hours) in an effort to categorize the types of discourse and actions present. The coders worked closely together to create coding categories on the basis of the data (i.e., a bottom-up approach). Table 1 presents the coding scheme of the study, including four categories of verbal and non-verbal behavior. Using this coding scheme, the researchers coded all video data. The unit of analysis was the "unit of meaning". The percent agreement between the coders was 85% for both segmentation (into units of analysis) and categorization. Finally, codes in each coding category were counted as presented in Table 2.

Table 1. Coding Scheme

Coding Category	Description	Example
Task/tool related talk	Information sharing, providing advice, seeking confirmation, general talk about the task, asking/commenting about the technology.	M3: "Why can't I drag this plant?" M2: "Because I have it…take a different one" (tool related, group 5) M4: "I know what a carob is. It is food…you can eat it. I can do this matching." (task related, group 2) M2: "Oh you took "savory"… The video said it is used in some recipes. Do you know how to match it?" M3: "Yes, it is food." (task related, group 3)
Questioning/answering	Specific content-related questions and answers amongst the participants.	M1: "Broom…How do we make a broom?" M2: "Someone in the video explained it. It has to do with basketry I think." (group 2)
Dominating talk/move	Asking to lead or physically blocking and controlling others' actions.	M1 is trying to match a plant to a category but M2 pushes M1's hand away from the surface to do it himself, while saying "No no no … let me do it" (group 7)
Body relocation	Moving body to face learning artifact at a proximally "normal" orientation.	Students move physically at a new location around the table to orient themselves towards the videos, images and text to ease reading/viewing.

Table 2. Counts Within Each Coding Category Across Groups

	G1	G2	G3	G4	G5	G6	G7	Total
Task/tool related talk	14	14	21	15	13	14	9	100
Questioning/answering	3	4	3	3	2	3	2	20
Dominating talk/move	9	12	13	8	10	11	4	67
Body relocation	1	1	1	1	1	1	1	7
Total	27	31	38	27	26	29	16	194

As the frequencies of Table 2 illustrate, the participants collaborated intensively overall, especially in Stage 2 of the activity. In particular, the participants shared information about the plants they recalled from Stage 1 or provided advice to their peers to help them find the correct matching. For example, in Stage 2, one participant advised another member: "Read the description of the plant and if it says that you can eat this plant you will match it to the cooking category" (task/tool related talk). Also, some talk concerned confirmation seeking (e.g. "I think this plant belongs here. I am matching it") or asking/commenting about the technology (e.g., "I cannot drag it, how do you do it?"). Specific content-related questions and answers were less frequent, although it was present in all groups. Interestingly, questions never went unnoticed by the cooperating peers, for example M3:"What does weaving means?" M4:"It is our cloths" (group 1).

Despite the intensive collaboration, in each group a peer dominated the activity by asking others to let him/her complete the tasks, for example, "Let me do it…I know the answer" or by blocking and pushing their hands away from the surface to touch him/her-self (dominating talk/move). Furthermore, in Stage 1 and throughout viewing the videos for information retrieval, students in all groups move physically at a new location around the table where they viewed the learning artifact at a proximally "normal" orientation (see Fig 3 left-side); then in Stage 2 students return to their working spaces for the matching activity (see Fig 3 right-side).

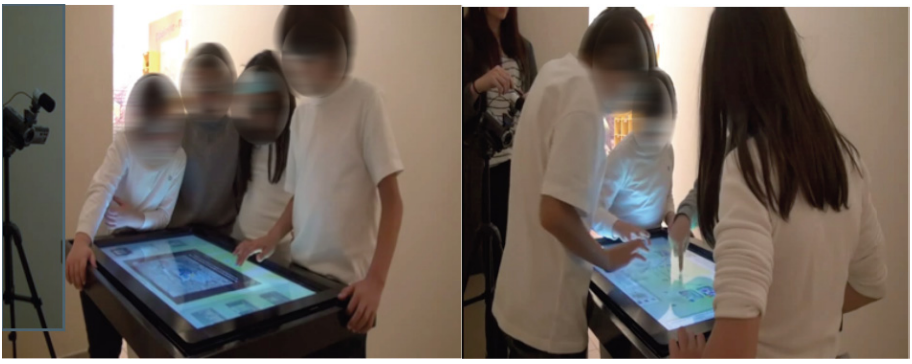

Fig. 3. Collaboration on the "Plants of Cyprus"

Following the video analysis, the data from the attitudes questionnaire was analyzed. Student feedback was overwhelmingly positive, with a mean of 4.42 (SD=.77) across the six items of the questionnaire, as shown in Table 3. Also, in the open-ended question of the questionnaire, many students expressed their enthusiasm about the tabletop (e.g., "I would like to have one at home!", "I would like to play again"). Overall, the results from the questionnaire informed the results of the video analysis showing that not only the completion of the task was a group effort, but it was also an enjoyable one.

Item	Mean (SD)
1. I enjoyed the activity around the tabletop.	4.79 (0.50)
2. I would like to use a tabletop for school activities.	4.44 (0.85)
3. The tabletop encouraged my participation in the task.	4.12 (0.93)
4. The tabletop encouraged my collaboration with other group members.	4.15 (0.90)
5. My group worked well for this activity	4.38 (0.90)
6. I learned new things from this activity	4.65 (0.56)

5 Discussion

Findings from this study demonstrated that the students collaborated intensively in completing the matching task of the "Plants of Cyprus" around the table. Students' interactions were rich in information sharing, offering advice, confirmation seeking,

questions and answers and general talk about the task and the technology as evident in Tables 1 and 2. Our investigation confirms previous research findings discussing the affordances of interactive tabletops to support collaboration (e.g., [1][2][4]).Also, student feedback was overwhelmingly positive, consistent with previous works suggesting that tabletops can enhance users' sense of teamwork [4] and can improve the (learning) experience and motivation to engage in the task [1].

Furthermore, the study showed that the orientation of the learning artifacts on the tabletop encouraged learners to physically move at a new location around the table to "correct" the orientation (i.e., oriented themselves towards the artifact to ease reading/viewing). This moving occurred in all groups during Stage 1; then students moved to their working space for Stage 2. This result confirms previous work with non-computer based, table-centered collaborative tasks showing that users consider straight-on orientated text as more readable (e.g., [3][5]). This finding suggests that learners around a tabletop should be free to move around to "correct" the orientation of the learning artifacts; being seated or restricted within the physical space can limit their ability to read/view.

Last, the study revealed asymmetric forms of collaboration in all participating groups with one group member dominating the activity, despite the deliberate design of the application to promote equal access to the tabletop and equal opportunity to match plants to categories. This finding divergences, in part, from the premise that multitouch interactive tables can support collaboration by allowing different patterns of turn taking and interaction [1][2]. This result might be suggesting that some form of facilitation or guidance is necessary for young learners to engage in a well-balanced collaboration free of dominant talk and blocking moves by peers.

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