# DanceUP: Immersive Dancing Lessons with Precise Feedback using a Multitouch Floor

**Michael Weisz, Mandy Klingbeil, Jan-Peter Heuzeroth, Robert Schmid**
Hasso Plattner Institute
Potsdam, Germany
{ michael.weisz, mandy.klingbeil, jan-peter.heuzeroth, robert.schmid }@student.hpi.uni-potsdam.de

## ABSTRACT
In this paper we present DanceUP, a system that allows to learn ballroom dances on an interactive multitouch floor. In particular, users can learn rhythm and patterns for different dances, alone or as a couple. Previous knowledge is not required. Our system provides feedback according to the dancer's performance in two ways: Users get visual feedback regarding the correctness of their feet positioning and potential mistakes, as well as acoustic signals on whether they are dancing on time according to the rhythm.

## INTRODUCTION
Over the last couple of years, learning ballroom dances has become mostly a leisure activity. People go to dancing schools in order to relax from work and meet other people. "As a dancing school, we offer a new experience", Matthias Freydank, a highly experienced dancing teacher, told us. "There is nothing you are obliged to do anymore. It's all about having fun."

"When people come to us, they have already taken the first step. Now it is important to keep them motivated, for example by starting with small tasks and easy ballroom dances like the Waltz, Disco Fox or Boogie."

Olga Khvostova, a dancing teacher at the college sports department of the University of Potsdam, explained to us: "At this point, the main problem is nervousness. Very often this causes students to move stiffly because they are having inhibitions and are afraid of making a fool of themselves in front of their partner."

**Figure 1: (left) Matthias Freydank at his dancing school "Balance"[1], (right) Olga Khvostova teaching a class.**

In addition, Mrs. Khvostova emphasized how important it is for beginners to fully master the steps all by themselves before getting together with their respective partner.

"Students also need to know how to properly keep their balance. To achieve this, it is important to quickly get familiar with rhythm and coordination."

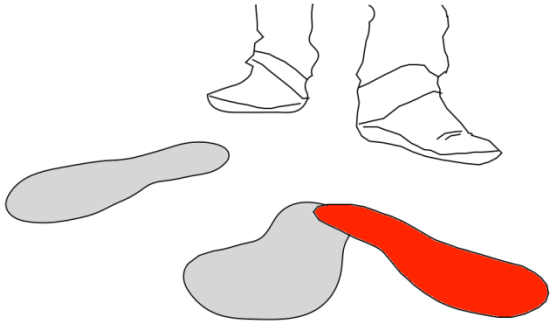

**Figure 2: While learning a new dance pattern, users receive ongoing precise feedback. When making a mistake, the system projects the user's footprint on top of an imaginary teacher's reference steps.**

Unfortunately, teaching rhythm is rather difficult and seems to be the major source of problems in dancing schools, as Khvostova pointed out. "Most students just do not dance on time. It is helpful, then, to become active as teacher and clap the rhythm while they are dancing along."

Regarding the actual patterns and moves Khvostova emphasized that "the accuracy of the steps doesn't need to be perfect. There is no such thing as an ideal positioning of the feet, it's more important to align to invisible characteristic key lines, instead." If students stick to these lines, she explained, they would adjust their body automatically, especially in accordance with their partner.

Last but not least, it is helpful for students to see themselves in a mirror, to help them easily spot their mistakes on their own. Alternatively, the dancing teacher can effectively provide a reference when dancing in front of the students, enabling them to simply imitate.

As a result of our contextual inquiry, we decided that our system should keep it simple and fun, to focus on rhythm,

[1] Photo credit ADTV Tanzschule "Balance"

coordination and on teaching the steps, to visualize important key lines for alignment purposes and to allow couples to use the system simultaneously.

In addition we concluded that learning a new dance pattern can effectively be split up into four different tasks:

**(1) Train sense of rhythm**. Users listen to the music while they step along and keep in time with the music.

**(2) Learn a new dance pattern** without a partner. Users watch the new pattern and try to repeat it. Continue practicing with music.

**(3) Improve the technique** without partner. Users dance with music and get permanent feedback about timing and accuracy of steps.

**(4) Improve the technique with a partner.** Users dance with their partner and improve their skills.

Our main test case is to teach a new dance pattern to a beginner (according to our second task) and is featured step by step in the walkthrough section below.

## DEVICE

Our software is designed for Multitoe [1], an interactive floor based on frustrated total internal reflection.

Multitoe allows us to identify and track users based on their shoes. This way, we are able to do an initialization process, scanning their individual step and shoe size to adapt the user information to the program. It also gives us the possibility to let our users work on their personal high score across multiple sessions, so that they will stay motivated and stimulated by gamification elements. In addition to that, it is possible to invoke menus and to provide ongoing feedback to each individual on the floor.

## WALKTHROUGH

We introduce John, who has never danced before in his life but plays an instrument, and wants to learn the basic pattern of the Waltz without a partner.

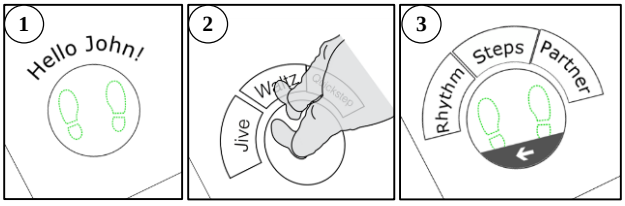


**Figure 4: (1) John steps onto the floor and the system identifies him. (2) After two seconds, a menu opens. John selects "Waltz" by foot-tapping. (3) John chooses "Steps" which will start the program.**

After moving onto the floor John is displayed a personal greeting and is asked to make a selection in a menu. He chooses the correct dance and since he is already familiar with rhythm he selects learning the steps, immediately.

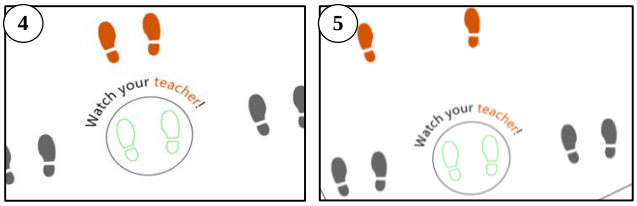


**Figure 5: (4) A virtual dancing teacher demonstrates the new dance pattern. (5) John's task is to observe and memorize the steps.**

The systems starts and John finds himself standing behind a virtual dancing teacher, shown as an orange pair of feet in front of him, and enclosed by virtual classmates (black footprints) on either sides. The teacher demonstrates the new pattern and John is asked to carefully observe and memorize the steps.

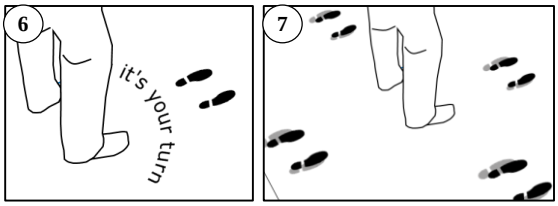


**Figure 6: (6) John is invited to imitate the steps and dance along. (7) John's correct steps will show up as light gray (virtual) footprints on the floor, projected on top of the teacher's and classmates' steps.**

After some iterations, John has fully memorized the pattern and is asked to join in and dance along. John is still able to see the teacher's reference steps. As additional assistance the virtual classmates on either sides and behind him start to dance along, providing reference steps in every direction, even when he needs to turn.

While dancing, John's steps are projected on top of the reference steps around him in a light-grey shade so that he can easily spot subtle inaccuracies regarding his foot positions.

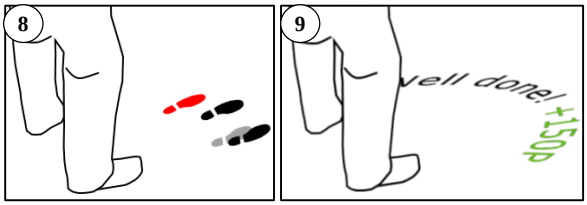


**Figure 7: (8) As John put his left foot in a wrong position, the system confronts him immediately with his mistake by coloring the projection of his steps in a dark red, placed relative to the teacher's reference. (9) After three flawless runs, the system stops the program and displays the score John achieved.**

Suddenly, John makes a mistake and the projection of his misplaced foot turns into an eye-catching red shade. John immediately notices and tries to improve that particular step next time.

For a short period of time John is not dancing on time according to the rhythm. The systems starts playing an alarming metronome sound indicating the correct beat. As soon as he dances on time again, the sound fades out.

After three flawless runs the system stops and John gets to see the score he managed to achieve. He received points for every correct step and every second he managed to dance on time.

## DESIGN

### Dancers shouldn't need to look down

Our first idea to demonstrate a dance pattern to a user was to position the virtual feet right below the user. In this case, the feet symbols are under the dancer's feet and shift continuously to the target positions for the next step where they stop. The dancer would be able to see the exact distance of the steps and get a feeling for the speed. In addition to that, the user would not need a direct feedback – if the user's feet do not match the virtual ones, the user automatically knows that the step was wrong.

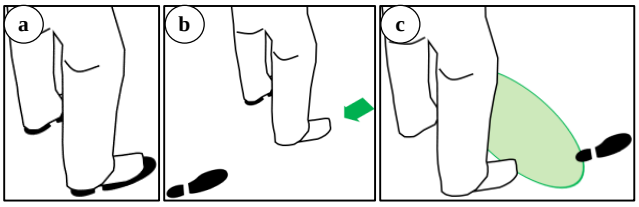


**Figure 8: (a) Initial design: Virtual feet below the user (b) Arrows indicate steps going backwards (c) Ellipse helps users to follow steps without having to stare at feet**

While testing this idea during paper prototyping, it was hard for the participants to follow the virtual feet. All three of them complained about the missing look-ahead: When they performed the pattern for the first time, they did not know where the virtual feet would go next. Especially the cases of moving backwards – so that the virtual feet were not in visual range of the user anymore – made it complicated. As a result, the movement of the participants was rather clumsy. Beyond that, all of them had a very unnatural posture because they had to look down all the time. As a result, they could hardly keep themselves balanced and made several mistakes.

We tried some modifications to avoid looking straight down. For example, we added an ellipse around the user that was much bigger than just the feet. But it was still not enough to avoid neck pain and remedy their posture. So we decided to use the concept of reference steps: The feet of a virtual teacher are displayed in front of the user, while no actual tapping onto the reference steps is intended. This alternative seemed more natural as it corresponds well to a real-world dancing lesson in which a teacher is dancing in front of the students.

As we found out during paper prototyping, users who tried to learn dancing with reference steps were far more successful than with the approaches mentioned before. Two of the users told us they would find it easy to learn steps – without having neck pain afterwards.

### Having a look-ahead is mandatory

But even with our dancing teacher, there was still a problem: Some of our paper prototype participants became frustrated, since they had never danced before and were not immediately able to follow the teacher's reference steps so quickly. So we tried to add arrows pointing to the next targeting position. This worked great for slow dances like waltz, but unfortunately not at all for faster ones.

So we refined our idea and added a real look-ahead: When users perform a pattern for the first time, they are asked to just observe the teacher, first. In the meantime, no score points are counted. Not before the animated feet have shown the pattern at least once, the user is asked to become active, as well. For this, it is very important that a pattern includes just a few steps – so that the user is able to remember and imitate them quickly.

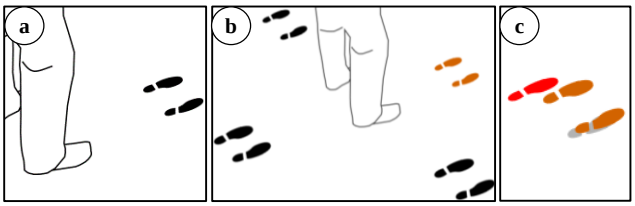


**Figure 9: (a) Final design: A virtual dance teacher is displayed in front of the user (b) Highlighted teacher, virtual classmates serve as additional reference in more complicated steps (c) Users feet are continuously projected onto reference steps, mistakes are highlighted with red color**

### Dealing with turns by introducing classmates

One of the paper prototype participants got bored, only dancing the basic waltz pattern all the time. So we tried to include a new waltz pattern: the left turn. This helped us realize what happens after turning around: The users simply cannot see the reference steps anymore, as they are right behind them. That is why we included virtual classmates who join the user on the dance floor, enclosing him. After turning around, the user can simply use them as a new reference. To avoid confusion at the beginning of the program, we also decided to color the teacher's feet orange, while showing the class mates' feet in a more subtle black.

### Showing mistakes immediately

In our first version, users only received a certain score at the end, giving them feedback about their performance as a whole. But during paper prototyping, the last participant asked for ongoing feedback, so that he would know which steps in particular had to be corrected next time. Thus, we let him dance again, giving him immediate feedback below his feet, indicating mistaken steps with a laser pointer. In order to see the feedback, he had to look down at his feet. However, since the participant was already supposed to look at the reference steps in front of him, he simply missed the indications provided below his feet.

As a result, we projected the wrong positioned feet of our participant directly onto the reference. That allowed users to easily spot mistakes – and to correct themselves immediately.

### Getting feedback while dancing correctly

In our heuristic evaluation, we presented an interactive prototype to seven different users. We got a lot of positive feedback for the reference steps and the flaw indication. Nevertheless, one of the participants asked to add ongoing positive feedback, as well: When she used the system for the first time, she danced all the steps correctly, and consequently received no error indications. Even so, she became confused because she was expecting at least some kind of ongoing feedback regarding her performance, too.

According to her experience, we chose to add positive feedback as well. To be consistent, we wanted to do it similarly to the negative feedback, showing the user's feet projection on top of the reference steps. But in contrast to the case of mistaken steps, the projection would mainly overlap with the reference steps, so there would only be a subtle difference to the reference steps. That is why positive feedback should not be as eye-catching as the negative feedback. So we decided to use a light gray shade for this purpose.

### Virtually clapping the rhythm

As we learned from our contextual inquiry, it is hard to teach rhythm. If the user is a beginner, it is important to become active as a teacher, indicating the rhythm for example by clapping. Because of that we included an alarming sound that will grow louder if the user is not on time according to the music. As the user gets better, the sound slowly fades out again. In our heuristic evaluation, the majority of the participants supported that idea.

## CONCLUSIONS

During the process of creating our system we gained some general insights on how to design for interactive floors.

### Guide the user along carefully

Because of the sheer size of the floor, especially when compared to a handheld device, users easily loses track on where their focus is required. Therefore it is vital to always provide a clear path throughout the entire experience and to precisely indicate where to look and where user attention is required.

### Make use of metaphors

As it turned out during our design process, the use of metaphors seems to be one of the most fruitful approaches for providing a discoverable user interface. So instead of teaching users a new set of specific feet-based gestures, the system should completely rely on natural motions the user is familiar with and would likely perform even on a real floor (like tapping and walking). This holds not only true for interaction techniques but also for the way you display information: In our case the metaphor of a real dancing lesson, in which you are imitating a teacher's steps in front of you, proved to be superior to coming up with completely new floor-specific ways of indicating where to go.

### Make it user-centric – literally

All the information and potential menus should dynamically appear in front of the user's current position and in a way that they are easily accessible for interaction. This is in contrast to having them appear at a static position on the floor which forced the user to first walk to that spot. The latter approach is not only bad because it adds unnecessary effort but it also violates our previously described principle of providing a clear path throughout the entire system, because the user might have missed the information entirely when it simply appeared outside the user's eyesight or current range of attention. In a word: The floor should adapt to the user, not the other way around.

## REFERENCES


1. Fetzer, C., Kaefer, K., Augsten, T., Meusel, R., Kanitz, D., Stoff, T, Becker, T, Holz, C. and Baudisch, P. Multitoe: High-Precision Interaction with Back-Projected Floors Based on High-Resolution Multi-Touch Input. In Proceedings of UIST 2010, pp. 209-218


## APPENDIX

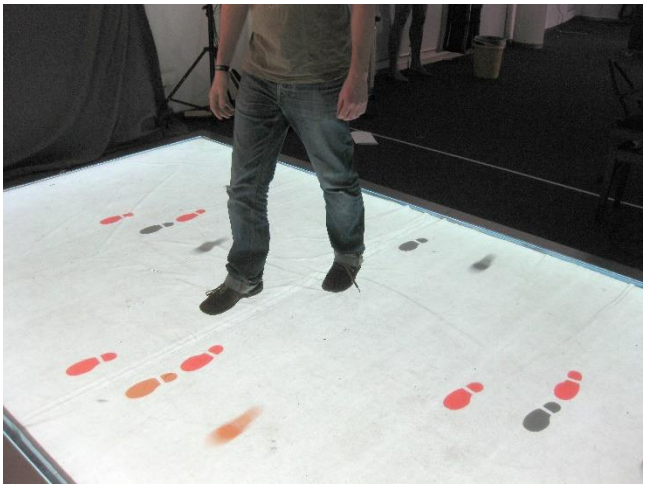

**Figure 10: A prototype of our system in use**