ClassBeacons: Enhancing Reflection-in-Action of Teachers through Spatially Distributed Ambient Information*

Pengcheng An
Department of Industrial Design
Eindhoven University of Technology, NL
p.an@tue.nl

Saskia Bakker
Department of Industrial Design
Eindhoven University of Technology, NL
s.bakker@tue.nl

Sara Ordanovski
Department of Experimental Psychology &
Helmholtz Institute, Utrecht University, NL
s.ordanovski@students.uu.nl

Ruurd Taconis
Eindhoven School of Education
Eindhoven University of Technology, NL
r.taconis@tue.nl

Chris L.E. Paffen
Department of Experimental Psychology &
Helmholtz Institute, Utrecht University, NL
c.l.e.paffen@uu.nl

Berry Eggen
Department of Industrial Design
Eindhoven University of Technology, NL
j.h.eggen@tue.nl

ABSTRACT

Reflection-in-action (RiA) refers to teachers' reflections on their teaching performance during busy classroom routines. RiA is a demanding competence for teachers, but little has been known about how HCI systems could support teachers' RiA during their busy and intensive teaching. To bridge this gap, we design and evaluate an ambient information system named ClassBeacons.

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KEYWORDS

Reflection-in-action; leaner-centered education; teacher proximity; reflective practitioner; classroom; ambient information system

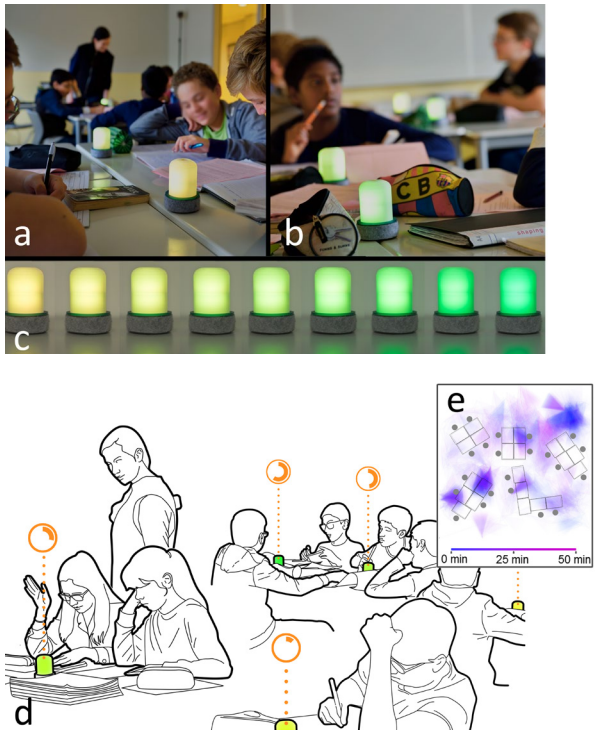

Figure 1: (a)(b): ClassBeacons; (c): each light-object of ClassBeacons subtly indicates how much time the teacher has spent around it, by slowly turning from yellow (no time spent) towards green (440 seconds spent); (d): the system supports teachers' reflection-in-action on how to divide their time and attention over individuals throughout a lesson; (e): the information shown by ClassBeacons is according to teachers' real-time positioning and heading data.

ClassBeacons aims to help teachers intuitively reflect-in-action on how to divide time and attention over pupils throughout a lesson. ClassBeacons subtly depicts teachers' division of time and attention over pupils through multiple light-objects distributed over students' desks. Each light-object indicates how long the teacher has been cumulatively around it (helping an adjacent student) by shifting color. A field evaluation with eleven teachers proved that ClassBeacons enhanced teachers' RiA by supporting their sensemaking of ongoing performance and modification of upcoming actions. Furthermore, ClassBeacons was experienced to unobtrusively fit into teachers' routines without overburdening teaching in progress.

INTRODUCTION

Reflection-in-action (RiA) [7] helps professionals to reflect on their current performance during actions. RiA is seen as an important competence for teachers [1,4], since it helps teachers optimize teaching behaviors on the spot, and avoid "over-routinized" performances. However, RiA is also a demanding competence, since it requires simultaneous reflecting and teaching. Given the complexity and intensity of teaching [3], there is often no time and attention available for teachers to think about their performance simultaneously[4] .

Little is known on how practitioners' RiA can be supported by HCI systems [9]. To bridge this gap, our work aims to shed light on how an HCI system can enhance teachers' RiA. Given the complex and intensive tasks of teaching, we argue that a system to support teachers' RiA should be unobtrusive: it should not interfere with ongoing teaching tasks or overburden teachers' mind. As a result, we designed an ambient information system named ClassBeacons [2], which aims to provide glanceable information that can unobtrusively facilitate teachers' RiA.

ClassBeacons is designed to support teachers' RiA on a very important aspect of teaching: teacher proximity [5], i.e. how the teacher allocates time and attention among different pupils in the classroom (see Figure 1). It has been suggested that teacher proximity has major influence on learning and expected to be deliberately managed by teachers during teaching [5,8] However, practically, given the busyness of teaching, teachers may face difficulty to monitor their whereabouts and properly allocate proximity to each pupil [2]. ClassBeacons is the first system that senses teachers' whereabouts (i.e. position and heading, Figure 1 (e)), and based on which it provides real-time display for teachers to reflect on their unfolding distribution of proximity.

Specifically, ClassBeacons uses distributed light-objects on students' desks to depict teacher proximity information (Figure 1). During a lesson, each light-object can slowly turn from yellow to green to indicate how much time the teacher has spent cumulatively around it helping adjacent students: as the teacher spends more time, a light-object will turn greener (Figure 1 (c)).

We evaluated ClassBeacons with eleven secondary school teachers during 22 of their regular lessons. The field evaluation proved that ClassBeacons enhanced teachers' RiA by supporting their sense-making and modification of their ongoing teaching performances. Moreover, the use of ClassBeacons was experienced as unobtrusive to teachers' primary teaching tasks, and compatible to their nomadic classroom routines.

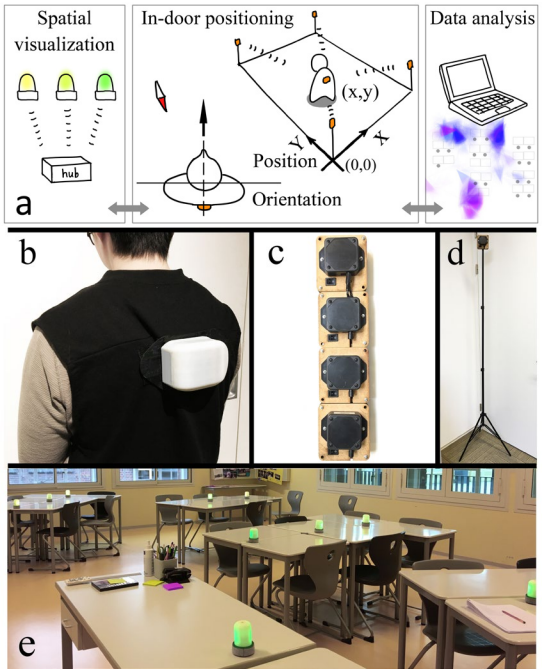

Figure 2: (a): The system design of ClassBeacons; (b): the wearable tracking unit on the teacher garment; (c): the four tracking anchors; (d): a tracking anchor mounted on a stand; (e): ClassBeacons system deployed in a classroom.

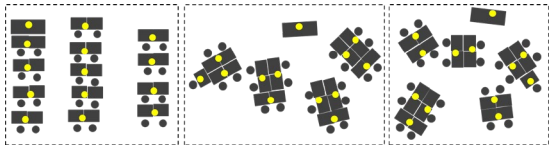

Figure 3: Examples of how the light-objects (yellow dots) were deployed in the participating teachers' classrooms with different desk layouts.

DESIGN AND FIELD DEPLOYMENT OF CLASSBEACONS

Functioning of ClassBeacons

As Figure 2 shows, via a wearable sensor unit attached to a teacher's garment, as well as four anchors installed in the classroom, ClassBeacons system can gather teachers' position and heading direction data in every two seconds during a lesson (see Figure 2). Such gathered data are in real time represented by the distributed light-objects. Each light-object reacts to the teacher when the teacher is within the distance of *close proximity* (≈1.6m, see [2]), and slowly changes color according to the amount of proximity it has received from the teacher (see Figure 1). For instance, it takes 440 seconds for a light-object to change from yellow to fully green if the teacher has been helping the students around it (see [2] for more details). At the beginning of a lesson, the light-objects will be reset to yellow and they can only turn greener over a period of one lesson.

Design Rationale of ClassBeacons

First, RiA is highly context-dependent [7]: it depends on a professional's own understanding about a practical situation at hand. This can be well reflected by the specific case of teacher proximity: an desirable distribution of teacher proximity does not mean allocating equal amount of time to each student in each lesson; it depends on the particular students and teaching content in that lesson and the practical understandings of the teacher [2]. Therefore, ClassBeacons only aims to facilitate teachers' RiA by providing neutral portrayal of data, rather than assessing or steering their teaching behaviors. Hence, no red colors were used to avoid negative or judgmental connotations. Also, the information was presented as objectively as possible with only minimal data processing.

Second, RiA occurs in practitioners' actions and has to be carried out shortly and intuitively, so that it can help practitioners quickly assess the situation at hand without interrupting their flow of practice. Therefore, we designed ClassBeacons as an unremarkable, low-res display to facilitate teachers' awareness of their whereabouts at a glance. Furthermore, the distributed ambient display of ClassBeacons is visible from different locations of the classroom, which is intended to support teachers' use in parallel with their nomadic routines happen in different places of the classroom.

Field Deployment of ClassBeacons

We deployed ClassBeacons in the regular classrooms of eleven Dutch secondary school teachers. Each teacher used ClassBeacons in two separate lesson periods. ClassBeacons was deployed in the teachers' classrooms based on their pre-existing desk layout (see Figure 3). After each lesson, a semi-structured interview was conducted with the teacher to gather in-depth qualitative empirical data about how ClassBeacons was used. The gathered data were subjected to a Conventional Qualitative Content Analysis to analyze if and how ClassBeacons supported the process of RiA.

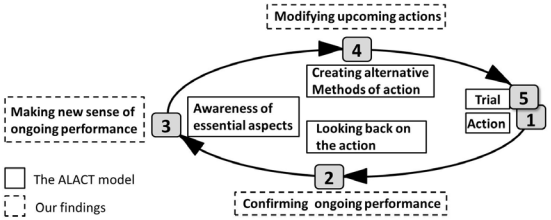

Figure 4: Three types of RiA were reported by the teachers, echoing three reflective stages described in ALACT model.

FINDINGS AND DISCUSSION

The field evaluation confirmed that ClassBeacons did enhanced teachers' RiA on their performance regarding teacher proximity. Rich examples of teachers' RiA relying on ClassBeacons have been reported. As Figure 4 shows, teachers reported three types of RiA, which echoes three stages of teachers' reflective process described by the ALACT model [6]. As experienced by teachers, the displayed information offered meaningful feedback on the spot, which helped them quickly deliberate on how they have been allocating time and attention to different individual pupils. This helped them (1) monitor and confirm their ongoing performance, (2) make new sense of their performance (e.g. discover and criticize *unwanted patterns* in their proximity distribution) and (3) modify upcoming moves (e.g. decide which students to help next and for how long).

Moreover, ClassBeacons was experienced as unobtrusive. Its slow and unremarkable display was not considered by teachers as a distraction to classroom activities. And teachers did not feel that its information overburdened their mind. As reported, the distributed display supported teachers' to seamlessly and effortlessly use the system in parallel with various primary teaching tasks in different locations of the classroom.

CONCLUSION

Reflection-in-action (RiA) is an important yet demanding competence for teachers. Little has been known on how HCI systems could ease teachers' RiA. To bridge this gap, we design and evaluate the ambient information system ClassBeacons. The field evaluation with eleven secondary school teachers proved that ClassBeacons unobtrusively enhanced teachers' RiA on how to divide time and attention over pupils throughout a lesson. We thereby contribute a case of as well as empirical insights in designing HCI system for supporting teachers' RiA.

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