

TARGET-tool

Participatory Design of an Interactive Professional Development Tool for Secondary School Physical Education Teachers

Weeldenburg, Gwen; Kromkamp, Len; Borghouts, Lars; Verburg, Pepijn; Hansen, Nicolai Brodersen; Vos, Steven

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TARGET-tool: Participatory Design of an Interactive Professional Development Tool for Secondary School Physical Education Teachers

Gwen Weeldenburg

School of Sport Studies, Fontys
University of Applied Sciences,
Eindhoven, The Netherlands
g.weeldenburg@fontys.nl
Department of Industrial Design,
Eindhoven University of Technology,
Eindhoven, The Netherlands
g.weeldenburg@tue.nl

Len Kromkamp

School of Sport Studies, Fontys
University of Applied Sciences,
Eindhoven, The Netherlands
l.kromkamp@fontys.nl

Lars Borghouts

School of Sport Studies, Fontys
University of Applied Sciences,
Eindhoven, The Netherlands
l.borghouts@fontys.nl

Pepijn Verburg

Department of Industrial Design,
Eindhoven University of Technology,
Eindhoven, The Netherlands
pepijn@moeilijkedingen.nl

Nicolai Brodersen Hansen

Department of Computer Science,
Aalborg University, Denmark
nbha@cs.aau.dk

Steven Vos

School of Sport Studies, Fontys
University of Applied Sciences,
Eindhoven, The Netherlands
steven.vos@fontys.nl
Department of Industrial Design,
Eindhoven University of Technology,
Eindhoven, The Netherlands
s.vos@tue.nl

ABSTRACT

Secondary school physical education (PE) teachers are continuously challenged to find ways to support students learning and motivate them for an active and healthy lifestyle. To address this complexity, continuing teacher professional development (TPD) is key. Technological tools can facilitate the effective delivery of TPD in this context. Successful implementation of this technology, however, is not self-evident. Based on the general aim of effectively integrating technologies in the educational process and focusing on the needs of educators, this study examines how the evidence-based theoretical TARGET framework for creating a motivating PE learning climate might be embedded into a digital professional development tool for PE teachers, useful in everyday practice. It presents a case study in which a multidisciplinary team of researchers, designers, and end-users iteratively went through several phases of need identification, idea generation, designing, development, and testing. By using a participatory approach, we were able to collect contextualized data and gain insights into users' preferences, requirements, and ideas for designing and engaging with the tool. Based on these insights the TPD TARGET-tool for PE teachers was ultimately developed. The most prominent characteristics of this tool are (1) the combination of an evaluative function with teaching strategy support, (2)

the strong emphasis on ease of use due to the complex PE teaching context, (3) the avoidance of social comparison, and suggestions of normative judgment, and (4) the allowance for a high level of customization and teacher autonomy.

CCS CONCEPTS

• Human-centered computing; • Interaction design; • Systems and tools for interaction design;

KEYWORDS

Educational Technology, Human-computer Interaction, Participatory Design, Teacher Professional Development, Physical Education

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1 INTRODUCTION

Considering the substantial heterogeneity among students in the psychomotor, social, and affective domains, physical education teachers (PE) are continuously challenged to find ways to support students learning and motivate them for an active and healthy lifestyle [27]. To address this complexity, continuing professional development is key [41, 55]. Professional development enables teachers to update their knowledge and enhance their teaching practice [75]. Several studies have shown that effective teacher professional

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development (TPD) mainly takes place in the informal context of their professional practice, for example through individual, critical reflection and consultation with colleagues in the workplace [32, 34, 48]. Technological tools can facilitate the effective delivery of TPD in this context [29]. As digital technologies continue to mature, new opportunities for supporting teachers in their professional development emerge. The use of digital technology has become widespread in the educational sector and is increasingly prominent in the context of PE [43, 59, 73]. Successful implementation of this technology, however, is not self-evident. Frequently heard critique regarding the use of technology within the context of PE in general, is that it can be both complex and time-consuming, whilst not necessarily improving the quality of PE practice [31]. If the technology is insufficiently aligned with, and diverts teachers from their practice, it will fail to support teachers' professional learning [62]. One of the main issues for human-computer interaction (HCI) research is therefore the design of technologies that are adequately embedded in the educational process and that focus on the needs of educators [13].

PE has been identified as an important context to promote an active and healthy lifestyle among young people [51]. Positive experiences in PE impact students' motivation and attitude toward lifelong participation in physical activities and sports [18]. Given this objective of PE, it is important for teachers to positively influence students' perceptions of their physical abilities and support them in adopting a physically active lifestyle. Secondary school PE teachers, however, struggle to find effective ways to establish a motivating PE learning environment. The research literature provides useful insights and frameworks to support teachers in creating such a motivating PE learning environment, including the TARGET framework [3, 22]. Although this framework is widely accepted, it does not automatically translate into PE practice [69]. Therefore, it is suggested by Grimshaw et al. [25] to develop tools that facilitate the access, dissemination, and use of scientific insights into teachers' professional practice. Such TPD tools could effectively support PE teachers in their professional development if they meet several prerequisites for effective professional development activities, such as active teacher involvement, direct applicability in teachers' professional practice, and a focus on student outcomes [8, 54].

To ensure a successful and sustainable implementation of such a TPD tool, it is important to address the intended users' needs, goals, practices, and professional contexts [25]. Teachers are considered a pivotal factor in the successful implementation of innovations in educational practice and therefore, it is suggested to explicitly involve them in the design process [36, 40]. The literature on conducting participatory research involving PE teachers is, however, very limited within the field of educational technology and HCI.

Based on the general aim of effectively integrating technologies in the educational process and focusing on the needs of educators, this study examines *how the TARGET framework for creating a motivating PE learning climate might be embedded into a digital professional development tool for PE teachers, useful in everyday practice*. It presents a case study in which a participatory approach was used and PE teachers and designers were involved in the design process. We first present related work to provide context and gain essential insights for the design and development of the tool. We

then describe the design process and preliminary user tests of the TARGET-tool.

2 RELATED WORK

In the following section related work on previous research on technology applied in the context of PE, student motivation, and the TARGET framework will be reviewed, as well as critical reflections on educational technology within PE.

2.1 Technology and PE teacher professional development

Over the past decades, technology has become increasingly prominent in the context of school-based PE [43, 59, 73]. Although design research regarding the development of technological applications within the context of PE has been conducted, these studies are relatively scarce. Furthermore, the majority of these design studies were focusing on the development of applications for student use and enhancing student learning, rather than facilitating the effective delivery of PE-TPD. For example, Mast et al. [45] developed BalanSAR by which animations are visually projected onto the sports floor or equipment to allow students to effectively conduct balancing exercises. In addition, Ma et al. [44] presented the multiplayer fitness game FitBirds through which students are encouraged to enhance their physical activity levels within the PE, whilst Goto and colleagues [24] developed a visualization and evaluation system for human movement trajectories, providing students with objective feedback on their performance. Only a few studies have focused on the development of technological applications that could support PE teachers in their complex pedagogical and educational tasks. Yang et al. [74] for example, designed a Voice Interactive Artificial Intelligence Educational Robot to assist the teacher in individualizing PE and responding to students' interests. Another interesting, but as yet unpublished tool related to PE-TPD, is the so-called V-observer. This is an online environment developed at Ghent University, in which PE teachers can identify their motivating teaching style and are presented with personalized opportunities to optimize this style (<https://www.victoris.be/projects/v-observer/>). Yet, to our knowledge, no further studies in the field of educational technology research to date have focused on the development of tools to support PE teachers in their professional development and enhance their teaching practice. TPD mediated through technology use has a significant potential to improve the quality of teaching practice and student learning outcomes. Although technology has been integrated into TPD for decades, the effectiveness of technology-based TPD is not self-evident [29]. It has been argued that TPD technology which focuses only on hardware or software solutions, is ineffective compared to technological tools that are integrated with other measures to facilitate teacher development [7, 47]. Key characteristics of effective TPD derived from research include that it should: be informed by research evidence concerning effective pedagogy [30, 53], build on teachers' existing knowledge, expertise, and practices [19, 65], integrate subject knowledge and pedagogy [23, 52], be participatory and addressing teachers' needs, constraints and interests [6, 58], focus on practical application, support iterative cycles of trial and refinement of new strategies within a safe environment [20, 57], and take a learner-centred approach

[28, 50]. However, these characteristics only become meaningful when they are connected with and translated to the specific and unique context of the teacher, in our case the PE teacher. To ensure meeting teachers' needs and addressing contextual challenges, it is suggested to use participatory approaches and thereby involve teachers in the design process of TPD technology [11].

2.2 Student motivation

The present design study is employed in the field of Dutch secondary school PE [43, 52]. The national PE objective is to facilitate and support students in becoming physically literate individuals that possess the skills, self-confidence, and motivation needed for a healthy and physically active lifestyle, now and later in life [67]. The understanding of what motivates students to adopt an active and healthy lifestyle is, therefore, of great interest to PE teachers. According to self-determination theory (SDT) [60], a widely accepted and applied theory of human motivation, the term 'motivation' refers to a (psychological) driving force that moves people to action. Or more specifically, that causes, energizes, maintains, and gives direction to their behaviour [60]. SDT defines various types of motivation. Students who are autonomously motivated to engage in PE, experience volition – they are fully willing to engage in this behaviour. In contrast, students who are controlled motivated toward PE experience feelings of external pressure (e.g., rewards or punishments from the teacher) or internal pressure (e.g., feelings of shame or pride). When intentionality and motivation are lacking, and student behaviour is passive or ineffective, the concept of amotivation applies [60]. Overall, autonomous motivation is correlated with adaptive outcomes, such as increased physical activity, enjoyment, concentration, and vitality, whereas controlled forms of student motivation and amotivation are associated with more maladaptive outcomes, such as disengagement, boredom, and unhappiness [68].

2.3 TARGET framework

Given the PE objectives, PE teachers need to create a learning environment in which students' autonomous motivation is facilitated and stimulated. The TARGET framework developed by Epstein [22], Ames, and Archer [4, 5] is considered an effective teaching framework to manipulate classroom dimensions to positively impact students' autonomous motivation within PE [14, 26]. TARGET is an acronym for six dimensions in which the teacher can apply certain teaching strategies, and thereby impact students' motivation. These dimensions are *task* (design of learning activities), *authority* (opportunities and location of decision-making), *recognition* (way of distribution of feedback and reinforcement), *grouping* (process and procedure of grouping students), *evaluation* (system or strategies for evaluating students learning) and *time* (pace of instruction and learning). By applying specific teaching principles within each TARGET dimension, the teacher can create a favourable PE learning climate [14]. For example, within the Task dimension, it is suggested to ensure alternation and variety within PE to meet students' motivational needs. Although several studies (e.g., [1, 2]) demonstrated the effectiveness of PE programs in which the teaching strategies within the TARGET dimensions were incorporated, the use of this framework in the everyday professional PE context remains very

limited. The main reason for this is that PE teachers find it difficult to successfully transform the content knowledge regarding the TARGET framework into their own unique PE context [69].

3 METHODOLOGY

We aimed to match the intentions of the envisaged digital TPD tool for creating a motivating PE climate with the users' needs and to optimize the successful implementation of the tool in real-life PE. Therefore the end-users (i.e., PE teachers) were actively involved in the process. We used a participatory design approach including co-design methods, to facilitate a collaborative process between designers and end-users. This allowed PE teachers to become a member of the design team as 'experts of their experience' [61].

The design process took place over a fourteen-month period and consisted of seven different phases in which several interactive and iterative research and design activities were conducted, and a considerable group of the targeted end-users was involved (see Figure 1). In this process, we identified PE teachers' challenges and needs concerning student motivation, explored ideas and opportunities for the TPD TARGET-tool, prototyped, designed, developed, tested, and critically reviewed the outcomes.

Ethical approval for this research project was granted by the university's research ethics committee. For all participants, informed consent was obtained after they had received information in which the purpose of the research project and its methods were explained, and voluntary participation and confidentiality were emphasized. For this study, a combination of qualitative and quantitative methods was used for data collection and analyses in different phases.

3.1 Preliminary Phases

The first phase consisted of characterizing the context and exploring PE teachers' experiences, practical challenges, and needs concerning student motivation within secondary school PE. We first conducted a web-based questionnaire with closed-ended and open-ended questions, among 58 secondary school PE teachers. Secondly, a focus group interview was held with 7 PE teachers to generate rich data and more detailed insights into the intended end-users' experiences, challenges, and needs concerning student motivation [33].

To explore the opportunities of the PE-TPD tool for optimizing students' motivation within PE, in the second phase, we conducted two consecutive 3-hour long co-design workshops with 12 PE teachers from as many secondary schools, two (industrial) designers, and two researchers. The first workshop focused on exploring ideas to address challenging issues concerning student motivation within PE and potential supporting tools. The second workshop continued from and built on the output of the first workshop, and focused on exploring potential opportunities and barriers of low-fidelity prototypes. The workshops were designed in line with co-design methods [35] to engage users in different activities such as scenario-making and brainstorming exercises. Data from the workshops were captured and collected through audio and video recordings, photographs, whiteboards, and sticky notes.

Based on both the co-design workshops and previous research activities, in the third phase, we designed and reviewed a low-fidelity prototype of the interactive TARGET-tool. To check if the design

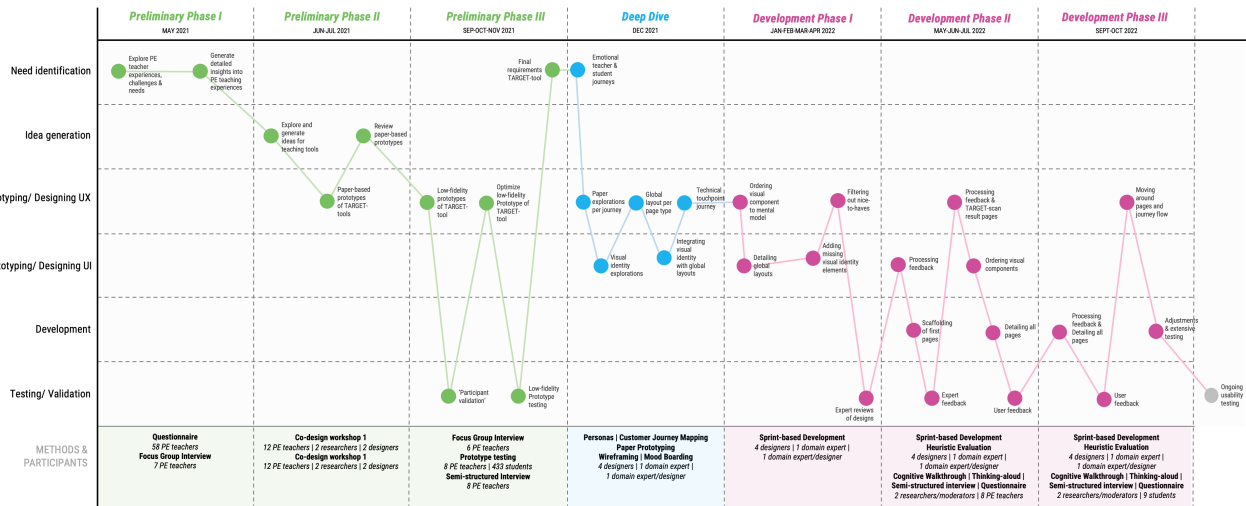


Figure 1: Overview of the different phases in the design process

concept of the tool was recognizable and promising, we conducted a follow-up online focus group meeting with 6 PE teachers from the co-design workshop group. By returning the results to the participants, also known as ‘participant validation’, the accuracy and credibility of these results could be explored and resonated with the participants’ experiences [12]. Subsequently, during a two-week time period, a pilot test of elements of the low-fidelity prototype of the TARGET-tool was conducted with 8 PE teachers and 433 of their students from 8 different secondary schools. This pilot test was focused on gaining insights for further improvement of the design concept of the TARGET-tool. After the pilot user test, each participating teacher was interviewed individually online, to explore their experiences and perceptions concerning the application and implementation of the TARGET-tool and potential additional user needs and design ideas.

3.2 Deep Dive

Based on the insights into PE teachers’ experiences and general design requirements, derived from the preliminary phases, a Deep Dive approach consisting of three consecutive days was applied to define the main user experience (UX) and user interface (UI) elements. The team consisted of four designers, one domain expert, and one with expertise in both. Firstly, the customer journey mapping method was used to visualize the daily activities and routines of PE teachers and their students, including needs, interactions, and emotions, in order to highlight and understand various stages, steps, and technical touchpoints. Secondly, simple UX paper prototyping methods were applied based on the identified key UX principles. Lastly, wireframing and mood-boarding methods were used to turn the paper prototypes into UX designs and visual identity.

3.3 Development Phases

Based on the designs that emerged from the Deep Dive activities, in this phase, the development process started. The first step consisted

mainly of scaffolding the infrastructure and modeling the various data entities. The designs were iteratively worked out in greater detail, and by using design review sessions with various domain experts, priorities were identified, and missing visual elements were added.

Throughout the development process of the TARGET-tool a number of usability inspection methods were used to inspect the user interface to uncover problems and opportunities of the designs at an early design stage. We conducted several heuristic evaluations [49] and consistency inspections. To gain more detailed user feedback on the user interface and assess how well the user could use the TARGET-tool effectively, efficiently, and satisfactorily, we conducted cognitive walkthroughs [42], thinking-aloud, semi-structured interviews and administered the System Usability Scale (SUS) [15] with 8 PE teachers and 9 students.

4 RESULTS

4.1 Preliminary Phases

The web-based questionnaire (N = 58) and focus group interview (N = 7) with PE teachers provided a deeper understanding of the context and teachers’ experiences concerning student motivation within secondary school PE. Overall, the PE teachers indicated that they are being challenged on daily basis to find ways to motivate all students to actively engage in physical activities during PE lessons. They stressed their need for support in addressing these motivational challenges and provided suggestions for potential supportive instruments. Regarding the requirements of the potential TPD tool, the teachers indicated the importance of usability in the actual PE context. In addition, it was suggested that the tool should contain practical suggestions and concrete examples that teachers could instantly apply in their PE lessons. The tool should also help to stimulate discussion about student motivation among PE teachers within the PE department at school. Lastly, the PE teachers proposed the idea of a feature to gain insight into the actual motivation and

experiences of individual students within their PE class, allowing them to make more targeted interventions.

To explore the opportunities of the TPD tool we conducted two consecutive co-design workshops with PE teachers ($N = 12$). The first co-design workshop provided us with interesting additional information on the existing motivating teaching strategies within the TARGET framework and design ideas for the tool. Combining this output and design ideas with those derived from the web-based questionnaire and focus group interview, we designed paper-based, low-fidelity prototypes of the potential TPD TARGET-tool to cover the suggested functionalities of 1) usability, 2) simplicity, 3) assessment of students' motivation, 4) provision of supportive information on how to impact on students' motivation positively, and 5) facilitation of collaboration with colleagues. The paper-based prototypes consisted of (i) the '*Motivational PE Climate Evaluation Tool*' by which PE teachers can effectively retrieve feedback from their students on how they perceive the motivational learning climate during the PE class, using mobile devices, (ii) the '*Motivational PE Strategy Idea Cards*' by which the PE-teacher are provided with ideas and examples on how a specific TARGET strategy can be implemented in the PE class, and (iii) the '*PE Conversation Stimulation Tool*' by which the discussion on the role of teachers in creating a motivating PE learning climate is stimulated and facilitated among PE teachers within the same department by so-called 'Glow' (i.e., strengths) and 'Grow' (i.e., weaknesses) cards. Overall, the added value of all three prototyped tools for PE practice was recognized by the participants. A combination of the presented tools was deemed preferable. However, the vast majority of the participating teachers (10 out of 12) stated that to manipulate and adjust the motivational PE climate and target students' motivation effectively, the teacher should always start with obtaining insights into students' perception of the motivational climate. This referred to the functionality of the '*Motivational PE Climate Evaluation Tool*'. Thereafter, they noted, it would be helpful if the teacher is provided with concrete suggestions for improvement of their teaching practice (referring to '*Motivational PE Strategy Idea Cards*') based on the perceptions of their students. Although the participants recognized the importance of discussion and consultation with their colleagues within the school PE department (referring to the '*PE Conversation Stimulation Tool*'), they indicated that this should not be the main objective of the teaching tool, but should be seen more as a desirable side effect. Furthermore, the importance of usability and applicability of the tool in daily PE practice was again pointed out. The organization of PE lessons is often more complex than that of more cognitive school subjects and should also always ensure the physical safety of students. The participants, therefore, noted that the tool should be easy to use and not come at the expense of safety or time for students to learn. In addition, they would like the tool to contain both digital/online and analog/tangible elements to meet their different needs and preferences.

Based on both the co-design workshops and previous research activities, the design concept of the interactive TARGET-tool was further extended by the designers and primary researchers involved in this project. Grounded in this concept we designed a prototype of the TARGET-tool using existing platforms of Microsoft Forms [39] and Microsoft Power Business Intelligence [8]. The tool existed of three functionalities. Firstly, a 'quick scan' functionality that enables

the PE teacher to collect information on how students perceive the motivational PE climate. In this quick scan, students had to rate items on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) on a mobile device. These items were based on the previously validated Mastery Teaching Perception Questionnaire [72] covering the TARGET dimensions of the motivational learning climate. The second functionality was a printed data visualization of the quick scan results. Lastly, the tool generated concrete textual suggestions and ideas for the improvement of PE teaching practice, based on the results of the quick scans. In a follow-up, online focus group meeting, the design concept, and prototype of the TARGET-tool was resonated with PE teachers ($N = 6$) from the co-design workshop group and was well received.

The additional insights from the focus group meeting led to small adjustments and a second prototype of the TARGET-tool which was pilot tested in PE practice by PE teachers ($N = 8$) and their students ($N = 433$) in 8 different secondary schools. The PE teachers' findings were gathered in individual semi-structured interviews. All participants were positive about the usability and efficiency of the quick scan and noted that the tool could be easily integrated into their PE practice. How the results of the quick scans and the subsequent suggestions for improvement based on these results were presented, were valued. Teachers felt this provided them with interesting insights into their students' perceptions and experiences within PE. At the same time, some teachers indicated that it caused anxiety placing themselves in a vulnerable position by asking students about their perceptions. Through the quick scan, they are indirectly receiving feedback on their teaching performance. However, given the intention of the tool (i.e., supporting rather than normatively assessing) they noted that they were able to put the feedback of students into perspective and use the information to optimize their teaching practice, thus contributing to further professional development. Asked how the TARGET-tool could be best implemented within their PE practice, a vast majority of the participants suggested an 8 to 10-week cycle in line with the most common school year structure of four periods. At the beginning of a cycle, they suggested carrying out a quick scan (i.e., baseline measurement) on one of the TARGET dimensions, regarded as the most interesting or relevant for the individual teacher. Subsequently, based on the tool-provided strategies and actions for improvement, the teachers proposed to work on the optimization of the motivational PE climate during a period of 7 to 9 weeks. At the end of the period, they suggested performing a second quick scan (i.e., effect measurement) to check if there is any improvement in student perceptions. In the second cycle/period, the teacher could then shift the focus to another TARGET dimension or keep working on the improvement of the initial TARGET dimension. To allow the monitoring of progress during the period some participants suggested the idea of an intermediate single-item scan by which the students (for example, on their way to the changing rooms) could provide the teacher with information on how they perceived the recent PE class.

4.2 Deep Dive

After a critical review of all outcomes of the preliminary phases, teacher and student customer journey maps were drawn up based

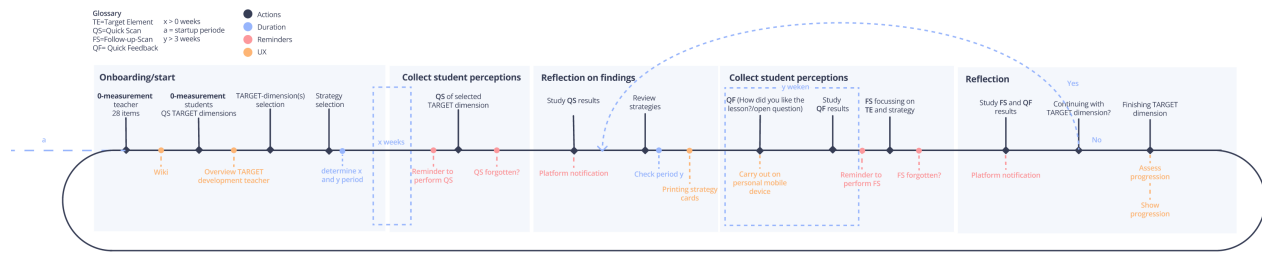


Figure 2: A technical touchpoint journey

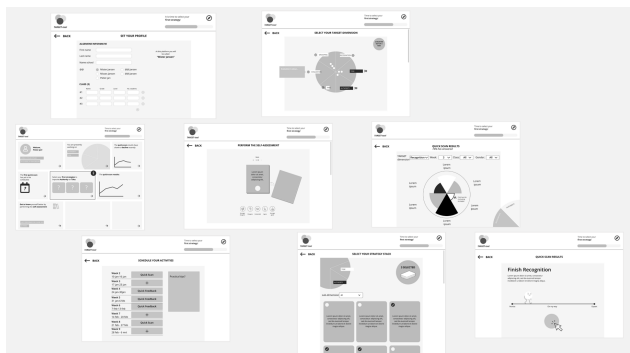


Figure 3: Global layout per page design

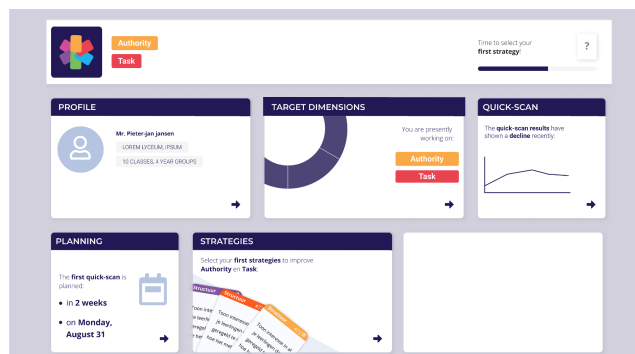


Figure 4: Example of how the visual identity was integrated

on personas. In these, the daily activities and routines of PE teachers and their students were visualized, and various stages, steps, and touchpoints were identified. These journeys helped identify key UX principles on which UX paper prototypes of a teacher's dashboard and a student motivational climate scan were created. Based on these paper prototypes and by making wireframes and mood boards, visual identity explorations were carried out, a technical touchpoint journey was detailed (Figure 2), a global layout per page type was designed (Figure 3), and the visual identity was integrated with the global layout per page type (Figure 4).

4.3 Development Phases

Drawing upon the output of the deep dive design session the designs were iteratively worked out in increasing detail. Based on multiple design review sessions, heuristic evaluations, and consistency inspections with designers and domain experts, bugs were fixed, missing visual elements were added, and priorities were set. Due to time constraints, for example, it was decided to focus only on developing a desktop version of the teacher's dashboard and drop the idea of developing an add-on or companion app in this phase.

In the design process, we were challenged to find ways how the tool could adequately respond to users' mental models, and support teachers in using the dashboard efficiently and effectively. Therefore, the idea of a 'progressive dashboard' emerged and was further developed. Depending on the process stage the teacher is in, only relevant content will be accessible, while pages with content still irrelevant remain closed (Figure 5). The student scans, providing the teacher with information about students' perceptions of the motivational learning climate, had to be simple, appealing, intuitive, and quick to perform. Hence, the 'playing cards' metaphor and swipe functionality were combined in the scan design. In this way, students could rate items concerning the motivational climate in an easy and attractive manner on their mobile devices (Figure 6). To meet the ideas and needs identified in the preliminary phases we ended up distinguishing between two different student motivational climate scans: (i) the 'TARGET-scan' consisting of 10 to 12 items by which the PE teacher can collect information on how students perceive the motivational PE climate regarding a specific TARGET dimension at the beginning (i.e., baseline measurement) and end (i.e., effect measurement) of a professional development cycle, and (ii) the 'QUICK-scan' consisting of two items by which the students can provide the teacher with information during the professional development cycle. Finally, all pages were implemented and connected to the relevant data models and a high-fidelity design of the TARGET-tool (Figure 7) was subjected to representative end-users for usability testing.

To gain detailed information on the extent to which users could effectively, efficiently, and satisfactorily use the TARGET-tool (i.e., teacher's dashboard and student scan), sessions with representative users were organized in which cognitive walkthroughs and thinking-aloud methods were applied, semi-structured interviews

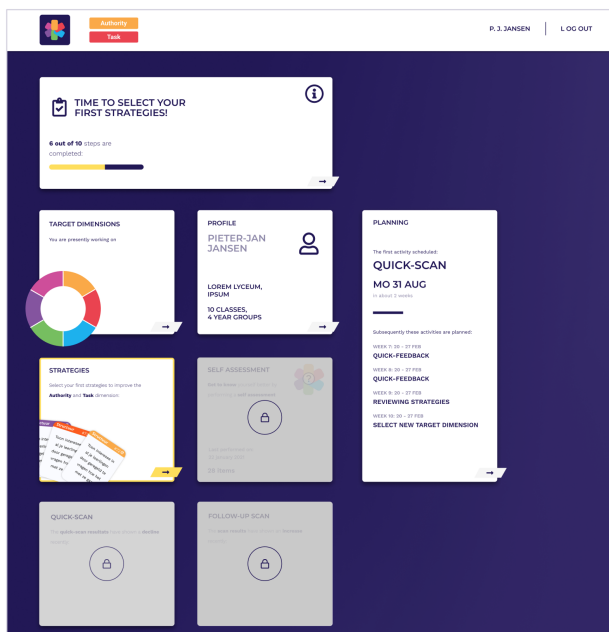


Figure 5: 'Progressive dashboard' to scaffold teachers' use

were held, and the System Usability Scale (SUS [15]) was administered. In the cognitive walkthrough combined with the thinking-aloud method, the participants (i.e., PE teachers; $N = 8$) were carrying out several tasks (e.g., 'Login into the dashboard'; 'Add two classes into the system'; 'Select a TARGET dimension'; 'Run a student scan') while continuously verbalizing their thoughts as they perform the tasks and move through the user interface. Based on these walkthroughs, the dashboard seemed to be considerably user-friendly. The participants accomplished the tasks fairly easily and quickly, without making many errors. These encouraging findings concerning the usability of the dashboard were verified in the interviews and the SUS. All interviewed participants were very positive concerning the look and feel of the dashboard. They valued the tiled structure of the dashboard and how the 'progressive dashboard' supports them going through the whole process, without frustrating their feelings of autonomy. Some participants spontaneously pointed out the innovative character of the TARGET-tool and the added value of this TPD instrument to the PE community. The total mean SUS score of the dashboard was 78,4 out of 100 ($SD = 11,1$). This score indicates that the usability of the tool can be considered 'good' [9]. However, the performed usability testing activities also identified some aspects that could be optimized and resulted in potential additional features and design ideas. For example, it was suggested to critically rethink the sequence of the tiles, to provide teachers with a short general introduction to the TARGET-tool when entering the application for the first time, to add a notification functionality and an automatization option within the scan-planning module, include 'information' buttons on the pages, and to adjust font sizes and highlight colors. The findings regarding the student scan were promising and satisfactory as well. The students ($N = 9$) performed the assignments easily and quickly.



Figure 6: 'Playing card' metaphor and swipe functionality within student scan

They were enthusiastic about the look and feel of the scans. They liked the playing card display and 'smiley' rating feature and perceived the scan as easy to use. The students made some suggestions for improvement as well, such as providing QR codes to optimize the findability of the online scan, and to give more clarity about the goal of the scan and once it is completed. The total mean SUS score of the students was 83,9 ($SD = 4,9$). This score indicates that the usability of the student scan can also be considered 'good' [9].

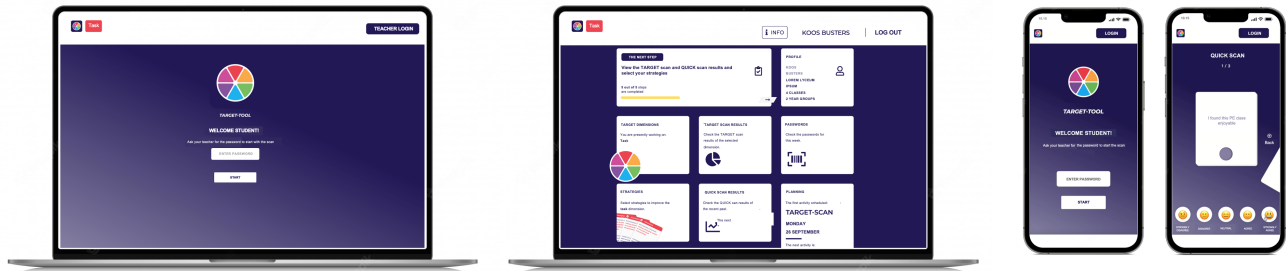


Figure 7: TARGET-tool design existing of a teacher's dashboard and student scans

The insights gained with the user tests led to some additional adjustments. We moved around titles and buttons on the TARGET dimension page, changed the titles and sequence of dashboard tiles, added 'information' buttons, and adjusted font sizes and colors for example. However, we did not follow up on all suggestions made, due to both time constraints and the uncertainty about whether the changes would lead to an improvement for all intended users. Therefore it was decided to set some potential improvements on hold and collect more user experience data in the meanwhile. Eventually, the final version of the PE-TPD TARGET-tool was developed (Figure 8) by which the teacher will go through the following steps to gain insights into students' motivational experiences and receive practical suggestions to optimize the motivational PE learning climate: (1) enter some general information in the profile and select classes to experiment with; (2) select one or two relevant TARGET dimensions after going through some more detailed information regarding all TARGET dimensions and (optional) completing the SELF-scan; (3) schedule the TARGET-scan; (4) perform a TARGET-scan at the beginning of PE class to retrieve information on students' perceptions of the motivational climate regarding the selected TARGET dimension(s) (i.e., baseline measurement); (5) critically review the TARGET-scan results and identify professional development opportunities; (6) select relevant and applicable potential motivating strategies based on the results; (7) apply and implement the selected motivating strategies within PE practice; (8) experiment for a substantial period with the selected motivating strategies; (9) perform a QUICK-scan (optional) at the end of a certain experimental PE lesson to gain information on students' experiences and make adjustments if needed; (10) perform a second TARGET-scan at the end of the experimental phase to gain insight into the effect of the interventions. Based on these results it can be decided to (a) continue experimenting within the selected TARGET dimension(s), (b) continue experimenting within the selected TARGET dimension(s) involving other classes, (c) finalize the experiment and shift the focus to another TARGET dimension, or (d) take a break.

5 DISCUSSION

In this paper, we presented the design process of a case study in which we aimed to examine how the evidence-based theoretical TARGET framework for creating a motivating PE learning climate,

might be embedded into a digital PE teacher professional development (TPD) tool, useful in everyday practice. To establish a successful and sustainable implementation of technology it is important to address the targeted users' needs, goals, practices, and professional context [25]. PE is a relatively complex and dynamic environment to implement technology into. Ensuring the educational value as well as the safety and well-being of students requires pedagogical and organizational skills from the PE teacher that are quite different from those required from a classroom teacher. In the present study, this was reflected by the PE teachers involved stressing the importance of ease of use of the TARGET tool. In addition to the complexity of PE class, students display a wide variability in motivation for physical activity, both intrinsically [71] and situationally [39]. Therefore, we developed a TARGET-tool which can monitor this variability and provide tailored teaching strategies that can be almost instantly applied by the teacher.

In the preliminary phases, we first explored directions, ideas, opportunities, and requirements for the design and successful implementation of such a tool. To ensure a comprehensive view of all relevant aspects involved in PE practice and the use of the tool, PE teachers as targeted end-users were explicitly included during the design process. We experienced both the active involvement of end-users in the design process and the multidisciplinary of the design team, as very valuable and meaningful. Consistent with previous design literature on educational technology [17, 66], this led to innovative ideas, new perspectives, and refreshing insights that enabled us to address teachers' specific challenges and needs. The initial findings showed that PE teachers are indeed challenged to find ways to motivate their students to actively engage in PE, and that supportive tools are needed. Technology and digital applications could support teachers in fulfilling this complex task and facilitate the access, dissemination, and use of evidence-based insights about student motivation and motivating learning environments [29]. This is reflected in the outcomes of the preliminary phase activities of the present study, and has previously been recognized in research literature in the context of PE [37]. The importance of the usability of the digital tool within the complex environment of actual PE practice was explicitly pointed out by the participants. In line with this, they expressed a need for suggestions and examples which are instantly applicable in teaching practice. Based on



Figure 8: An visual overview of the final version of the PE-TPD TARGET-tool

these findings and endorsed by the findings of Casey et al. [16] and Mayes et al. [46] context awareness became an important assessment criterion during the design process. Context awareness refers to the capability to collect and use information that characterizes the situation, location, persons, or objects, that are perceived as relevant to the interaction between a user and an application [21]. The involvement of the PE teachers in the design process provided us with a realistic and therefore essential perspective by which this awareness was ensured.

Findings from the preliminary phase of our study suggested that including a feature to evaluate the actual motivation and experiences of students would allow for more targeted interventions. According to the PE teachers, such an evaluation should be the starting point of a combined tool, upon which subsequent suggestions for improvement of their teaching practice could be based. It was stated that this would aid the PE teacher to reflect on his/her professional practice based on students' perceptions. Reflection refers to a metacognitive process aimed at developing a greater understanding of oneself, the other, and the situation, which can lead to change and professional development [70]. This implies that, in addition to providing teachers with effective practical motivating strategies, the teaching tool could also facilitate a more structured and systematic reflection on, and awareness of, professional practice and thus contribute to enhancing professional growth [38]. There is an increasing interest in HCI research on how technology could support human reflection and how this has been conceptualized and deployed in interactive system design [10]. Therefore, the current study and future work could be of interest to this field of research

and contributes to a more comprehensive view of designing for reflection as part of teacher professional development.

The preliminary phases produced several valuable design requirements: data should be efficiently collected and displayed, and provide insights into the actual perceptions of students and progression over time; teachers should be supported in the interpretation of the data; the tool should enable comparisons between groups and over time; it should provide practical suggestions based on the outcomes and facilitate teachers to reflect on their professional practice.

Using the resulting low-fidelity prototype of the TARGET-tool during the testing phase, it emerged that although teachers considered assessing students' perceptions of PE to be essential, student feedback could also be experienced as confronting and stressful by the teacher. Since stressful situations can negatively impact teachers' physical and emotional health and can lead to work dissatisfaction [56], the design of the tool should prevent these negative emotions. Although 'social comparison' is seen as an important persuasive strategy to promote user engagement in technology [63], we subsequently avoided social comparison with colleagues within the developed TARGET-tool and emphasized its individual and private character to avoid stressful teacher experiences when using the tool.

To move beyond persuasive strategies, and more importantly, intrinsically motivate and empower PE teachers in the sustainable use of the TARGET-tool, we applied elements of the theoretical model of motivational technology [64]. By creating the 'progressive dashboard', for example, we optimized the 'navigability' of

the user interface and scaffolded teachers in accessing the large body of information effectively. Hereby the complexity of the tool is reduced and ample structure is provided, aiming to support feelings of competence (i.e., a sense of control and effectiveness) and positively influence intrinsic motivation [60, 64]. Given the interactive character of the tool, through which teacher and students are interconnected, we attempt to support teachers' feelings of relatedness (i.e., warm feelings of connection and sharing). Interactive features are essential for a deeper connection between users and the content they consume [64]. Finally, the TARGET-tool builds on teachers' feelings of autonomy (i.e., experiencing a sense of volition), by offering choices and customization features that actively involve them in specifying their individual professional development goals. The tool allows teachers to select TARGET dimensions and motivating teaching strategies that are personally relevant and meaningful, and to tailor them to their unique PE context.

5.1 Limitations

Since the work consisted of a case study, the context in which the design process took place was limited to Dutch secondary school physical education. Therefore, generalization of our findings to other countries, contexts, and school subjects is neither possible nor intended. However, due to similar issues concerning designing and implementing technology into complex educational practice in other school subjects, our findings could provide to some extent guidance for other researchers, designers, and practitioners. Furthermore, we used a convenience sample and as such, the participants could be somewhat biased in that they are eager to innovate their PE practice and adopt new ideas. Nonetheless, all educational tracks within secondary school education (i.e., pre-vocational; senior general; university preparatory) were represented, and the sample consisted of more and less experienced male and female teachers, which allowed us to gain input and feedback from many different viewpoints.

6 CONCLUSION AND FUTURE WORK

In this work, we presented a design process in which a multidisciplinary team of researchers, designers, and end-users iteratively went through several phases of need identification, idea generation, designing, development, and testing. By using a participatory approach, we were able to collect contextualized data and gain insights into users' preferences, requirements, and ideas for designing and engaging with the tool. Based on these insights we ultimately developed the PE-TPD TARGET-tool. A tool that potentially impacts PE teachers' professional growth by facilitating the access, dissemination, and use of scientific insights regarding student motivation and motivational learning climates, and providing teachers with insights into their students' perceptions of the motivational PE climate and practical suggestions for improvement. The most prominent characteristics of this tool are (1) the combination of an evaluative function with teaching strategy support, (2) the strong emphasis on ease of use due to the complex PE teaching context, (3) the avoidance of social comparison, and suggestions of normative judgment, and (4) the allowance for a high level of customization and teacher autonomy. The presented work offers several options for future study. First, we plan to test and evaluate the TARGET-tool

on a large scale, to examine its usability and usefulness within a real-life secondary school PE context, identify factors that support and/or frustrate successful implementation, and examine the impact on teachers' professional development. Finally, we plan to examine the impact of the use of the TARGET-tool on student motivation within secondary school PE.

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