



Evaluation of the digital teacher professional development TARGET-tool for optimizing the motivational climate in secondary school physical education

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Abstract

Given the complexity of teaching, continuing teacher professional development (CPD) is essential for maintaining and enhancing teaching effectiveness, and bridging the gap between ever-evolving theory and practice. Technological advancements have opened new opportunities for digital tools to support CPD. However, the successful integration of such digital tools into practice poses challenges. It requires adherence to CPD prerequisites and acknowledgment of the complexity of the professional development process. This study explored the applicability of the developed digital PE teacher professional development TARGET-tool in a secondary school PE context. We examined the perceived usability of this tool and gained insights into the process of teachers' professional development as a result of using the tool. Ten PE teachers from different schools implemented the TARGET-tool within their PE context for a period of 4 to 6 weeks. Individual semi-structured interviews and the System Usability Scale provided insights into the perceived usability and the process of teacher professional development. The TARGET-tool demonstrated its potential as an effective tool for supporting teachers' professional development. Future tool improvements were identified to further optimize the perceived usability, such as simplifying complex features, providing additional support and resources, and improving (data) presentations. Using the Interconnected Model of Professional Growth as a theoretical basis, it was demonstrated how the use of the TARGET-tool engages teachers as active and reflective participants in their professional development and induces changes within the external domain, the domain of practice, the domain of consequences, and the personal domain.

Keywords Teacher professional development · TARGET · IMPG · Educational technology · Physical education · Perceived usability

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Introduction

Teaching is considered complex given the dynamic context and constantly evolving practice confronting teachers with relational, emotional, and intellectual challenges on a daily basis (Day, 2017). Effective teaching involves understanding students' individual needs and using teaching strategies to meet these needs. Due to the substantial heterogeneity in the psychomotor, social, and affective domains present among secondary school students, physical education (PE) teachers in particular, are confronted with a wide range of abilities and needs in class (Komar et al., 2019; Moen et al., 2020; Warburton et al., 2019). For students to adopt a physically active lifestyle (i.e., objective of PE; WHO, 2018), it is crucial to build inclusive PE learning environments in which students' differential needs are met, and positive student experiences are ensured (Cox & Williams, 2008; Haerens et al., 2010; Hagger et al., 2005). The TARGET framework (Ames, 1992; Epstein, 1989) is a valuable theoretical framework to support PE teachers in achieving this goal. By manipulating the classroom dimensions *task*, *authority*, *recognition*, *grouping*, *evaluation*, and *time*, a favorable PE learning climate (i.e., mastery climate) can be created (Braithwaite et al., 2011; Harwood et al., 2015; Urdan & Kaplan, 2020). By employing several teaching strategies, the teacher can modify the (learning) *tasks* assigned to students, the *authority* provided to complete them, the manner students are *recognized*, *grouped*, and *evaluated*, and the amount of *time* available for instruction. Examples of these teaching strategies include providing variety and alternation within the learning tasks (task dimension) of empowering students to take responsibility for their learning through choice and opportunities for self-regulation (authority dimension). The implementation of these research-based insights, however, is not self-evident (Hastie et al., 2014; Weeldenburg et al., 2021). Transforming content knowledge of the TARGET framework into the unique and individual PE context is a complex and challenging process for many PE teachers (Velija et al., 2008). Continuing teacher professional development (CPD) is vital to update teachers' knowledge, enhance teaching effectiveness, and address the complexity of teaching (Atencio et al., 2012; Lander et al., 2022; Parker & Patton, 2017; Yoon et al., 2007). CPD can involve various formal and informal activities, such as attending workshops, participating in peer-to-peer discussions on online PE forums, and pursuing an advanced teaching degree. To ensure the effectiveness of CPD activities, teachers need support in bridging the gap between theory and practice (Armour et al., 2017), and tools that facilitate the access and use of scientific insights in their professional practice should be developed (Grimshaw et al., 2012).

Technological advancements have led to new opportunities for developing digital tools for CPD (An, 2021; Hennessy et al., 2022; Philipsen et al., 2019; Walker et al., 2012). With the development of online environments, such as social media platforms, online forums, virtual learning environments, and collaborative workspaces, for example, promising CPD opportunities for teachers to enhance their professional development more flexibly and responsively appeared. Online professional learning communities (PLCs) have become increasingly popular in education as a way for teachers to connect with peers, share ideas, and improve their practice. Research showed that participation in online PLCs can be beneficial and could lead to increased teacher efficacy, improved student achievement, and greater job satisfaction (Ekici, 2018; Parsons et al., 2019; Trust et al., 2016; Xue et al., 2021). The application of technological tools within the teaching practice itself provides opportunities for teachers as well. In the context of PE, a variety of technologies have been developed and are currently used, such as tablets, mobile applications, video, wearables (e.g., accelerometers), and exergames

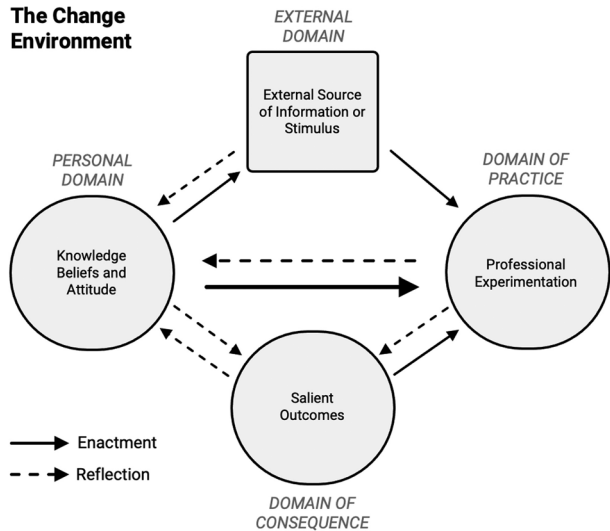
(Phelps et al., 2021). However, most of these types of technology focus on enhancing student learning, rather than supporting teachers in performing the fundamental teaching tasks (i.e., lesson planning, instructing, and assessing) and their professional development. For example, Goto et al. (2020) developed a visualization and evaluation system for human movement trajectories, providing students with objective feedback on their performance, whereas Mast et al. (2017) reported on the tool ‘BalanSAR’ which visually projects animations to allow students to conduct balancing exercises. In contrast, some studies are reporting on types of technology that primarily focus on the process of teachers’ learning and enhancing skills, knowledge, and expertise (i.e., CPD), rather than improving student learning. Calderón and Tannehill (2021), for example, used the ‘Phys app’ to support and empower teachers to enact a new curriculum models-based framework, while Penney et al. (2012) developed and implemented a digital assessment tool for secondary school PE. Yang et al. (2020) developed the ‘Voice Interactive Artificial Intelligence Educational Robot’ to assist teachers in individualizing PE and responding to students’ interests, and the ‘V-observer’, an online environment developed at Ghent University, allows PE teachers to identify and optimize their motivating teaching style (Bouten et al., 2023).

Although the added value of such tools has become apparent (Lupton, 2013; Roth, 2014; Williamson, 2014), successful implementation is complex and not evident (Hilvoorde & Koekoek, 2018). To be effective, digital tools should preferably meet the prerequisites for CPD as described in the literature, such as being evidence-informed (Hennessy et al., 2021; Osborne et al., 2013), facilitating active teacher involvement, addressing teachers’ needs and interests (Anamuah-Mensah et al., 2012; Power, 2019), being aligned with and applicable in teachers’ professional practice (Bødker, 2015; Seely et al., 2000), stimulating critical reflection on current teaching practice (Sargent & Calderón, 2021), supporting iterative cycles of experimentation and reflection within a safe environment (Bakkenes et al., 2010; DeLuca et al., 2015; Korthagen, 2017; Polly & Hannafin, 2010), and focusing on student outcomes (Armour et al., 2017; O’Sullivan & Deglau, 2006).

A widely accepted theoretical framework that acknowledges this complexity of CPD is the Interconnected Model of Professional Growth (IMPG; Clarke & Hollingsworth, 2002). This model (see Fig. 1) is useful for understanding how teachers develop their skills and knowledge over time. It proposes the perspective of teachers as active learners who shape their professional development by actively engaging in reflective participation in both professional development programs and in their day-to-day teaching practice. According to the IMPG, professional development results from the reflection and enactment in the various domains that encompass the teacher’s world: (1) the *external domain*, which refers to external sources of new information, stimulus, or support emerging from outside the teacher’s daily practice; (2) the *domain of practice*, which refers to all kinds of professional experimentation, including the enactment of developed learning materials in class; (3) the *domain of consequences*, which refers to salient outcomes such as student learning or student motivation; (4) the *personal domain*, which refers to teacher’s knowledge, beliefs, and attitudes.

In a previous publication (Weeldenburg et al., 2023) we described the development of a digital teacher professional development tool that acknowledges these domains. This so-called ‘TARGET-tool’ aims to support PE teachers in building and optimizing an inclusive and motivating learning climate in secondary school PE. It consists of an online teacher dashboard and mobile device student scans. By using the tool, the teachers will go through several process steps to gain insights into students’ motivational experiences within PE class, receive practical suggestions to improve the PE

Fig. 1 The interconnected model of professional growth (Clarke & Hollingsworth, 2002)



motivational learning climate, experiment with the selected motivating strategies within PE practice, reflect on their teaching performance and monitor changes in student motivational experiences over time.

Although PE teachers were actively involved in the design process as targeted end-users and conducted several user tests, real-life implementation of the finalized TARGET-tool is needed to investigate its applicability in the secondary school PE context. Therefore, the first aim of the present study was to examine the perceived usability of the TARGET-tool within a real-life secondary school PE context. Perceived usability refers to the subjective feelings toward products from the perspective of usage and encompasses various factors such as ease of use, learnability, efficiency, error frequency, and satisfaction (Yang et al., 2012). Secondly, using the IMPG as a framework, we aimed to gain insights into the process of teacher professional development as a result of using the digital tool. To provide a comprehensive view we first describe the main function and functionalities of the TARGET-tool, and of some technical components and processes that enable the TARGET-tool to perform its intended function, followed by the results of the evaluation study.

Description of the developed TARGET-tool

The TARGET-tool was developed using a participatory design approach (Sanders, 2008), involving researchers, designers, and PE teachers. The collaborative process spanned 14 months and consisted of seven phases, incorporating interactive and iterative research and design activities. Throughout this process, the challenges and needs of PE teachers regarding a motivational PE climate were identified. Ideas for the TARGET-tool were then explored, prototyped, designed, developed, validated, tested, and critically reviewed. A full description of this design and development process can be found in our previous paper (Weeldenburg et al., 2023). In the following section, we provide a short description of the TARGET-tool's function, content, and functionalities.

Function and content of the TARGET-tool

The digital TARGET-tool was developed to support PE teachers in building an optimal motivational learning climate in secondary school PE and enhancing their knowledge and skills. It comprises an online teacher dashboard and student scans (see Fig. 2). Drawing from research on the evidence-based theoretical TARGET framework (e.g., Bortoli et al., 2017; Cecchini et al., 2020; Urdan & Kaplan, 2020; Weeldenburg et al., 2021), several potential motivating teaching strategies and matching teacher actions within the *task, authority, recognition, grouping, evaluation, and time* dimension were identified and embedded in the tool. Within the authority dimension, for example, the tool provides the teachers with the suggestion to enhance students' involvement in decision-making processes (i.e., teaching strategy) through the following teacher action options: the application of questioning; creating moments for students to discuss (e.g., time outs); providing opportunities for choice and promoting personal goal setting. These teaching strategies and actions are made accessible for teachers by printable cards and provided by the tool after finishing the previous user process steps (see Fig. 3).

The TARGET-tool user process

The TARGET-tool supports teachers in going through a specific process (see Fig. 3), enabling them to gain insights into students' motivational PE experiences and optimize the motivational climate. This process involves several predefined steps implemented in the desktop interface and visualized in a teacher dashboard (see Fig. 2). Even though the tool was designed to be as self-explanatory as possible, the availability of high-quality support materials can be expected to enhance its uptake. Therefore, upon the teacher's first login to the TARGET-tool, they are directed to a dedicated landing page that introduces the tool's functionalities. This page provides supportive information about the importance of fostering a motivating PE learning climate and how the tool can assist teachers in optimizing it. Included on this landing page is an introductory video (in Dutch) accessible by the following link: <https://vimeo.com/764468446>.

The following user steps are predefined and implemented in the dashboard of the TARGET-tool:

- (1) Enter general information into the user **profile** and select the **classes** for experimentation.
- (2) **Select** one or two relevant **TARGET dimensions** after reviewing detailed information about all TARGET dimensions and optionally completing the SELF-scan. The

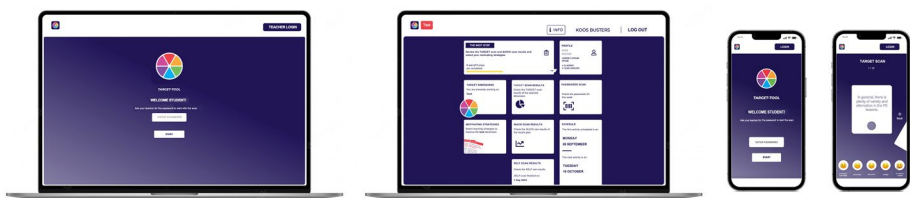


Fig. 2 TARGET-tool interfaces existing of a teacher dashboard (left and center, desktop) and student scans (right, mobile device)

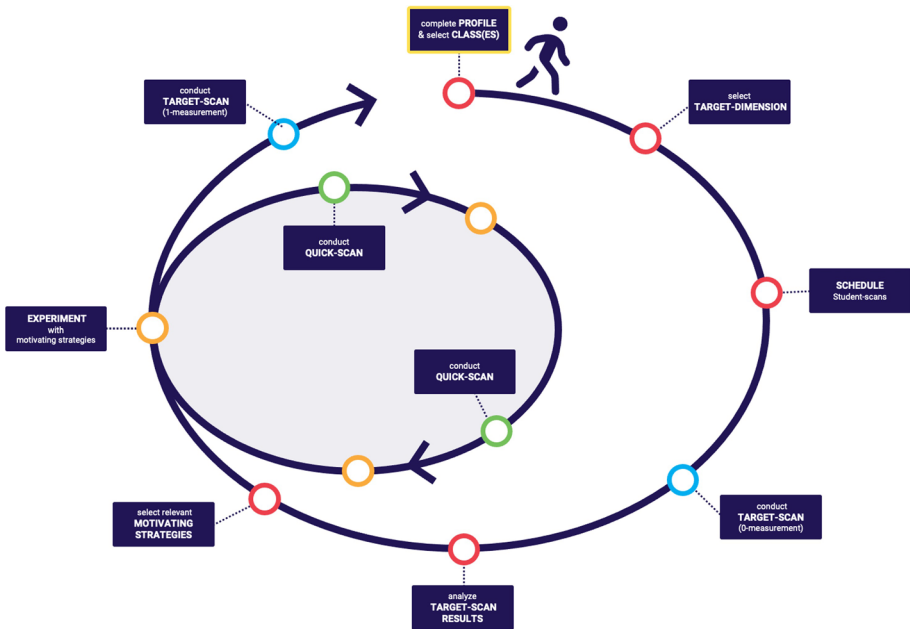


Fig. 3 The process involved predefined steps

SELF-scan assesses the teacher's perceived abilities in applying motivating teaching strategies across all **TARGET** dimensions by responding to 62 items (e.g., 'In general, I provide plenty of variety and alternation in the PE lessons') using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). This results in scores on all **TARGET** dimensions providing the teacher with insights to identify their strengths and opportunities for professional development.

- (3) **Schedule** the **TARGET-scan** for students and generate student scan **passwords**.
- (4) **Conduct** a **TARGET-scan** at the beginning of PE class to retrieve information on students' overall perceptions of the motivational climate regarding the selected **TARGET** dimension(s) (i.e., baseline measurement). The **TARGET-scan** involves a short questionnaire (10–13 items; e.g., 'In general, there is plenty of variety and alternation in the PE lessons') that students administer on their mobile device by using a five-point Likert scale ranging from 1 to 5. Students' answers are logged in the **TARGET-tool** database and form the baseline measurement.
- (5) **Review** the **TARGET-scan results** to identify professional development opportunities and gain insights for the next step in the process.
- (6) **Select** relevant and applicable potential **motivating teaching strategies** based on the results within the selected dimension(s). These strategies are presented as printable cards.
- (7) **Experiment** for a substantial period with the selected motivating strategies by implementing them in PE practice.
- (8) **Conduct** a **QUICK-scan** (optional) at the end of an experimental PE lesson to gain information on students' experiences and make adjustments if needed. This scan consists of a two-item questionnaire related to how interesting and enjoyable (i.e., intrinsic motivation; (Ryan & Deci, 2017) the students found the current PE lesson.

- (9) **Review** the **QUICK-scan results** (optional) and identify potential improvements regarding the implemented teaching strategies. The data collected from students is processed and presented to the teacher. This provides the teacher with insights to make interim adjustments if needed.
- (10) **Conduct** 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) pause.

For more detailed information concerning the functionalities, technical specifications of the teacher dashboard, student scans, data visualization, and privacy concerns, we refer to Supplementary Information.

Evaluation of the TARGET-tool

To identify potential flaws in the design, uncover opportunities to improve, and learn about the target users, several usability tests were conducted on prototypes of the TARGET-tool in the previous development phases. The perceived usability of the completed TARGET-tool, however, has not yet been examined. Therefore, this study aimed to examine the perceived usability of the completed TARGET-tool within a real-life secondary school PE context. As the tool is intended to support and stimulate teachers in their professional development, we also aimed to gain insights into the process of teacher professional development as a result of using the digital tool.

Methods

Participants and settings

After ethical approval was granted by the university's research ethics committee, participants were recruited by inviting PE teachers from the university's network to participate in this study. The convenience sample consisted of 10 PE teachers (9 male; 1 female) and their 18 PE classes (i.e., 399 students) from 10 different secondary schools in the Netherlands. The mean age of the PE teachers was 39.5 years ($SD=9.9$) and an average of 16.9 years ($SD=9.3$) of teaching experience. PE in these schools was mixed-gender grouped and mandatory for two lessons (of 50–60 min each) per week throughout the school year. In the Netherlands, all PE teachers in secondary education are specialist teachers who obtained their teacher qualifications through a 4-year physical education teacher education bachelor's program. For all participants written 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.

Study design

To test and evaluate the TARGET-tool within the PE context participants were asked to experiment with the TARGET-tool for a period of 4 to 6 weeks within their PE practice.

Leading up to the experimental phase the participants received login details and instructions to set up their individual TARGET-tool accounts. Based on the idea that teachers should be able to work with the tool individually and independently, no further instructions on how to use the tool were provided to the participants.

Data collection

Individual semi-structured interviews Individual online interviews were conducted to explore PE teachers' perceptions of the usability of the TARGET-tool and gain insights into the process of teacher professional development. A semi-structured approach was used to ensure data comparability and coverage of relevant topics while allowing for follow-up questions (Fontana & Frey, 2005). Each participating teacher was interviewed individually for approximately 30–40 min using the Microsoft Teams platform. The interviews consisted of a series of questions that focused (i) on the perceived usability (e.g., 'How did you use the TARGET-tool in your PE practice and what were your findings?'), and (ii) on the process of professional development (e.g., 'What did you do differently in your PE lessons and what did that look like?'). The interview guide was constructed based on the concepts of usability and professional development to identify relevant variables and provide a basis for data interpretation. All interviews were recorded and transcribed verbatim.

System Usability Scale The System Usability Scale (SUS; Brooke, 1996, 2013; Lewis, 2018) was used to collect quantitative data regarding the perceived usability of the TARGET-tool. The SUS is a standardized and validated questionnaire designed to assess the perceived usability of a wide range of systems, products, and services (Brooke, 1996, 2013; Sauro, 2011). The instrument consists of 10 items (e.g., 'I thought the tool was easy to use'), each scored on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The questionnaire was administered online by using Microsoft Forms. To examine potential changes in the perceived usability over time, the SUS was carried out at the mid-term and the end of the experimental phase.

Data analysis

Individual semi-structured interviews The data were analyzed using the Framework Method (Gale et al., 2013). This method organizes and analyzes teachers' interview data systematically, identifying overlaps and inconsistencies in their perceptions (Gale et al., 2013; Nowell et al., 2017). While themes were pre-defined based on specific areas of interest and existing theory (deductive approach), the method also allows for the emergence of new themes from the data (i.e., inductive approach; (Gale et al., 2013; Nowell et al., 2017). After the audio recordings were transcribed verbatim, the coding process commenced. To minimize bias throughout the coding process and optimize the trustworthiness (Nowell et al., 2017) of the data analysis, several sequential and interconnected steps were taken. The first author checked each transcript with the audio recordings for accuracy and with that became familiar with the data. Thereafter the coding process took place using ATLAS.ti Mac version 22.0.0 software. With the pre-defined themes from the interviews, the first and second authors of this study first generated a code set independently and subsequently discussed this to reach a consensus about an initial working version of the code set. Next, two transcripts were independently coded by both researchers. The coded transcripts, including notes containing suggestions for new or adapted themes or codes, were compared

and discussed before agreement on the final set of codes applicable to all transcripts (see Table 1). All transcripts were then coded, and following the Framework Method, quotes were lifted from the transcripts and charted into a framework matrix. Each quote was summarized and placed within a specific row (participant) and column (code) which allowed us to compare the views of all participants concerning each theme. This matrix structure was then employed for interpreting the data.

System Usability Scale Although the SUS evaluates perceived elements of effectiveness, efficiency, and user satisfaction, the instrument yields a single number representing a composite measure of the overall perceived usability of the system or product. To compute the overall SUS score, the following calculation methodology is used: For the positively worded items (odd numbers), the score contribution is the scale position minus 1. For negatively worded items (even numbers), the score contribution is 5 minus the scale position. Ultimately, to calculate the final SUS score, the sum of the item score contributions was multiplied by 2.5. This generates a score that ranges from 0 (very poor perceived usability) to 100 (excellent perceived usability) in 2.5-point increments (Bangor et al., 2009). To analyze the differences between the SUS scores at the mid-term and the end of the experimental phase, a paired sample t-test was conducted after examining the assumptions of normality. In addition, the effect size was calculated using Hedges' *g*, which is appropriate for relatively small sample sizes (Hedges, 1981). Cohen's criteria were used for interpretation as follows: ≤ 0.20 as small, 0.50 as medium, ≥ 0.80 as large (Cohen, 2013).

Results

The results will be presented along two main themes, i.e., perceived usability and professional development, and the underlying subthemes. These findings will be illustrated by quotes to support the narrative.

Perceived usability

Learnability Regarding the learnability of the TARGET-tool, which refers to how easy it is for users to learn to perform basic tasks effectively the first time they are dealing with the tool, the teachers valued and pointed out the importance of the 'progressive' dashboard. This dashboard seems to contribute to the learnability of the tool. It optimizes the navigability of the user interface and supports teachers going through the whole process independently:

"Well, I like the dashboard, and the different steps were easy to go through, so it went pretty smoothly" [R7].

Table 1 Overview of the final set of codes organized into two themes

Perceived usability	Professional development
Learnability	External domain
Efficiency	Domain of Practice
Error Frequency	Domain of Consequences
Satisfaction	Personal Domain
Potential Tool Improvements	Constraints for Professional Development

Overall, the different functionalities of the tool (e.g., conduct a self-scan, select TARGET dimensions, and perform student scans) are experienced as being relatively easy to learn and understand:

"The tool is very handy in use, and very simple. Clear symbols, I really like that" [R2].

To generate passwords for conducting the student scans the teacher first needs to schedule the student scans. Most teachers, however, experienced this functionality in the tool as highly complex. It frustrated teachers and impeded their ability to perform the task efficiently for the first time:

"But, uh, I find the schedule feature a bit confusing" [R5].

Lastly, the teachers indicated that despite the introduction video on the home page in which the function and functionalities of the TARGET tool are explained, the effective use of the tool in the initial stage could increase if they were provided with an overview and some more explanation of the tool before the implementation:

"What I found difficult at the beginning of the process was the lack of an overview of all functionalities of the tool. The introduction clip was helpful, but not enough to get a good picture" [R2].

Efficiency Concerning how quickly and accurately users can perform the intended tasks within the tool (i.e., efficiency), the teachers were particularly positive about the self-scan and student scans. They described how simply they could perform the self-scan by which they gained information on their strengths and opportunities within the different TARGET teaching dimensions. The teachers noted how easily they could perform the student scan within PE practice and efficiently gain information on students' PE experience and identify opportunities to optimize the motivational climate:

"Well, it's nice that the scans can be conducted on students' mobile phones. Students could complete them very quickly at the beginning or end of the lesson" [R10].

In addition, some teachers reported on the complexity of locating and analyzing the student scan results per class. They seem to overlook the functionality within the tool by which the results can be presented per class, gender, and period, and that enables comparison between groups and over time as well. After the teacher has critically reviewed the TARGET-scan results and identified professional development opportunities, the tool prompts the teacher to select relevant and applicable potential motivating strategies to experiment with in their PE practice. The number of potential motivating strategies provided by the tool, however, is perceived by some teachers as overwhelming and therefore dysfunctional:

"Then I ended up with the motivational strategies. And, to be honest, I kind of dropped out. I found all those motivational strategies so extensive that I found it difficult to select a few" [R1].

Error frequency With respect to the error frequency which refers to how many errors the users make while interacting with the tool, and how easily they can recover from them, it was notable that the (dis)functionality of scheduling student scans emerged from the data once more. Aside from the complexity of this functionality impacting the learnability of the tool, it was reported that once the teachers discovered what went wrong, they could recover from it:

"Those passwords didn't work. So that was a bit of a hassle with my students. But I soon realized what the problem was, so I rescheduled the scan" [R7].

No further references were made regarding the error frequency of the tool.

Satisfaction Satisfaction refers to the level of comfort the user experiences when using the tool and involves the user's attitude toward the tool. In general, the teachers in the present study expressed a positive attitude towards the TARGET-tool and valued the intention of the tool by which they were encouraged to examine student PE experiences more objectively, and critically reflect on their existing teaching practice and improve it:

"I think it's an interesting instrument. It stimulates you to take a critical look at teaching practice and routines" [R2].

The emphasis of the tool is placed on the supportive, individualized, and private character. Nevertheless, it is conceivable that teachers would find it stressful to collect data among students concerning their teaching practice. The teachers stated that they were aware that asking for student feedback put them in a vulnerable position, yet, they considered this feedback very useful and noticed that students appreciated the opportunity to provide the teachers with information about their PE experiences:

"On the one hand, it [i.e., student feedback] makes you vulnerable, but at the same time, children appreciate it very much if you ask for their opinion and respect their opinion. And especially if you say, that you would like to learn from this feedback and do better" [R10].

System usability scale In addition to the qualitative data, the SUS was used to collect quantitative data regarding the perceived usability of the TARGET-tool. The total mean SUS score at mid-term was 57.3 (SD=20.7) and at the end of the experimental phase 67.0 (SD=21.2) out of 100. These scores indicate that the perceived usability of the tool can be considered 'OK' (Bangor et al., 2009). The mean increase represents a medium effect size ($g=0.47$). However, the change was not statistically significant ($p=0.38$).

Tool improvements The results highlighted several key areas for tool improvement. Firstly, many teachers found the feature for scheduling student scans and generating passwords too complex and in need of improvement. Additionally, it was suggested that the tool could assist teachers in the selection process of motivating strategies by providing a curated list of strategies. The visibility and accessibility of the function that allows results to be presented per class, gender, and period, enabling comparisons over time and between groups, should also be enhanced. Some specific suggestions were made for tool improvements and expansion, such as including an option to generate QR codes alongside passwords. To provide teachers with just-in-time information and assistance, adding a FAQ feature with video tutorials was recommended. Furthermore, it was suggested to include additional theoretical background information and offer practical suggestions at different levels to cater to variations in teachers' knowledge, skills, and abilities:

"Well, I think I already know quite a bit, maybe more than some colleagues. So perhaps it is interesting to refer to literature based on the suggestions that are given or to offer these suggestions at different levels" [R10].

Although the motivating teaching strategies are printable, it was proposed to also deliver a tangible card set of these strategies along with the digital TARGET-tool to keep

drawing attention to these teaching strategies and stimulate the discussion within the PE department:

"Because the tool is digital, the focus on the strategies and their implementation into PE practice may move into the background. By using physical cards and placing them on a wall or other visible locations, for example, the strategies are kept in the teacher's attention. This could also encourage PE colleagues to consider the strategies as well" [R7].

Lastly, the idea of building a learning community by connecting a forum feature to the tool, for example, was proposed. Some teachers described their need for a supportive environment where TARGET-tool users can collaborate, learn from each other, and expand their knowledge and skills. Especially when the teacher is the only member of the PE department using the tool:

"It would be very nice if you could exchange ideas with someone who is also using the tool and wants to improve their PE practice. Preferably this happens among teachers from the same PE department. However, if you are the only one in the team then it would be nice to share ideas with other users from other schools" [R10].

Professional development Individual online interviews were conducted to gain insights into the complex process of teacher professional development as a result of using the TARGET-tool. This process involves ongoing reflection and enactment in four interrelated domains.

External domain With regard to the external domain, the teachers described how the tool provided them with new knowledge, and how the tool encouraged them to start thinking about and discussing student motivation and motivating teaching strategies within PE:

"As I said, with the TARGET-tool you are getting informed about student motivation and provided with tools to get started in your lessons. [...] It is also a stimulus to start conversations with your colleagues about this topic" [R5].

By performing the student scans, the teachers noted that they were provided with new information and insights into students' perceptions and experiences within PE, and how this information increased their self-awareness and formed a stimulus for potential change:

"I think I am quite well informed and doing well in PE, but it was interesting to find out that students experience things differently than I intended" [R6].

Domain of practice The teachers explained how they experimented with the motivating teaching strategies recommended by the TARGET-tool (i.e., domain of practice). Some teachers, for example, selected the grouping dimension and implemented strategies that focused on working with smaller and more flexible groups and involving students in the grouping process:

"In the last 10 minutes of the two versus two basketball game, the students were allowed to change and determine new pairs" [R1].

"So, I varied in the student groups. Sometimes I let the students choose themselves, at times I made the groups myself, and we varied between heterogeneous and homogeneous groups" [R2].

Further, a teacher described how experimenting with motivating teaching strategies within the evaluation dimension also led to the development of new educational materials, such as an assessment rubric. And how this assessment tool subsequently aided the teacher in providing students with feed-up, feedback, and feed-forward information to scaffold the learning process:

"Based on this rubric I first let the students perform a self-assessment, and I did a formative assessment in the second lesson. Based on the scores the students knew exactly how they performed on the task [i.e., somersault] and could see what they could do to perform better. According to the motivating strategy, this information is important for student motivation" [R4].

Another example of how teachers experimented within their own PE practice, is related to the authority dimension. Teachers translated the suggestion to enhance students' involvement in decision-making processes (i.e., teaching strategy) by providing opportunities for choice and self-regulation:

"With korfbal, for example, the students were allowed to change or develop new playing rules to improve the game" [R6].

Domain of consequence Concerning the domain of consequence, which refers to the salient outcomes and impact of teachers' new teaching practice, they noted that their experiments generally worked out well and that students appreciated the changes:

"I also asked some students how they experienced it. They told me that they found it very motivating because they now know what is expected from them and how to improve" [R4].

Although the teaching strategies within the different TARGET dimensions provided by the tool can be considered as motivating for all students, the teachers in the present study pointed out the potential differential outcomes or impact on different (groups of) students:

"The changes have been well received by most students, however less so by some other students. I don't think that it is possible to please all students and ensure enjoyment with all students in PE" [R7].

Personal domain As a result of working with the TARGET-tool there were some changes reported regarding the personal domain. The teachers described how they gained new knowledge and insights:

"Well, I noticed that students have a need for autonomy and that they can bear the associated responsibility as well" [R3].

Teachers also reflected on how their personal experiences when implementing new teaching practices have led to changes in their thoughts or convictions and attitudes toward specific teaching strategies:

"I have become convinced that I can provide my students with more opportunities for self-regulation and that I sometimes have to change my teaching habits to ensure more enjoyable experiences for my students" [R2].

Constraints for professional development The teachers pointed out some (potential) barriers that could limit their professional development opportunities. All teachers referred to

the time aspect and how hectic situations in schools often demand immediate attention and consume a significant amount of time and resources:

"I just didn't get around to it due to lack of time" [R1].

"I actually worked with the tool less than I had planned. Because we just have a new sports hall and you can't imagine how much extra work that takes" [R9].

While teachers emphasized the importance of consultation and collaboration among PE teachers in the school for professional development, there were limited moments or opportunities created for meaningful discussions:

"Increasing the debate on this in the team would be beneficial and necessary" [R7].

One teacher also reflected on how resistance or reluctance towards adopting new PE practices among certain colleagues can frustrate professional development:

"We still practice some outdated methods which I want to change. But it is challenging to bring my older colleagues on board and embrace other practices" [R2].

Concerning the digital TARGET-tool specifically, another potential barrier was highlighted in the interviews. It was noted that the implementation of stricter policies regarding mobile device use in schools could jeopardize the use of student scans to gain objective data on students' perceptions within PE:

"I wanted to perform quick scans as well, but in our new school policies, the use of mobile phones in the classroom will become prohibited. So, therefore I restricted myself to the target scans [R10].

Discussion and conclusion

CPD is crucial for enhancing effective teaching, bridging the theory–practice gap, and addressing the complexity of teaching (Armour et al., 2017; Atencio et al., 2012; Lander et al., 2022; Parker & Patton, 2017; Yoon et al., 2007). Digital tools offer new opportunities for supporting CPD (An, 2021; Hennessy et al., 2022; Philipson et al., 2019; Walker et al., 2012). However, integrating these tools successfully in educational practice requires adhering to CPD prerequisites and recognizing the complexity of the professional development process. In this study, we examined the perceived applicability of the TARGET-tool in real-life secondary school PE contexts and gained insights into the complex process of teachers' professional development as a result of using the digital tool. The most salient outcomes and implications will be discussed.

Perceived usability

Perceived usability plays a crucial role in determining the effectiveness and user acceptance of a product (Yang et al., 2012). The present study provides valuable insights into aspects of the usability of the TARGET-tool, including perceived learnability, efficiency, error frequency, and satisfaction. Overall, teachers indicated that the usability of the TARGET-tool can be considered satisfactory. The teachers valued, for example, the 'progressive' dashboard which improved the learnability of the tool by enhancing user interface navigability. It enabled them to become familiar with the tool's functionalities gradually and perform tasks independently and effectively. When user interfaces are easy to

understand and navigate, and the technology is relatively simple to learn, users are more likely to adopt and integrate it into their work routines (Carroll et al., 2003; Roldán-Álvarez et al., 2016). Some teachers, however, expressed the need for a more comprehensive overview and explanation of the TARGET-tool before implementation to improve its effectiveness in the initial stages. This finding highlights the importance of providing teachers with additional information and instruction prior to the TARGET-tool usage. This is in line with the findings of Havard et al. (2018) and O'Neal et al. (2017) who emphasized the value of supporting teachers in integrating technology effectively into their educational practice. Accordingly, the TPACK model (Koehler et al., 2013; Mishra & Koehler, 2006), which focuses on incorporating technology effectively into teaching, stresses the importance of teachers' technological content knowledge (TCK) and technological pedagogical knowledge (TPK). Therefore, equipping PE teachers with information on how the TARGET-tool can enhance or transform specific PE content areas (TCK) and providing insights on its use and integration in PE teaching practice (TPK) would be beneficial.

The present study highlighted the tool's effectiveness in providing PE teachers with valuable information about their teaching practices. Teachers highly appreciated the simplicity and ease of use of the self-scan feature, which allowed them to quickly identify their strengths and areas for improvement across TARGET dimensions. The student scan feature was found efficient in gathering information about students' PE experience and identifying opportunities to enhance the motivational climate. However, some teachers felt overwhelmed by the abundance of motivating strategies provided by the tool. This perception of overload may hinder the tool's usability, as the efficiency of digital tools impacts teachers' adoption and integration of technology into their teaching practices (Kearney et al., 2018). Therefore, it is important to address this issue by refining the tool's design and presentation of motivating strategies to enhance usability.

Despite areas identified for improvement, such as simplifying complex features and providing additional support and resources, this study indicates that teachers had a positive attitude towards the TARGET-tool. They expressed satisfaction with its intention and purpose, seeing it as potentially beneficial for objectively examining students' PE experiences, critical reflection on their teaching practice, and making improvements. This positive attitude highlights the tool's potential to foster self-reflection and professional growth among teachers.

Professional development

Teachers need to be recognized as active learners who shape their professional development through reflection and enactment in various domains, including the external domain, the domain of practice, the domain of consequence, and the personal domain (Clarke & Hollingsworth, 2002). The results of this study provided insights into the various aspects of these domains and their impact on PE teachers' professional development.

The IMPG perspective suggests that learning and growth occur when changes in one domain lead to changes in another through the mediating process of reflection and enactment (Clarke & Hollingsworth, 2002). Our study revealed the impact of working with the TARGET-tool on teachers' knowledge and understanding of student motivation and motivating teaching strategies in PE. For example, the tool introduced them to the theoretical TARGET framework (Ames, 1992; Epstein, 1989) which was previously unknown to them, expanding their insights into student motivation. Moreover, the TARGET-tool prompted teachers to critically reflect on student motivation and their teaching strategies.

By conducting student scans, teachers gained a deeper understanding of how students perceive PE and their own instructional approaches. The tool seemed to increase teachers' self-awareness and stimulate reflection, potentially leading to changes in their teaching practices. These findings indicate that the TARGET-tool effectively supports teachers in acquiring new knowledge and encourages reflection, aligned with the intended goals of the tool.

The results of our study showed how the teachers experimented with motivating teaching strategies recommended by the TARGET-tool within the domain of practice. According to the IMPG, professional experimentation is key to CPD, and professional development should be deliberately designed to offer teachers the opportunity to enact change in a variety of forms (Clarke & Hollingsworth, 2002). The TARGET-tool allowed teachers to select and try out teaching strategies that they considered suitable in their specific context. An example of this put forward by the teachers involved the authority dimension in which they explored the suggestion to enhance students' involvement in decision-making processes, aiming to foster autonomy and self-regulation. These teachers saw this as fitting because the data collected with the TARGET-tool suggested this was an area for improvement. Furthermore, it was described how the experimentation within the evaluation dimension, led to the development of new educational materials to support student learning. Coenders and colleagues (2015, 2019) demonstrated how the development of educational material substantially contributed to teacher growth. Therefore, they revised the IMPG to the 'Extended Interconnected Model of Teacher Professional Growth' (Coenders & Terlouw, 2015; Coenders & Verhoef, 2019) by adding the 'developed material domain'. The examples of teachers' experimentation with motivating teaching strategies, as well as evidence of changes in the domains, showcased the potential impact of the TARGET-tool on teachers' professional development.

Within the domain of consequence, the findings of this study indicated that the experiments conducted by teachers generally yielded positive results. The teachers' reflections on the consequences of their new teaching practices revealed a sense of satisfaction. They expressed, for example, that seeing their experiments work out well was a rewarding experience. The positive outcomes experienced by teachers in our study can therefore be considered important for reinforcing their confidence and beliefs in the applied teaching strategies and for encouraging them to further explore alternative teaching strategies.

Our study suggests that using the TARGET-tool can impact teachers' personal domain. They reported gaining new knowledge and insights which suggest that the TARGET-tool is supportive in bridging the gap between theory and practice and thereby meeting a significant prerequisite of effective professional development tools (Armour et al., 2017; Grimshaw et al., 2012). Moreover, our study revealed that the teachers' personal experiences in using the tool and implementing new teaching strategies played a role in shaping their thoughts, convictions, and attitudes toward specific teaching strategies. As teachers experimented with different instructional approaches, they encountered evidence of the impact these strategies had on student outcomes. According to the seminal work by Guskey (1986) and Guskey and Yoon (2009) teachers' attitudes and beliefs about effective teaching strategies, will change only after they have personally experienced positive changes in students' learning outcomes. This 'proven' added value is deemed to be important for teachers' willingness to innovate their teaching practice and ensure professional growth (Clarke & Hollingsworth, 2002; Parker & Patton, 2017). The TARGET-tool motivates teachers to implement and experiment with motivating teaching strategies. Our findings suggest that this experiential learning process prompted a reflection on their existing beliefs and practices, leading to a reconsideration and, in some cases, a modification of it. The willingness to

re-evaluate beliefs and embrace new teaching strategies suggests an openness to change and a commitment to continuous improvement. Indeed, active involvement and conducting iterative cycles of experimentation and reflection are considered crucial for effective CPD (Korthagen, 2017; Sargent & Calderón, 2021; Tannehill et al., 2021).

Despite the positive aspects of the TARGET-tool, several potential barriers to professional development were identified by the teachers. Time constraints emerged as a major challenge, with teachers expressing the difficulty of allocating sufficient time and resources for professional development due to the demanding nature of their work. This problem was already highlighted prior to the commencement of the current study when nine PE teachers withdrew due to time constraints and excessive workload. These teachers indicated they were engaged in a demanding period at school, which left them unable to participate in this study despite their initial commitments. Consistent with previous studies related to teacher professional development (e.g., Khalid et al., 2014; Parker et al., 2012; Slingerland et al., 2021; Taylor, 2020; Xue et al., 2021) our findings emphasize the importance of providing teachers with sufficient time and opportunities for professional development activities.

The limited opportunities for meaningful discussions and collaboration among PE teachers within and between schools were also pointed out by the teachers in this study. This implies there is a need for opportunities to exchange ideas, experiences, and expertise among teachers. Indeed, several studies (e.g., Hunuk et al., 2013; Parker et al., 2012; Tannehill & MacPhail, 2017; Trust et al., 2016; vanOostveen et al., 2019) stress the importance of building learning communities to impact the professional development of teachers positively. Research has shown that participation in (online or in-person) learning communities leads to, for example, the enhancement of teachers' content knowledge and the improvement of their teaching practice (Makopoulou & Armour, 2011; Yu & Chao, 2022). In addition, participation in learning communities can support teacher empowerment (Parker et al., 2010; Tannehill & MacPhail, 2017), increase their willingness to jointly solve problems (Yu & Chao, 2022) and enhance their confidence in implementing digital technologies into their practice (OECD, 2014; Sheffield et al., 2018). Hence, we strongly advocate for facilitating collaborative opportunities among users of the TARGET-tool to optimize its potential and ensure the effective professional development of PE teachers.

Contribution and implications

We presented a comprehensive case study detailing the implementation and evaluation of the TARGET-tool, a unique teacher professional development tool designed to support PE teachers in creating an inclusive and motivating learning environment within secondary school PE settings. Our study contributes to various academic domains, including educational technology, human–computer interaction (HCI), teacher professional development, and physical education.

The theoretical contributions of our research are twofold. Firstly, we advance pedagogical knowledge by showcasing how technology, such as the TARGET-tool, could effectively bridge the theory–practice gap in teacher professional development. In doing so, we respond to the call made by a substantial group of international HCI experts, to gain insights into how technologies can be effectively integrated into the complex educational context and better tailored to the specific needs of teachers (Stephanidis et al., 2019). Secondly, we add to the theoretical foundations of technology integration in pedagogy, emphasizing the importance of aligning technology with pedagogical objectives, as put forward

in the Technological Pedagogical Content Knowledge (TPACK) model (Koehler et al., 2013; Mishra & Koehler, 2006).

On the practical front, our study provides valuable insights into the importance of the perceived usability of technology in educational settings. We explored factors such as learnability, efficiency, error frequency, and satisfaction, underlining the potential for successful integration of technology such as the TARGET-tool into teachers' work routines. Moreover, since our study has established the potential effectiveness of the TARGET-tool for enhancing motivating teaching practices, it offers PE teachers a tangible instrument for critical reflection and professional development. Our research illustrates how a technological tool could impact various domains of teachers' professional growth, including changes in knowledge, teaching strategies, and personal beliefs. However, this study has also uncovered practical challenges, such as time constraints and limited collaboration opportunities as barriers to professional development. This emphasizes the importance of providing teachers with conditions for effective use of digital tools in the educational context (e.g., adequate time and establishing collaborative learning communities). Despite acknowledging the positive aspects of the use of the TARGET-tool, our study shows the importance of ongoing support, refinement, and collaborative opportunities for sustaining the long-term impact of professional development tools. Overall, our study not only highlights the practical applicability of the TARGET-tool but also makes substantive contributions to the broader discourse on optimizing educational technology for enhanced teaching practices and student engagement in the field of PE.

Strengths and limitations

To the best of our knowledge, this is the first study in the context of PE in which a digital tool for teacher professional development is presented and evaluated. We did not only evaluate the perceived usability of the tool in the authentic PE setting, we also explored its intended function of supporting the process of teachers' professional development. With that, the tool was reviewed from a broader perspective in which the interrelationship between technology and pedagogy was acknowledged. We believe our research contributes to the understanding of how digital tools can effectively be embedded in the educational process and enhance teaching practices. However, there are limitations to consider. The findings are based on the subjective perspectives of a small, convenience sample of teachers, potentially leading to sampling bias. Future research with a larger and more diverse sample would provide a more comprehensive understanding of the process of professional development as a result of using the TARGET-tool. Additionally, studying the tool's usability and impact over a longer period would be valuable.

Conclusion and recommendations

The TARGET-tool has demonstrated its potential as an effective tool for supporting teachers' professional development in a secondary school context. Furthermore, it has been shown how the use of the TARGET-tool engages teachers as active and reflective participants in their professional development and induces changes across all domains of professional growth.

Future opportunities for TARGET-tool development and improvement have been identified. Based on the findings of the present study, it is recommended to enhance the perceived usability of the TARGET-tool by simplifying complex features such as scheduling

student scans, generating scan passwords, analyzing student scan results, and selecting motivating teaching strategies. To enhance the tool's effectiveness in the initial stages, it is suggested to provide PE teachers with a more comprehensive overview and insights on its use and integration in teaching practice before using the tool. For instance, organizing a brief online introduction meeting for new users could be beneficial. Moreover, facilitating learning communities among TARGET-tool users is recommended to optimize its effective implementation. Utilizing platforms like Microsoft Teams can facilitate the creation of such a learning community, connecting users and enabling them to discuss, learn from one another, collaboratively resolve issues, and enhance their teaching practices. Additionally, these communities could offer teachers support, empowering them to build confidence in integrating the TARGET-tool into their unique teaching practices.

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Data availability The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

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