

## The Use of Personal Digital Assistants as Tools for Work-Based Learning in Clinical Internships

Sanne Akkerman  
Renée Filius  
Utrecht University

### Abstract

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*Though mobile technologies have been studied, their specific value in supporting work-based learning has not yet been investigated. This paper describes a small exploratory study in health care education in which medical students work in clinical practice. The study investigates both the perceived potential as well as the actual role of PDAs in supporting a range of work-based learning activities. Based on the results, the authors claim that PDAs can facilitate work-based learning only when they are deliberately used as a “boundary object” between college and working practices. (Keywords: PDA, personal digital assistant, mobile learning, boundary object, internship)*

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More and more people use mobile devices such as mobile phones, handheld PCs, tablets, netbooks, and more recently the iPad and devices such as the iPod touch, which run mobile applications. They seem to become an anchor point for organizing work as well as private life. They are popular because they are small and convenient, combining functionalities such as a digital diary, phone, e-mail access, music player, audio recorder, camera, and satellite navigation. Moreover, central to mobile devices is that their functions can be accessed where and when they are needed (Attewell, 2005). Along with the increasing use of mobile devices in work and everyday life, we have witnessed a mass adoption of mobile computing devices by the current student generation. Significant opportunities have emerged for genuinely supporting differentiated and personalized learning experiences through mobile devices such as PDAs.

Most research on the use of mobile technologies for supporting learning is directed towards primary and secondary education (see for example, Chen, Kao, & Sheum, 2003; Rogers, Price, Randell, Fraser, Weal, & Fitzpatrick, 2005; Sharples, Corlett, & Westmancott, 2002). Some studies focus on mobile technologies in higher education (e.g., Bradley, Haynes, & Boyle, 2005; Brown & Adler, 2008, Churchill & Churchill, 2008). Consistently these studies are concerned with the way that specific functionalities of mobile devices can be employed for designing educational assignments. Despite

the fact that mobility is the main distinctive character of mobile devices, we found no studies investigating how students can use mobile devices in different contexts. We argue that mobile devices have an important potential that educational scholars have not yet recognized or theorized: their value in exploiting relevant learning and working experiences outside formal educational contexts. This potential value holds true especially for internships in vocational and higher education, an area that stands at the border of college and work. Mobile devices allow connections to educational resources during periods of working.

This paper aims to stress the particular value of mobile technologies in supporting work-based learning. We will point out that internships often do not include work-based learning due to the complexity and intensity of the work that needs to be performed. To reinforce the potential of mobile devices to support work-based learning, we report on a small exploratory study that we conducted in health care education in which medical students work in hospital practice. We consider the ways that medical students would expect to use PDAs as a work-based learning device during common internship activities. Based on the results, we claim that PDAs can facilitate work-based learning only when they are deliberately used as a “boundary object” (Star, 1989) between college and working practices. In the following two sections, we elaborate on our theoretical interest in work-based learning challenges and the way that mobile devices can help address these challenges.

### **The Challenge of Work-Based Learning**

In both vocational and higher education, it has become common to work in practice during formal educational programs. Working in practice is then a means to learning the requirements and complexities of a particular real-life vocation or profession. This way of learning has been especially promoted by situated learning theories (e.g., Brown, Collins, & Duguid, 1989; Lave & Wenger, 1991). Following an apprenticeship model of learning, students are able to learn through a process of observation and gradual participation. Tynjälä, Välimaa, and Sarja (2003) described especially how higher education is challenged to connect more to adults’ working life. Often, this connection is realized in the form of one or more internships during the final stages of an educational trajectory. Internships are meant to ground the theory in practice and to draw new lessons from the field of work in all its complexities.

Despite these intentions, it is precisely due to the complexity of the work that the students often seem to lack the time or space to reflect and draw lessons from their working experiences. Recent studies in the context of teacher education consistently show the difficulty students have relating to what they have learned in college to what they encounter at work (Alsop, 2006; Edwards & Mutton, 2007; Finlay, 2008; Tsui & Law, 2007;

Yoon, Pedretti, Bencze, Hewitt, Perris, & Van Oostveen, 2006). Rather than interpreting this problem merely as a theory–practice gap, it is argued that college and work environments can best be regarded as separate systems of activity (Tuomi-Gröhn & Engeström, 2003). Basically, one can say that college and work have different objectives (learning versus working). Accordingly, both environments concentrate on a different role of the student—that of a learner versus that of a novice professional. As a novice professional in day-to-day work, the student is often expected to make quick and effective decisions; these decisions need to take into account the cultural, technical, and practical standards that typify working practice. As Edwards and Mutton (2007) have pointed out, workplaces such as schools often expect those who enter their system to work on their terms. This is more difficult when the college and work environment of the student have different norms and values regarding the same domain. For example, in teacher education student teachers often report encountering conflicts between the values within teacher education programmes and the values within the schools, for example, regarding what is perceived to be good pedagogy (e.g., Alsup, 2006). These challenges are not unique to internships in teacher education; they have also been reported in other educational contexts, such as trade vocational education (Tanggaard, 2007) and occupational therapy education (Konkola, Tuomi-Gröhn, Lambert, & Ludvigsen, 2007).

These challenges especially hold for medical education, where students are increasingly sent out to clinical workplaces to learn (Bleakley, 2006; Prince, Boshuizen, van der Vleuten, & Scherpbier, 2005). Clinical practice is a typical example of a highly dynamic working environment for students; it consists of a continuous process of decision-making, includes interaction among many different actors (patients, nurses, other types of specialists), and reflects a high flow of information. Hence, although medical students' internships are intended to be part of their education, in reality the daily work is demanding due to the hands-on effort and quality of service expected from them. Consequently, the above mentioned studies report how internships tend to reflect periods of working to and fulfilling local standards rather than being periods of learning.

Nonetheless, Simons (2005) stresses that educational practitioners should not respond to this lack of space for learning by what he calls “educationalizing” the work practice. He notes that we often tend to guarantee and control learning by planning and organizing the work beforehand according to certain learning goals. The value of work-based experience is precisely that it can lead to spontaneous learning in response to local problems. For internships, this means that we need to find a balance between organizing and supporting learning and leaving open when and how this occurs spontaneously during work-based experiences. It is in this context that we see the potential value of mobile devices.

## Mobile Devices for Facilitating Work-Based Learning

The proliferation of mobile technologies has given rise to the use of PDAs by both students and professionals. Mobile technologies such as PDAs are frequently described as tools for organizing and structuring one's diary and work flow. Students might also find PDAs to be effective administration tools to help them to manage their day-to-day activities (e.g., incorporating calendars, task managers or contacts) (Patten, Arnedillo Sánchez, & Tangney, 2006). Yet we contend that they can also begin to function as a device for facilitating learning during work. Mobile devices allow for continuous access to support when and where it is needed during work. This makes it possible to avoid what Simons called "educationalizing" work practices—that is, completely planning and deciding beforehand the required support for students during work. At the same time, these devices allow avoiding a completely open process of working without offering supportive resources, which, as we have described, in internships can lead to a lack of space for learning. The value of mobile devices in supporting work-based learning, therefore, is the potential for the user to continuously diagnose and choose the kind of support he or she needs. However, this does require some student self-regulation, in the sense that they have to determine themselves when they need help or additional information to conduct a certain task (Butler & Winne, 1995). Mobile devices offer four types of support during the conduct of daily work: searching for information, taking notes, recording data, and communicating with others. One can expect that using this variety of support when and where it's needed during actual work situations makes it possible to learn more deliberately and reflectively from work.

Though we can be very positive about the potential of mobile devices in facilitating work-based learning, we cannot attribute this to the tool. Naturally, the fact that someone has a mobile device does not invoke all of the above described characteristics of a learning process; it merely allows for them. In the end, the actual value of a mobile device as a tool for facilitating work-based learning lies in the way it is perceived and used in a given context. Hence, the aim of this study is to explore how mobile devices are perceived and when and where they are used by so-called co-assistants during internships in the context of clinical practice. Based on this exploration, we aim to answer the following research question: What is the potential role of PDAs to support work-based learning during the internships of co-assistants? Co-assistants are medical students who are in the last phase of their master study, conducting several internships in clinical practice. The co-assistant phase can amount to 3 years, including a scientific internship. During the internships, the co-assistants have to apply theory in practice and learn to independently conduct patient care. Formally, co-assistants always work under supervision and responsibility of a medical doctor or doctor-assistant.

**Table 1.** Overview of Activities in Clinical Work

Type of Work-Based Learning Activity	Specific Activity in Clinical Work
Searching for information	Searching in reference books Searching for guidelines and protocols Searching for rules of thumb (formulas, nomograms) Patient records*
Taking notes	To-do lists Questions received from patients Questions received from colleagues Own reflections
Recording data	Patient sounds (e.g., heart beat) Conversations with other students, patients, teachers or experts Dictation of letters
Communicating with others*	Communicating with other students (phone, e-mail) Communication with patients (phone, e-mail) Communicating with colleagues, experts, or teachers (phone, e-mail)

\* It was indicated that for these activities mobile devices were prohibited in Dutch hospitals due to legal restrictions.

## Methods

To explore the potential value of mobile devices in facilitating work-based learning during the internships of medical students in clinical practice, we conducted a study in three phases.

### Phase 1: Preparation

In the preparatory phase, we investigated first how mobile devices could offer specific support in the context of clinical internships. We considered literature on mobile devices in the context of clinical work (Kendall, Lauscher, Broudo, Jarvis-Selinger, Fraser, Hewes, & Scott, 2009; Looi, Seow, Zhang, So, Chen, & Wong, 2009; Patten et al., 2006; Treadwell, 2006). This literature pointed to a particular increase in the use of PDAs, both by professionals in clinical practice (see Treadwell, 2006) as well as more recently by students as educational tools (e.g., Kendall et al., 2009). Because of these findings, we decided to concentrate our research on PDAs. We interviewed two clinical experts and one co-assistant of the Medical Faculty of Utrecht University to gather the following information:

- Specific types of clinical work-based learning activities that can occur during internships and in which the use of a PDA could be beneficial. An overview of these activities is provided in Table 1.
- Specific situations in which the work-based learning activities could occur. This led to the identification of five situations: recording the status of the patient, writing the report, preparing work shifts or visits, writing a prescription and standing at the patient's bedside.
- Requirements of a PDA with respect to hardware and software that enable support of the various activities.

Regarding the last point, we also consulted aforementioned literature on the use of PDAs in clinical work as well as talking to local technicians in the

Information and Communication Technologies department of the hospital. Based on this information, we selected a PDA that could support all of the activities listed in Table 1, with the exception of supporting mobile access to patient records and mobile communication. Those functionalities, although potentially useful, are currently not allowed in the academic hospital of Utrecht. With respect to the software, we arrived at a final set of accepted and possibly relevant programs, including Microsoft Office 2000 programs, a medical calculator, Dutch medical standards, and pharmaceutical tools.

## **Phase 2: Questionnaire about Current Work**

The second phase of this study consisted of a small survey in which 12 co-assistants completed a questionnaire. The questionnaire consisted of questions about the work activities that were identified in the preparatory phase (as listed in Table 1), asking:

- How often these activities occurred while working, irrespective of whether or not using a PDA (based on a 5-point Likert scale ranging from not at all to more than once a day, and including an open text option to elaborate on reasons why not)
- In which work situations these occurred (listing five specific situations and an open text answer for other situations)
- The extent to which it would be useful to support these activities with a PDA (based on a 5-point Likert scale)

Additionally, questions were included about the use of a PDA, and the (extent of) access to and use of a PC at work.

We developed the questionnaire based on the findings of the preparatory phase by means of feedback from a co-assistant (who did not participate in the pilot) and from several supervisors of co-assistants. This enabled the questions to pinpoint those work activities that were considered realistic regarding the nature of the work of co-assistants during their internships.

We sent the questionnaire to 40 co-assistants, which represented the entire population of co-assistants at Utrecht University who were in their final year of study at the time of inquiry. Although the response was low, the 12 co-assistants represented a diversity of disciplines (e.g., nephrology, haematology, plastic surgery, children's intensive care, genealogy, general practitioners, clinical geriatrics), and there were no indications of response bias. Hence, we interpreted the results as giving an overview of actual tendencies in the working practices of co-assistants.

## **Phase 3: When and How Participants Use PDAs**

The third phase consisted of a pilot to find out when and how co-assistants would use a PDA when it was provided to them during the course of an internship. After establishing an agreement with the head of the internal medicine for conducting this study, all five co-assistants in internal medicine

who were in their final year of study were admitted to the pilot and received a PDA. Before the start of their internship, the participants attended a collaborative workshop where they learned how to use the PDA. The second author and the local project leader of this study organized the collaborative workshop. After attending the workshop, they were able to use the PDA for 3 months for free with no obligations or restrictions on its use. During this period, they were able to ask for technical assistance any time, and we checked several times to see if they needed to do so.

After this period of 3 months, the five participants filled out the same questionnaire as in Phase 2. In addition, the second author and local project leader interviewed them with a semi-structured interview scheme, with questions addressing, respectively, the frequency, situations, and purposes of using the PDA in daily work activities and their reasons for using or not using the PDA.

## Analysis

To answer the research question, we first considered the questionnaire results of the small survey. For the questionnaires, we summarized the descriptive statistics in a similar manner as described above for the small survey. In addition, we conducted a content analysis on the interviews with the five co-assistants in the pilot, categorizing for each type of work-based learning activity (see Table 1) the responses and explanations respectively about whether they used the PDA for that purpose, and if so, how often and in what situations. The results section discusses the findings of the survey and the pilot for each type of work-based learning activity. We summarized the descriptive statistics of the questionnaires, indicating the frequency of specific work-based learning activities, the specific work situations in which these occurred, and the extent to which co-assistants consider it useful to support these activities with a PDA. Second, we analysed the questionnaires and interview responses of the co-assistants in the pilot to reveal the actual and potential role of PDAs in supporting specific work-based learning activities. We also analysed the interview responses to assess the reasons mentioned for not using PDAs for specific purposes or in specific situations. The Results section discusses the findings of the survey and the pilot for each type of work-based learning activity.

## Results

We will now discuss the findings for the different activities that a PDA can support, searching for information, taking notes, recording, and communicating respectively. For each type of activity, we will discuss first the results from the survey on the occurrence of specific activities and situations and on the potential role of PDAs in supporting these. We then move on to the results from the pilots and discuss the actual and potential role of PDAs in supporting work-based learning activities, as well as the explanations

provided for using or not using PDAs in specific ways. We include citations from the interview to illustrate the answers.

### Searching for Information

A growing amount of medical information used by professionals is programmed for PDAs. Relevant medical information includes reference books (such as Kumar & Clark, 2005), guidelines and protocols, and rules of thumb such as formulas and nomograms. Nomograms are graphically displayed calculation methods that help to obtain an answer (e.g., how much medicine should be given) based on some known values.

The survey results revealed that co-assistants frequently search for information during their internship. Most co-assistants (10 and 8 out of 12, respectively) look up guidelines and protocols as well as rules of thumb at least once a week. Eleven out of 12 co-assistants consult reference books and patient records on a daily basis. These results also show the diversity of information sources that co-assistants need in their daily work. They call upon these various information sources not only frequently but also in various situations: when recording the status of the patient, when writing a patient report, when preparing a work shift or visit, and when writing a prescription. In addition, co-assistants look into patient records, reference books and guidelines, and protocols during consultations. Few resources were consulted at the patient's bedside; in this situation, one co-assistant looked at patient records and two co-assistants consulted rules of thumb. In response to our survey questions on whether a PDA could be a valuable tool in accessing information sources, 11 out of 12 agree or strongly agree when it concerns accessing reference books, guidelines and protocols, and rules of thumb. With respect to the use of a PDA for accessing patient records, the co-assistants are less consistent: five (strongly) disagree, whereas five (strongly) agree with the usefulness of a PDA. This diversity in answers might be related to current privacy debates on patient records in health care.

The results of the pilot give further insight into the actual and potential role of a PDA in searching for information. The co-assistants who participated received a PDA during their internships and had no obligations regarding its use. Only one out of the five co-assistants started to use the PDA on a daily basis. The others used the PDA only several times during the 3-month period. In almost all instances, the purpose of using the PDA was to search for information. The co-assistant using the PDA most frequently for searching information commented on its value as follows, in the interview after the pilot:

I mainly used the content-related programs, which I found were the most useful. For instance, there was a useful list of disorders, which gives additional information. When you are dealing with a patient it is easy to access that list and decide on the right medication together. It is also handy when



you have a laboratory result and you want to find out what you can do in terms of additional laboratory research.

As with this co-assistant, the others in the pilot emphasized the value of the PDA in terms of “just in time, just in case” education. An example follows:

The interaction with HIV medicine is very useful, as you can search very easily and then you know right away. And it was the same with the NHG standards [i.e., formal standards agreed by the National Foundation of Medical Practitioners]; I could easily see whether they contained some advice and whether I had done the right thing.

An important factor contributing to the use of the PDA for the purpose of information gathering was the fact that it had more material than a regular personal computer. One participant noted, “I could not find that program on the computer, but I did find it on the PDA and that worked really well,” and another stated, “If you would like to find an answer really quickly, a PDA is easier than a PC.”

Conversely, it becomes clear from the interviews that the most important explanation for not using the PDA as frequently as possible is the availability of other tools of support, with the PC at work and at home mentioned as primary tools. One co-assistant estimated she used the PC on average 2 hours a day to look up information. Although co-assistants commonly need to share the PC with peers doing an internship in the same department, four out five in our pilot happened to have a PC available full time. Only the co-assistant using the PDA daily noted having very limited opportunity to sit at the shared PC. This suggests that the spontaneous and frequent use of a PDA is at least partly related to the lack of other supporting tools.

Besides a PC, the co-assistants mentioned other tools they used for important information. Co-assistants all carry pocket book(s) as reference for diagnostic activities and for basic medical standards. Some noted it was easier to look up information in such books compared to a PDA. This ease was related to personal comfort with the book as a medium and its physical make-up. One participant expressed this comfort as: “I am a paper person,” another stated, “In books it is easy to turn the pages and keep the overview so that you can see where you are in the book.” In contrast, the PDA was not considered to offer a suitable structure for searching information:

The information programs on the PDA are less handy when you are looking for an idea. For instance, when you do not know what is wrong with a patient, you want to search for a complaint or clinical symptoms and not for anything specific. If such a program were to be installed, that would be possible.

When asking for a possible correlation between the use of the PDA and the presence of others, all co-assistants stressed that they would not hesitate to use a PDA in the presence of other co-assistants or doctors. However, the four less frequent users indicated they did not want to use a PDA beside the bed of a patient. Three co-assistants indicated that this situation did not allow the time for using PDA functionalities. One co-assistant indicated that she did not feel comfortable using the PDA in the presence of the patient due to a lack of skill with this medium:

I did not use it in the presence of patients, because I am not very good at quickly finding information in the PDA. Also I did not want to seem to be trying to impress the patient by using a mobile device. When there is a question from or about a patient I would rather say that I will find out and get back to them.

When asking the co-assistants from the pilot about the potential role of the PDA in searching for information, in the interviews and questionnaire, most co-assistants were positive regarding searching reference books (four), guidelines or protocols (four), and rules of thumb (three). As in the survey, the co-assistants were negative about accessing patient records by means of a PDA.

The contrast between the potential and actual role of the PDA in searching for information can be explained by the aforementioned reasons. The co-assistants' elaborations on using other tools, such as a PC and pocket books, and not using a PDA in front of patients, all indicate a common way of working. This common way of working seems to be enhanced by the structure offered to them in the workplace, but also by their inexperience with using a PDA.

### **Taking Notes**

Besides facilitating searching for information, a PDA enables note taking for certain kinds of information. In our preparatory phase, it appeared plausible and potentially relevant to note several types of information.

The survey revealed that taking notes occurs frequently—specifically for “to-do” items (all 12 on a daily basis) and questions from colleagues or patients (9 out of 12 on a daily basis), but also for personal reflections (7 do this once a week). Three co-assistants reported not noting any reflections, as two reasoned that it is not necessary to write down reflections and one indicated that there are other situations to reflect, such as patient evaluations and presentations. Similar to when they are searching for information, co-assistants take notes when recording the status of the patient, when writing a patient report, and when preparing work shifts or visits. However, an important difference is that co-assistants also report at the bedside of the patient. In this situation, 7 of the co-assistants report to-do items, 8 report questions received, and 3 report personal reflections.

On the usefulness of a PDA in supporting the notation of to-do items, questions, and personal reflections, most co-assistants (respectively, 8, 7, and 6) strongly agree, whereas a small group (respectively, 2, 2, and 3) co-assistants disagrees.

When asking the co-assistants in the pilot about the actual use of PDAs for taking notes, only one indicated having used the PDA for taking notes, specifically for the to-do items because of the ease of listing and ticking off tasks. The four other co-assistants did not use the PDA for taking notes. The explanation they give for not using the PDA is threefold. First of all, they state that they use other tools during the shift, such as paper notes and daily patient records that are designed with open text spaces for notes. Second, they indicate that they have little time in their work to make notes:

No, I would be far too busy to use a PDA for preparation. The supervisor would usually arrive by one o'clock. I would have just seen the patients, so I would still remember all the details, but I would not have had time to update the charts, for instance.

Third, they also report discomfort with the PDA for taking notes. One stated that digital notes would end up in chaos.

The potential usefulness of a PDA in supporting specific note taking appears to exceed their current use of the PDA. Two are positive about using the PDA for keeping track of to-do items, work activities, and time spent on these activities; two are positive about reporting questions from patients or colleagues; and three are positive about writing down personal reflections by means of a PDA. These results suggest that using a PDA for taking notes is hampered mainly by a lack of time for reporting and by the use of other more familiar tools.

### **Recording Activities/Data Logging**

Most PDAs have a voice recorder to record sound. In the preparatory phase, it became clear that most relevant and plausible recording activities in clinical work could be recording of patient sounds (e.g., heartbeat, breathing, or coughing), but also making records of conversations with others or dictation of letters and notes to transcribe or have an administrative assistant transcribe. Recording enables the gathering of relevant and concrete material for future reflection in certain patient cases or reflection on the way one communicates with different actors as a novice professional.

In comparison with informing and reporting activities, the survey shows that recording activities are the least used. Only two co-assistants reported recording patient sounds; one indicates doing this on a daily basis and one on a monthly basis. Only one co-assistant records conversations. The only recording activity that frequently took place was dictating letters for future transcription; six did this on a daily basis.

The responses about the potential role of a PDA in recording activities give a varied picture: three agree, four are neutral, and five disagree about the usefulness of recording patient sounds. For recording their own conversations, three agree, four are neutral, and four disagree. These varying results may represent doubts about whether it is realistic to expect such recordings to be allowed and become part of clinical work. Co-assistants are also diverse in their opinions about whether PDAs are useful tools for dictating letters: seven agree and five disagree. The co-assistants in the pilot did not use the PDAs for recording but continued to use independent voice recorders. They explained that the PDA was not part of their routine behaviour, whereas using the voice recorder was. In addition, they doubted whether they could hand the recordings on the PDA over to the administrative department for full transcription as easily as recordings from their voice recorders. Although they did not use the PDA for recording activities, the pilot participants did see its potential, mainly for enabling the dictation of letters.

### **Communication and General Potential**

In our preparatory phase, participants indicated that mobile communication with others by phone or e-mail was a possible work-based learning activity a PDA could support (see Table 1). Although mobile communication was not part of our experiment due to the legal restrictions in the hospital, we asked the co-assistants in the survey as well as the co-assistants in our pilot about whether they could see a potential role for PDAs in facilitating mobile communication. Taking the results of the survey and pilot questionnaires together, we find that only a small group perceived a PDA as a useful support for communication: 5 out of 17 co-assistants confirmed its usefulness for communication with other students; 3 saw its usefulness for communication with patients; and 3 thought it had potential for communication with colleagues, experts, and teachers. Others were neutral or disagreed on the usefulness of a PDA with respect to communication.

In addition to the listed potentials of a PDA, three co-assistants in the survey saw other possibilities. One co-assistant noted the possibility of taking a visual image of a symptom of a patient (e.g., skin problems) in order to directly add it to the electronic patient record. Two others noted a role of a PDA as a notebook of relevant matters and knowledge encountered during practice for later reflection.

Generally, all co-assistants marked in the questionnaires that they saw value in the PDA and indicated interest in using a PDA during their internship and future work. Six out of the 17 stressed the portability, mobility, and unity of functionalities of the PDA. Several co-assistants (6) also mentioned its particular value for accessing and exchanging information. One co-assistant wrote in the questionnaire that it would enhance students' knowledge and would be in the interests of patients.

There seems to be a contradiction between the positive attitudes toward the PDA expressed in the survey and pilot interviews and the lack of frequent use in the pilot. In the pilot interviews, the co-assistants explained that they would work with the PDA more frequently when they had more time to learn to work with it and could make it part of their routine:

Now this PDA has been added, while everything is still so new. If I were to continue using it I would probably create a structure, a routine, and files which would make things easier.

### Conclusions

In response to a lack of studies on the role of mobile technology beyond formal educational contexts, this paper investigates the potential value of mobile devices in supporting work-based learning because of its interconnectivity across contexts. The study considers the potential value of mobile devices in the context of internships of co-assistants in clinical practice. Herein we explored the perceived potential as well as the actual role of PDAs in supporting a range of work-based learning activities.

Beginning with the perceived potential, the results show that co-assistants in both the survey and the pilot are most positive about the potential role of the PDA in searching for clinical information, such as reference books, guidelines or protocols, and rules of thumb. To a somewhat lesser extent, co-assistants are positive about the potential role of a PDA for taking notes, such as keeping track of what they need to do, writing down questions from patients and colleagues, and noting personal reflections during work. The co-assistants are diverse in their opinions about the potential role of a PDA to record patient sounds, conversations, and letters to be transcribed. This may be explained by the fact that only dictating letters is part of the current work, whereas making records of patient sounds and of conversations is not. And with respect to dictating letters, co-assistants currently use voice recorders, which they hand over to administrative assistants. Most co-assistants do not see the PDA as a valuable tool for communicating with others, perhaps because mobile communication is currently not allowed in hospitals and therefore not considered to be a realistic option.

We set up a pilot with five co-assistants to explore how they would actually use a PDA for these various activities when they were provided to them without any restrictions or obligations regarding use. The findings reported above reveal that one co-assistant used the PDA on a daily basis by, whereas the four other co-assistants used it only several times during the 3-month internship. The purpose of using the PDA was to access information that they could not find as easily in computer programs.

The pilot interviews offer several explanations for less frequent use than one would expect, based on the perceived potential of the PDA. First of all, they may have less motivation to use a PDA because of the variety of other

support tools available to them: the pocket books containing the most direct information, the departmental computer with several programs installed to search for relevant clinical information, the paper notebook to make notes, and the voice recorder for dictating letters. It transpired that the co-assistants did not start to use the PDA instead of these tools, even though they were carrying pocket books, a notebook, and a voice recorder, and having to go back and forth to the often shared computer to access information does not seem to be very efficient. This shows that the implementation of a PDA is a matter of changing a routine way of working.

With respect to the potential use of a PDA, we can conclude that there are perceived possibilities, but the actual use requires changing working routines. As we have seen in the pilot, this is not only a matter of individuals learning to use and be comfortable with a PDA, but also a matter of changing the support structure offered to them in the workplace. In addition, using a PDA just in time and just in case—for example, for looking up information when a question arises—requires finding new ways of interacting with patients and colleagues.

The lack of frequent use of a PDA in the pilot did not allow us to study its effect in supporting and stimulating work-based learning. Nevertheless, its daily use at various times and places and the use of many other support tools suggest that it enables better learning about diagnostic problems and clinical procedures. It also indicates that co-assistants have questions to be answered and reflections to be revisited. It is important to recognize this when thinking about the role of a PDA in supporting work-based learning.

Besides physically integrating the variety of tools used, we see two ways a PDA can make a real difference to current work-based learning processes. First of all, because a PDA allows access to an integrative set of resources when and where it is needed, it can turn current work-based learning processes during work into a more situated responsive and reflective process.

Second, a PDA, with its capabilities to log actions, save notes, and record data, could be used for revisiting co-assistants' questions, reflections, and recordings. It can thereby also enhance work-based learning outside of the work context. All that is automatically or deliberately stored on a PDA can provide material to be used in educational settings; for example, one can discuss with teachers and peers certain questions or problems encountered during work. But to achieve this second potential of a PDA for supporting work-based learning, not only do working routines need to be changed, but also work-based learning itself needs to be acknowledged and become a more explicit part of the internship trajectories that co-assistants experience. Clearly, the co-assistants in our study are now out there on their own to find their answers by means of a set of tools. There seems to be little support from others for dealing with and discussing their questions and reflections.

Guile and Griffiths (2001) argue that learning through work experience can be enhanced by following a connectivity model in which the role of education is to develop partnerships with workplaces and create environments for learning.

We propose that PDAs can function as potential boundary objects between college and work. Boundary objects is a term introduced by Star (1989) and by Star and Griesemer (1989) to describe objects that translate and combine ingredients of different worlds. PDAs are boundary objects in the sense that they allow continuous access to resources for situated, responsive, and reflective learning during work, and at the same time allow consolidation of patients' data and of questions and reflections for learning after and based on work.

Further research into the role of mobile devices in supporting work-based learning is needed. Though our study focused on PDAs, current smartphone technologies and the newest generation of tabloids (e.g., the iPad) should be considered as alternative mobile devices to support work-based learning. Besides aforementioned functionalities of PDAs, current smartphones have important advantages, as they are designed as feature-rich miniature multimedia computers with high-speed Internet connectivity, high-resolution digital displays, built-in video cameras, and easy-to-use touch screens. And, as Cochrane and Bateman (2010) point out, functionalities are increasing by a continuous design and development of specific applications that integrate Web 2.0 social software. In addition to technological advantages, smartphones seem to be replacing previous models of cell phones and are becoming increasingly familiar to people not only in a professional context, but also in private spheres. Nevertheless, in line with our findings on PDAs, Cochrane and Bateman (2010) find in their exploratory study of educational use of smartphones that there is still a cultural shift needed for both students and lecturers to ensure that students use this technology not only for work or private settings, but for learning as well. They have to be encouraged to use their smartphones differently.

On the basis of our findings, we propose organizing interventions in which students use mobile devices as boundary objects between college and work. This requires the involvement of teachers and workplace supervisors, commitment in changing working routines, and an attempt to turn internships into periods of and bases for work-based learning. This does not mean predefining the content and direction of work-based learning processes. Rather it means making explicit use of the naturally emerging questions and problems of students during work.

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### Author Notes

*Sanne Akkerman is an associate professor at Utrecht University. She is involved in research on the role of interactive media in the everyday lives of students and the role of technology in professional internships. One of her main interests is the way technology can bridge the processes of working and learning. Please address correspondence regarding this article to Sanne Akkerman, Heidelberglaan 8, 3508 TC Utrecht, The Netherlands. E-mail: s.f.akkerman@uu.nl*

*Renée Filius is a member of the support staff at the Julius Center for Health Sciences and Primary Care at the University Medical Center at Utrecht. She is a policy advisor specialising in education. More specifically, she works on the role of interactive media in education and how to facilitate and stimulate the way people learn. Please address correspondence regarding this article to Renée Filius, Postbus 85500, 3508 GA Utrecht, The Netherlands. E-mail: r.m.filius@umcutrecht.nl*

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