

Introducing and Adapting a Novel Method for Investigating Learning Experiences in Clinical Learning Environments

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ABSTRACT

The Contextual Activity Sampling System (CASS) is a novel methodology designed for collecting data of on-going learning experiences through frequent sampling by using mobile phones. This paper describes how it for the first time has been introduced to clinical learning environments. The purposes of this study were to cross-culturally adapt the CASS tool and questionnaire for use in clinical learning environments, investigate whether the methodology is suitable for collecting data and how it is experienced by students. A study was carried out with 51 students who reported about their activities and experiences five times a day during a two-week course on an interprofessional training ward. Interviews were conducted after the course. The study showed that CASS provided a range of detailed and interesting qualitative and quantitative data, which we would not have been able to collect using traditional methods such as post-course questionnaires or interviews. Moreover, the participants reported that CASS worked well, was easy to use, helped them structure their days and reflect on their learning activities. This methodology proved to be a fruitful way of collecting information about experiences, which could be useful for not only researchers but also students, teachers and course designers.

INTRODUCTION

Post-course questionnaires and interviews are methods, which are generally used to investigate how a course or a placement at a ward was experienced. One weakness of such approaches is that the respondents are asked to generalise about their experiences in retrospect instead of reporting on their learning as it occurs. Retrospective self-reports, are usually individually oriented, with a focus on the participants' beliefs about their experiences, which carry risks of overlooking problems, embellishing, exaggerating, or simply forgetting and other recall or social desirability biases. An alternative approach is to use moment-by-moment reports to capture on-going experiences just as the events have taken place [1]. To avoid the abovementioned kinds of risks, a novel approach, the Contextual Activity Sampling System (CASS) research methodology and the CASS Query application, have therefore been designed with the aim to provide researchers and users with means to collect frequent and systematic data on on-going learning activities [2, 3].

The CASS methodology is inspired by ideas stemming from the Experience Sampling Method [4] also called Ecological Momentary Assessment, which are used to capture and improve repeated self-reported data in natural environments in a minimally intrusive and maximally reflective way from individuals' on going impressions [1, 5, 6]. The Experience Sampling Method enabled a range of diaries by using different technologies, e.g. from paper-and-pencil to computerised personal digital assistants and mobile phones [7]. CASS is a context and process sensitive methodology for studying knowledge practices with a mobile tool: the CASS-Query tool is a Java application that runs on 3G mobile phones using the Symbian operating system, and a web based administrative server tool is used to set up studies: for construction of queries, defining questions and types of responses (free text, Likert scale, audio or video recordings and pictures). When participants start the application on their phones it connects to the Internet and downloads the intended query from the server and responses are returned to a server database from which data can be transferred to statistical software packages or spreadsheet programs [3, 8].

When using CASS the participants' learning activities are followed contextually by allowing them to report frequently about, e.g., experiences and emotions via their mobile phones by responding to questions defined by researchers, not relying on the aggregation of memories reported in a different context.

Research on academic emotions has suggested that conditions for 'optimal experiences' – "flow" – are highest when there are both feelings of high challenge in combination with feelings of adequate competence for managing a situation or task [9]. In contrast high challenge in combination with low competence can lead to experiences of anxiety whereas low challenge and high competence will result in boredom or possibly relaxation. Both low challenge and low competence will lead to apathy with difficulties to concentrate and learn. People enter a flow state when they are absorbed in an activity, lose sense of time and feel great satisfaction in it for its own sake. Csikszentmihalyi [4] and Fave and Massimini [10] have stated that the notion of, positive optimal experiences are a prerequisite for long-term effects on and support individual development and create a positive circle of appreciating the situation.

The CASS methodology provides a context and process sensitive methodology for studying emotions during activities with the opportunity of capturing the experiences of flow. The CASS research methodology and application have been developed in an European project

and have been used to assess university students' activities and their personal experiences of learning, collaboration and affects (e.g. stress, feeling of competence) [2, 8]. CASS has not previously been translated or cross-culturally adapted for use in other countries than Finland or used in clinical learning environments. The previous work has investigated issues about collaborative knowledge-creation [11]; i.e., students' collaborative construction of knowledge around shared objects (e.g., documents) beyond mere individual knowledge-acquisition or participation in cultural practices [12]. And while the previous work has typically had a focus on students in rather traditional academic settings a question is how such issues translate into clinical learning contexts.

The World Health Organisation [13] and its partners acknowledge that there is sufficient evidence indicating that interprofessional education enables effective collaborative practice [13]. Most health care students have clinical placements on hospital wards during their training. One such placement at our university is an interprofessional training ward (IPTW), which is a regular orthopaedic ward with nine beds. On the IPTW the students get a good opportunity to practise their clinical skills and apply their theoretical knowledge [14]. The aim of the course is to develop the students' professional roles and enhance their understanding of other professions as well as the importance of good communication for teamwork and patient care [15, 16]. There is however a lack of knowledge about the interprofessional interaction among the students' during the IPTW course.

Aims

The aims of this study were to cross-culturally adapt the original CASS questions, the CASS methodology, and Query application for use in a clinical learning environment in terms of language, content, interface interaction and logistics and, to investigate whether CASS is suitable for collecting contextualised data in a clinical learning environment and how it is experienced by students.

METHODS

The cross-cultural adaptation process is described first followed by the contents, context and procedures of the CASS studies. Thereafter the semi-structured interviews and statistical analyses are described.

The cross-cultural adaptation process

The CASS questions, which had previously been used in Finland [8], were translated into Swedish according to the guidelines described by [17] for cross-cultural adaption of self-report measures. Stage one in the adaptation process was a translation of the Finnish version of the questions into Swedish by two independent bilingual translators with Swedish as their native language. One of the translators was a researcher trained in medical education and one was a health care professional, trained and informed about the aim of the questionnaire. The two forward translations were discussed and differences were resolved by consensus. These versions of the Swedish CASS-questionnaires' items were given to two persons with Finnish as their native language for back translation into Finnish. Both of these translators were health care professionals, but only one was aware of the purpose of the translation or the use of the questionnaire. The translations were reviewed in a meeting attended by one of the forward translators and one of the back translators. Differences were resolved by consensus.

Beyond linguistic adaptation the CASS methodology needed to be adapted into a clinical learning environment, which was done, based on the researchers' own observations and

experiences as well as on interviews with participants. Fifty-one students were encouraged to give feedback in individual interviews, share their experiences and opinions especially focused on experienced difficulties and benefits of using the CASS methodology. The first 26 healthcare students' experiences of and suggestions about how to improve the CASS methodology were discussed, considered and used as input for improving and refining the approach. The remaining students were also interviewed but these interviews did not result in additional modifications.

Contents of the CASS questionnaires

The focus of the original CASS questions [3] was on learning contexts and experiences as well as on the students' affects during courses [8]. To a large extent many such questions could be used but a number of questions needed to be created or adapted to a clinical learning environment. Academic emotions such as feelings of competence, commitment, challenge and importance were addressed by asking the participants to rate on a Likert scale of 1–7. Moreover, the PANAS scale [2, 18] was used to address positive affects (interest, enthusiasm and resoluteness) and negative affects (irritation, anxiety and nervousness) with the same Likert scale. To address interprofessional issues they were also asked to describe how they thought their collaboration with other students in the team was working out, if they had had any problems and also to make suggestions about how to improve collaboration (free text answers).

Each morning the participants were asked to describe the plans they had for their study day and, in the evening, to report how they had experienced their day (free text answers).

Three types of questions were used in the questionnaires: (a) free text answers with up to 1000 characters, e.g. 'What is the most important IPTW activity you will take part in today?'; (b) Likert scale ratings (1–7, with 7 indicating the maximum), e.g. 'Do you feel competent in this situation?' and (c) multiple-choice questions, with stated alternatives, e.g. 'Where are you right now? (in the emergency ward, patient room, bathroom or at a medical conference (round))'. And they were also given the possibility to take a picture of the context they were in when responding.

Context of the study and the participants

During a two-week mandatory course on the IPTW, teams consisting of medical students (n = 1–2), nursing students (n = 2–3), occupational therapy students (n = 0–1) and physiotherapy students (n = 0–1) are responsible for medical, nursing and rehabilitation care under the supervision of their occupation-specific tutors. On the IPTW a new group of students begin the course every two weeks and each group is divided into three teams of 5–6 students. Two of these three teams were randomly assigned to be presumptive participants in the present study.

A total of 63 students were approached during the study period and 51 (81%) agreed to participate. Of these, the last 25 students were asked to also rate their experiences in the post course interviews about how difficult or time consuming CASS was to use. The most common reason for non-participation was fear of stress owing to other mandatory activities during the course. Nineteen of the 51 participants were medical students (12 females), 21

were nursing students (18 females), 6 occupational therapy students (6 females) and 5 were physiotherapy students (3 females) aged 22–51 (Table I).

Table I. Students participating in this study during 2009

	Medical students Total (♂/♀)	Nursing students Total (♂/♀)	Occupational therapy students Total (♂/♀)	Physiotherapy students Total (♂/♀)	Total (♂/♀)
n	19 (7/12)	21 (3/18)	6 (0/6)	5 (2/3)	51 (12/39)
%	37	41	12	10	100
Of the 51 students in this study, 25 students were asked to also rate their experiences in post course interviews about how difficult or time consuming CASS was to use.					
n	10 (5/5)	11 (2/9)	3 (0/3)	1 (1/0)	25 (8/17)
%	40	44	12	4	100

The students were informed (orally and in writing) about the study design during their introduction session on their first day of the course. They were told that their participation was voluntary and that the results would only be used for research purposes and would not have any impact on course gradings.

The study was approved by the Regional Ethical Review Board, Karolinska Institutet, Stockholm, Sweden (Dnr: 008/1769-31/2).

Procedure for using CASS

The participants were provided with mobile phones and given short instructions (oral and written) on how CASS functions. CASS questionnaires were available on the participating students' mobile phones five times each day on the IPTW (one before the beginning of the workday, three during the workday and finally one after completed workday), i.e. each student was asked to respond to 30-40 questionnaires during the course depending on the number of study days (six to eight) at the IPTW. In total 1788 CASS questionnaires could have been possible to obtain if the data collection had worked without any problems and if there had not been any absence among the students. But because of technological difficulties such as failing server connections and weak mobile signals and because of absence due to illness 1021 questionnaires were available for downloading by the students.

The students connected to a database server by using the CASS Query application and retrieved the questionnaires. After answering, the data automatically returned to the database server. Data collection was administered with the web-based CASS-Admin application, which stored, viewed and uploaded collected data results, which were then downloaded for post-processing. Data were available thereafter for statistical analysis (e.g. using PASW and Excel).

Semi-structured interviews

At the end of each course, semi-structured interviews were conducted (by HL) individually with each participant. The interviews were aimed at getting a deeper understanding of the use

of CASS in a clinical learning environment. The interviews lasted about 30 minutes and were recorded, to which none of the participants had objections.

First, the students were asked to report how they felt about CASS as an instrument and method and also to comment on the relevance of the CASS questions. Thereafter, they were asked if participation was a negative or positive experience, if they had been stimulated or interrupted in any way by CASS in their duties during the course. The last 25 students that participated in this study during the autumn of 2009 were asked to also rate whether it was difficult or time-consuming to use CASS.

The texts were transcribed verbatim and analysed by qualitative content analysis, going through them word by word to seek the meaning of the students' experiences [19, 20]. The text was sorted into 'meaning units' with similar content and then combined into themes to clarify the students' experiences. Each theme was named on the basis of the meaning units. To ensure the trustworthiness of the study, the content areas and themes were discussed within the research group until consensus was reached [19, 20]. The main findings are illustrated by quotations (translated into English).

Statistical analysis

Descriptive statistics were used in this study. Likert scale data were treated as ordinal data in the statistical analyses and presented as means, medians and standard deviations.

RESULTS

The adaption will be discussed first followed by results from data collection using CASS and user experiences.

Translation and cross-cultural adaptation of CASS

During the cross-cultural translation and adaption a number of challenging issues were brought up which needed to be tackled because these risked leading to that the questionnaires were misunderstood. Stylistic issues in the language needed to be discussed at length to balance the objective of finding the most correct translation with the – sometimes conflicting – objective of finding usable and comprehensible formulations in the target language. These concerned nuances in the language used such as avoiding unusual expressions even though they were closer to the original translation and ambiguities when translating between two quite different languages. Since words in different languages may emphasise different aspects – languages have different "semantic structuring" – direct translation between words becomes difficult or even impossible and decisions therefore had to be made as to which expressions would best reflect the intended meaning of the words to be translated. The process also provided an opportunity to remove vagueness and to simplify language.

When words, which are less usual in the source language, were back translated these tended to result in several alternative words rather than the original one. In such cases the question was whether the right translation had been found since ideally, in the chain of translations, the original word would appear in back-translations. And should an equally unusual word be selected in the target language? For example, a direct translation of the word 'excitability' (in Finnish: *ärtyneisyys*) results in a word, which is uncommon in Swedish everyday language (*retlighet*, cf. *testiness* in English). For stylistic reasons and for the sake of comprehensibility, we decided to replace it with the word 'irritated' (in Swedish: *irriterad*),

which is a more common word. Also, word classes needed to be adjusted even though this meant diverging from the original Finnish formulations which used nouns consistently but were experienced as less smooth in Swedish (cf. feeling irritated rather than feeling irritation).

Ambiguity issues were occasionally tricky to resolve - when several different words corresponded to the original word it was sometimes difficult or impossible to select a word that would render the original word when translated back to the source language. Words in the original language sometimes corresponded to more than one possible word with different meanings when translated to the target language. The word 'obligated' (in Finnish: sitoutunut) could after translation be misunderstood as meaning being 'forced to' and not capturing the students' feelings of commitment to their tasks which the Finnish word carried. This became evident during back translation to Finnish since the translations now only emphasised compulsion and duty rather than commitment or engagement. We had to select a word which best captured the essence of the original question and we therefore chose the word 'engaged' (in Swedish: engagerad) instead even though it does not perfectly reflect the entire meaning of the original word.

A related issue was that direct translations of certain words were experienced as too specific or too technical in Swedish. Therefore a more common word had to be chosen although the word was literally not a direct translation but instead more comprehensible. One such example was the word "vuorovaikutus" literally meaning "interaction" which in Swedish has a more technical ring to it. Therefore a more common word (in Swedish: samarbete, in English cooperation/collaboration) was chosen for the sake of comprehensibility although the word was further from the direct translation.

The translation process not only involved a series of problems and challenges, the process itself improved the material. Vagueness was noted during the translation process and the language was improved and simplified so that the translations became shorter or more precise. For instance, "paid work" was simply replaced by "work" as it was not relevant whether work was paid or not. "How important is this to you" was modified into "How important is what you are doing right now to you" which thereby more explicitly related the question to the responders' current activities which is central to the approach.

Cross-cultural adaptation of CASS for use in clinical learning environments

Beyond translating from one language to another, the cross-cultural adaptation also involved dealing with a number of issues that pertained to adapting CASS to a course in a clinical learning environment. Some questions needed to be contextualised to the clinical learning environment: e.g., when asking questions about who students were interacting with we replaced options about teachers, friends, partners, family members etc. to patients, team supervisors, profession-specific supervisors etc. Similarly, the options to the question "Where are you right now?" were replaced by more contextualized options; instead of lecture/seminar, small group/ library/coffee shop-restaurant/home, traveling/at work/carrying out a hobby/at a friend's place we used emergency ward / clinic reception/showers/conference room, patient room/staff room/x-ray round). The choice of wordings was not just a stylistic issue or a matter of contextualising and we observed that it affected user behaviour in a concrete manner. Schedules at an IPTW may be irregular compared to the schedules of regular university courses and therefore following the original phrasing sometimes led to that students would misunderstand and refrain from responding. E.g., because the first questionnaires were labelled "morning questionnaires" students reported that they refrained from responding to

these if their workdays were scheduled to begin in the afternoons. And using a greeting such as “Good morning!” was for the same reason confusing, as they believed that they had received the wrong set of questions.

When collecting students’ experiences with CASS there is a possibility to ask them to take a picture of the activities that they are currently engaged in. This may work well in more traditional university courses but turned out to be difficult in a clinical learning environment. Students were not allowed to take photos of patients so this possibility could unfortunately not be used to any significant extent and the photos that were taken were often taken in the coffee room and therefore of less interest.

Since the original CASS questions were developed for more traditionally oriented academic learning contexts, some questions needed to be adapted to the specific clinical learning environment. The previously used questions addressed knowledge-creation activities among students [3, 8]. Some of these questions did not make any sense for students in a clinical learning environment, e.g., rating a statement such as “I am developing an idea or product” was simply not applicable in a clinical learning environment. Instead such questions had to be reformulated to be meaningful on an IPTW. One important learning objective of the IPTW course is that students develop their understanding of interprofessional collaboration and therefore questions with a focus on such issues were developed instead. After discussion within the research group, a new question, namely ‘By reflecting on what I’m doing now, I will support my team in developing our understanding of interprofessional collaboration’, was chosen to replace the original one, which is more in line with the learning objectives of the IPTW.

One of the challenges when adjusting CASS to clinical learning environments was to find a good sampling strategy to adjust the questionnaires to the schedules of a clinical course. In the original studies [3, 8] fixed times of the day were used to collect data from the students, but this was not possible in the clinical learning environment as the students had irregular schedules on the ward. Instead, another data collection strategy was adopted: data were collected at fixed intervals of time: the questionnaires were made available at all times and the students determined when the first questionnaire was to be filled in. This approach was a more flexible solution for students with irregular schedules.

When CASS was tested another related problem emerged, however: instead of completing the questionnaires at fixed intervals, some students would postpone their responses to coffee breaks. This was problematic as the data would then again either constitute the students’ retrospective accounts of what had happened previously rather than the immediate contextualised data we were searching for or the students would not respond to their experiences at the fixed time intervals and only respond to how they experienced the coffee breaks rather than the other activities on the ward, in which we had a special interest. The fact that the students used CASS to document photographs of their coffee cups confirmed that at least the latter was true.

As it was understandable that students who were taking blood samples or participating in medical conferences were unable to stop such or other demanding activities to respond to questions several times a day, another solution was needed. By using the mobile telephones’ sound and vibration signals, students were reminded to respond and at the same time the signals helped them connect their replies to specific activities in which they were engaged. If it was not possible for them to respond immediately, they were instructed to respond as soon

as possible and to have in mind the specific situation and activity that they were engaged in when they observed the reminder signal, thus providing concrete support for connecting responses to specific situations, even if they were unable to respond promptly. Furthermore, the number of questions was limited and the lengths of texts in the questionnaires were reduced for speedy reading and responding.

The use of the contextual activity sampling system (CASS)

The overall response rate to CASS questionnaires ended up being 95% (n= 974) of the available questionnaires (n=1021). The total number of available questionnaires was lower than it could have been because of technological difficulties, such as failing server connections and weak signals from the mobile operator at the hospital and because of absence due to illness among participating students (Figure 1).

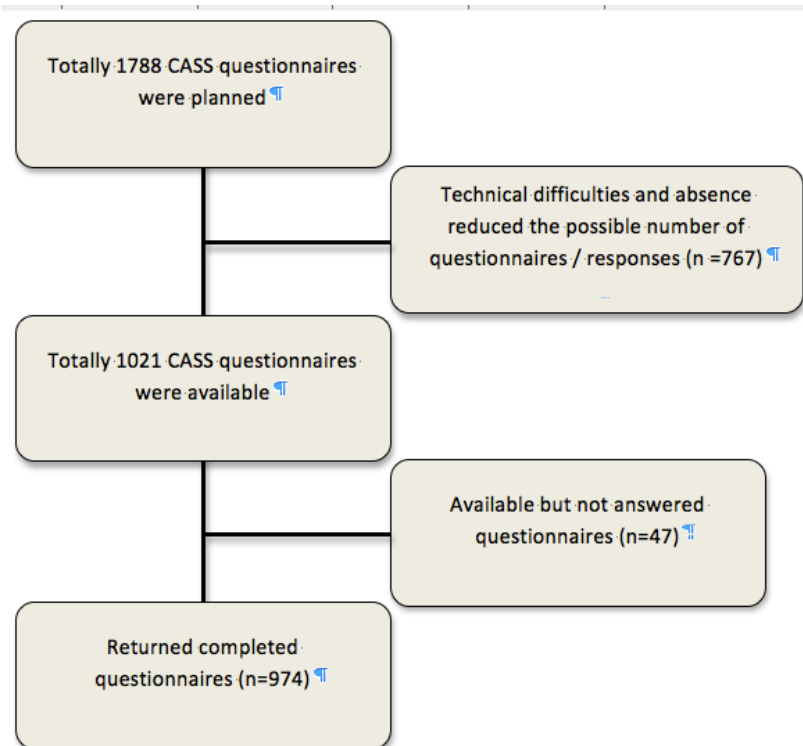


Figure 1. CASS questionnaires during the study

The question asking what students were doing was answered by 98% and the questions related to feelings (e.g. challenge, anxiety) by 96% of the students. There were no significant differences in the response rates between the students regarding gender or age.

Data collected via CASS

Data collected by the CASS method can be visualised by graphs showing each student's experiences in relation to activities that they participated in over a time period. Figure 2 shows this type of data for one student during three days of the course, i.e. the student's clinical activities are connected timewise to his feelings of interest, competence, challenge and stress.

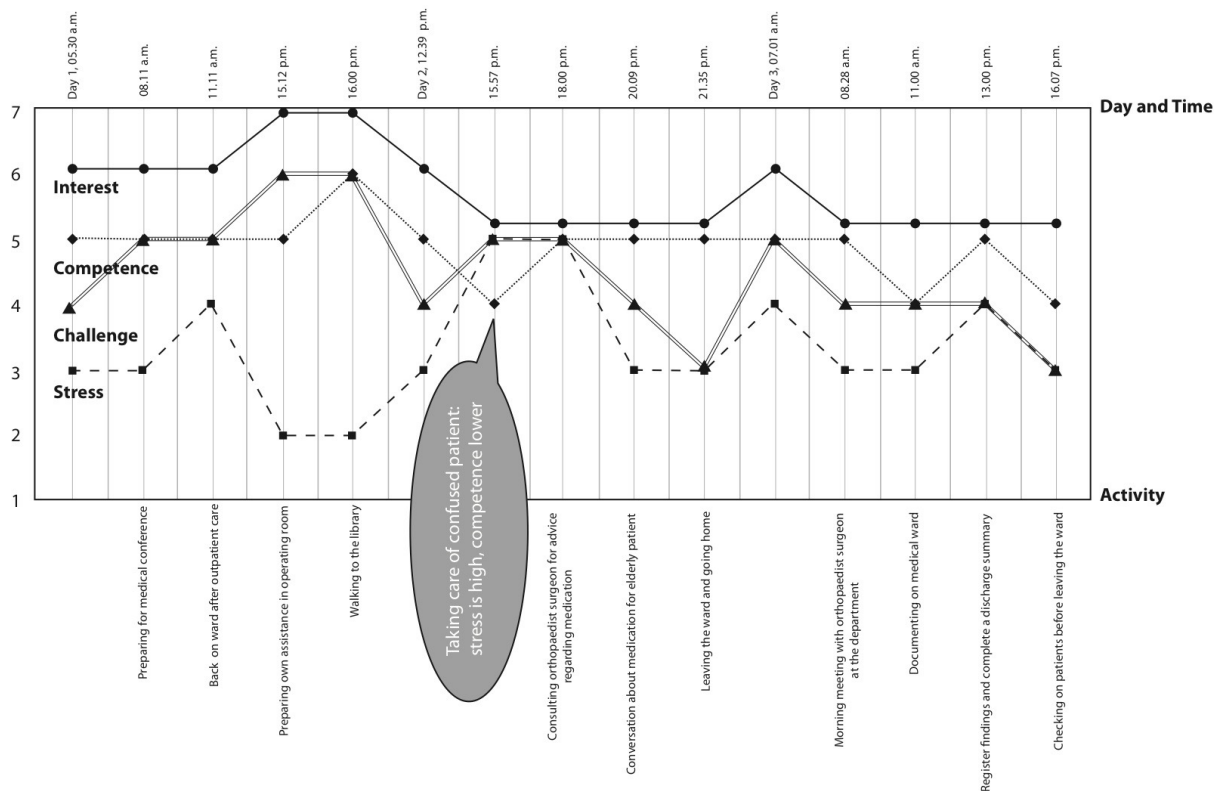


Figure 2. Data collected via CASS on one student during three days of the course (time at the top of the chart). The student's ratings on a Likert scale (1–7, with 7 indicating the maximum) of his feelings of stress, challenge, competence and interest (horizontal lines) during different activities (bottom of the chart). For example, the time point when the student reported that he was taking care of a confused patient and that he felt stressed and somewhat less competent is marked on the chart.

This method captured data that were not, and probably could not have been, collected using questionnaires or interviews. The collected data showed that students occasionally responded that they were challenged / stressed when using CASS, but in the post-course interviews they did not bring this up, or even recognise or admit such experiences. When using CASS students would make comments like the following:

I feel a bit anxious and nervous because I don't know what is going to happen, and if I will manage the tasks. (Occupational therapist [OT], female, age 31).

While the same students in the post-course interviews stated, for instance:

...the level and challenge was just right for us. (OT, female, age 31)

The students took the opportunity to write free text responses if they had something particular to reflect on; they made comments on the course and teamwork, which they did not refer to in the post-course interviews. Here are some of their comments:

In the open-ended CASS question during the IPTW course the OT-student (female, age 27) wrote:

Collaboration with the tutor doesn't work; I feel stressed by the situation, feel forced to answer her questions.

And in the post-course interview, the same student said:

...the collaboration has worked out well and we complemented each other... (OT,

female, age 27),

One nursing student [N] (female, age 34) wrote in one open-ended CASS question:

Most frustrating is that you learned one thing, but here it seems wrong, different information to what I learned in school.

In the post-course interview the same student did not bring up such problems:

...it has worked incredibly well from the beginning. (N, female, age 34).

Students' experiences of using CASS

Some of the students reported being worried about using the CASS-mobile technology, but after answering the first questionnaires they felt that it worked out well. They felt that it was easy and that answering questionnaires could be done swiftly, partly because the response times were kept short, three to five minutes per questionnaire and that the questions were repeated so as to allow them to become familiar with them.

The semi-structured interviews revealed that some students did not download CASS questionnaires because they had left their mobile phones at home and some because they had been too busy on the ward.

There were some technological difficulties such as failing server connections or a weak signal from the mobile operator at the hospital, which decreased the students' interest in participation.

The content analysis of the interviews regarding the students' experiences of using CASS during the IPTW course resulted in two themes and four subthemes, namely:

- 1: 'Usability' with the subthemes: Easy and Structured
- 2: 'Reflection' with the two subthemes: Planning and Evaluation

The usability experiences can be illustrated by the following quotations concerning experiences of using the CASS:

...it has worked out well, I have not had any problems... (Medical student [M], male, age 25),

...no problem, simply structured... (Physiotherapist [PT], female, age 23).

The participants felt that CASS helped them to plan their workdays and to reflect over the tasks they were doing, with whom and why. Routinely engaging in reflection during study days was a positive experience.

... I have evaluated myself several times a day and have thought about what, and why I'm doing things instead of just doing them on routine. (M, male, age 24)

...This is a good routine, neither hard nor complicated... (PT, female, age 23).

During the interviews the students were also asked if they felt being 'watched' when using CASS, but that did not seem to be the case,

If I have felt being watched, it did not have to do with the phone. (N, female, age 33).

The last 25 students were asked to rate the difficulty of using CASS on a Likert scale (1–7, with 7 indicating agreement) and gave a mean rating of 3.0, median 3.0 (SD =1.5, range 1–6) and when also asked if CASS was time-consuming, the mean rating was 3.6, median 3.0 (SD =1.4, range 2–7).

DISCUSSION

This study reports on the development of CASS for clinical learning environments. Despite some initial technological problems and logistical challenges, the approach was experienced as usable and promising. CASS provided interesting data about students' experiences especially when compared to the interviews that were carried out after the courses. There were striking differences in the responses via CASS compared to what was said in the retrospective interviews, e.g., displeasure with collaboration or the tutoring reported in the CASS responses was surprisingly left unmentioned in the post-course interviews. Such observations will be discussed further below.

After cross-cultural adaptation, CASS was modified and adapted and tested among health care students on an IPTW. A number of challenges were brought up during the adaptation process which needed to be tackled because these risked leading to that the questionnaires were misunderstood: these concerned nuances in the language used, ambiguities when translating due to semantic incompatibilities in the two quite different languages, and, avoiding unusual expressions even though they were closer to the original translation. The choice of wordings was not just a stylistic issue but affected user behaviour in a concrete manner: e.g., following the original phrasing sometimes led to misunderstandings or even that entire questionnaires were left unanswered.

Moreover, beyond linguistic considerations, the CASS methodology and the query application needed to be adapted to a clinical learning environment in terms of content, interface interaction, and logistics and especially sampling strategy.

One lesson learned concerning the logistics of the methodology in a hectic clinical learning environment was that using reminder signals appeared to be important to help students who were busily engaged in their work to connect their responses to specific activities and thereby avoiding postponing responses. The reminder signal allowed participants some flexibility in responding, while maintaining the context of their responses by supporting them in keeping a specific point of time in mind. The situatedness [21] of the responses and the reminder signals in the context of everyday activities increase the ecological validity [22], which is one of the advantages of using CASS.

Moreover, the study showed that the students found using CASS easy. Even so, some of the students had fears about how to use the mobile technology before the study started but, fortunately, these fears were not confirmed. Our main concern before starting the study was that the CASS usage might bother the students in their clinical activities. By using the same kind of questions and scales in the frequent sampling, they quickly became familiar with the questions and the time spent responding was kept short: three to five minutes per questionnaire. And by using a discreet vibration signal we managed to remind students without disturbing the patients or the interaction with them. We were also concerned that

students would feel being monitored because they were asked to report in a detailed way about their feelings and activities. We were therefore careful to stress that the data would be treated anonymously and would not have any impact on their course grades. The post-course interviews showed that this approach appeared to be successful since the students reported not having felt being watched.

Nearly all their downloaded questionnaires were returned. Some students reported that the reason for not downloading a questionnaire was being too busy with patient care. Based on the interview data, two other reasons for not responding were also identified: leaving the mobile phone at home and technological difficulties in downloading the questionnaire. The first reason can be considered student-dependent and difficult to avoid while the technology-related failures were avoidable although introducing new technology always risks involving new problems. Even though use of CASS was generally not particularly time-consuming, server and application-related problems were noted, especially during the start of the study, thereby underlining the importance of continuous development of the technology.

The CASS questionnaires included items asking students to report experiences of challenge, commitment and emotions such as interest, determination and anxiety. The participants felt that it was more challenging to respond to questions about emotions compared to the other questions, due to the fact that their emotions are seldom discussed during a clinical course. Even so, 96% of these questions were replied to in the downloaded questionnaires.

Besides providing an opportunity to obtain important contextual information about the students' activities during a clinical course, the CASS methodology seemed to help them to reflect on their own activities, i.e. why, with whom and how they were collaborating. The Reflection theme emerging from the content analysis strongly supports this idea. Reflection is known to stimulate learning and support students in their professional development [23], and there are plans to use CASS for encouraging users to analyse and reflect on their on-going activities.

It was interesting to note that by using graphs (see Figure 2), the students' learning experiences could easily be connected to their activities at specific points in time. We believe that this type of data could be useful feedback for students or even be used as a basis for developing courses.

Especially interesting was the observation that with CASS we were able to collect data on the students' experiences, which we would not have been able to capture using traditional methods such as post-course questionnaires or interviews. Data on the students' experiences connected to specific activities were gathered throughout the course, and clearly it would not have been possible for the participants to report such data, and especially the level of detail attained therein, in retrospect. So, CASS provided both more and qualitatively different kind of data. The collected data revealed observations about the course experiences, which are not mentioned by the students in interviews after courses.

For instance, problems encountered on the ward, such as criticism concerning the team's collaboration or of the tutoring that were noted in the CASS responses were left unmentioned when such problems were asked about after the course. In several cases we noticed that students using CASS reported about experiences that they did not mention when asked about their experiences after the course. In one case a student had reported about

negative experiences of anxiousness and nervousness during the course, yet after the course such negative experiences were not mentioned at all and the same student stated instead that the level of challenge was just right for her. Another student had reported about collaboration problems when answering CASS questions. After the course the same student said that the collaboration had worked well and did not mention any of the collaboration problems. In a third case, a student expressed frustration regarding her learning. Again, the same student did not mention such frustration when interviewed in retrospect, instead she stated, "it had worked incredibly well from the beginning".

There are many possible explanations for such discrepancies. In some cases students may simply have changed their minds after a course. It is possible that the teams have found ways of handling problems and frustration in fruitful ways, or, that they have accepted or learned to live with the problems so that they do not find the issues important to bring up in the interviews after the courses.

Nevertheless it seems likely that in many cases when students are interviewed that they have forgotten details about their experiences and that they instead report an overall, generalised picture of their experiences from the course. If their overall picture is positive, negative incidents may be left unmentioned or overlooked since they no longer appear representative for their experiences of the course and perhaps vice versa. From a motivational perspective, students have less incentive to bring up negative experiences after a course, as it has become too late to do anything about them. However, from the perspective of researchers' or course designers there is much to learn from students' experiences - perhaps especially so from the negative or problematic ones - and CASS provides opportunities to capture details about such experiences, which may be difficult to capture with post-course questionnaires or interviews.

We readily recognise that it may be challenging to carry out studies with this kind of approach, but we also find it promising in several ways. On the one hand, the approach requires more planning than just handing out a paper based questionnaire. Data collection needs to be prepared in the administrative system, telephones are needed for the participants and the application needs to be installed on these. There is always the risk of technology breaking down, telephones being lost or forgotten at home or that network connections fail. The approach also requires a high level of commitment of the participants who may be busy with pressing activities at a ward. When participants are involved with taking care of patients there is not room for taking pictures or responding to questionnaires. And the approach generates large amounts of data, which can be time-consuming to analyse compared to more traditional questionnaires or interviews.

On the other hand, and despite these challenges a number of observations indicated that the methodology is useful, even in a clinical learning environment. As mentioned, high response rates were obtained which was encouraging and certainly not something that we took for granted. Taking photos did not work well in the sensitive environment and that possibility had to be dropped in the study. But apart from picture-taking the response rates were surprisingly high. From the reactions from the participants, we realised that CASS may be appropriate in a clinical learning environment precisely because they were quite busy during workdays: as they normally rarely had time to reflect and especially "in action" [24], they experienced the CASS questionnaires as welcome occasions giving structure to their reflection. With the various measures taken to adapt the methodology, many of the drawbacks

and challenges were diminished or avoided. Furthermore as almost all students have a mobile phone this gives good possibilities to use these as tools for capturing meaningful information about learning experiences in a systematic way while they take place.

CASS-based data-collection is in one sense vulnerable since it attempts to capture momentary experiences. If an occasion to respond is missed because of technological problems or because participants are too busy to respond at a particular time it is missed in a definitive way that is rarely the case for traditional questionnaires. Questionnaires can usually be handed in a day or week later than planned without seriously compromising analyses. And interviews can often be rescheduled if missed even though rescheduling is inconvenient. The strength of the CASS approach is the large amount of data collected from each person over time which provides robustness and compensates for lacking responses.

Introducing new routines like frequent responding to CASS queries may have a complex impact on the participants and their activities, which is difficult to get an overview of. The intrusiveness of the methodology and the problem of diverting participants' attention at a clinic have been discussed above. And, from the comments from the participants we have also learned that they were not only disturbed but sometimes, on the contrary, stimulated by the routine itself since it encouraged them in reflecting on their own activities.

We believe that the graphs and analyses that can be obtained through analysing the CASS data can potentially be very useful. Not only as interesting data for researchers, but also as input for discussion with respondents either during retrospective interviews or even better, regularly, during courses. This idea was supported by several of the participating students, which asked for such feedback. Generating such graphs and analyses is however time-consuming and another cost is that meetings need to be scheduled with the participants for discussing the results. If such occasions can be scheduled, the CASS data graphs can be a useful topic of discussion during, e.g., supervision, mentoring, feedback or debriefing sessions. There is of course the question whether the self-reflectiveness of the participants is permanent or just passing and lost after the data collection period [25]. Further studies are needed to answer such questions. There is also the risk that introducing a set of issues to focus on will control and limit the students' learning: we may achieve that students reflect on the issues that were highlighted in the queries but there may of course be other issues which are equally important but which now are not given due attention. A related risk is that responding to the queries becomes an overly routinized procedure, which no longer stimulates reflection. While none of the participants expressed such concerns we acknowledge the risk nevertheless. One possible way of addressing this risk is to always provide possibilities for free text comments from the participants and thereby opening for student-initiated topics to be addressed in the data-collection. Another way is to limit the data collection periods over time since the data-collection is so intense and thereby avoiding that reflection becomes too much of a routine. In our case a couple of weeks worked well. This relates to another issue; the methodology can potentially be useful for investigating development among students by utilising a more longitudinal approach where intensive data-collection periods are repeated, for instance, yearly [3]. This would offer the opportunity of letting the participants' feedback more directly influence the contents of the CASS queries in the new data-collection round. The obvious cost for such an approach is the extra work required. Finally, a tricky balance between query length and completeness must be found. Traditional questionnaires and interviews can be long and cover many areas because they are rare. CASS has the strength of

collecting large quantities of data per person over time through the repeated querying but at the expense of requiring relatively short and simple queries not to disturb and to ensure high response rates.

In sum, the CASS-research methodology provides promising opportunities for capturing students' experiences in the context of a clinical course, which otherwise risk going unnoticed. Moreover, the participants reported that responding via CASS gave them structured opportunities for reflection, and, interestingly, the CASS responses provided us with data, which was overlooked in post-course interviews. While post-course interviews and questionnaires are simpler to administer they rely on students' attempts to generalise over time from memory and thereby render frozen pictures of what has taken place in entire courses [1], the CASS methodology follows experiences over time leaving the generalisations to be done by the researchers. This study shows that CASS is promising also in a clinical learning environment.

CONTRIBUTORS

Hanna Lachmann participated in the study design, in developing the CASS method and in developing the questionnaire used in this study, collected data, performed the major portion of the analyses and wrote the draft paper.

Klas Karlgren participated in the development of the CASS method, had the main responsibility for the study design and for development of the questionnaire used in this study, participated in the data analyses and took part in writing of the draft paper.

Sari Ponzer and Unn-Britt Johansson participated in the study design, in developing the questionnaire, in the data analyses and also commented on the draft paper.

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DECLARATION of INTEREST

None.

REFERENCES

1. Reis, H. T., & Gable, S. L (2000). *Event sampling and other methods for studying daily experience*, New York: Cambridge University Press.
2. Muukkonen, H., Hakkarainen, K., Jalonen, S., Kosonen, K., Heikkilä, A., Lonka, K., Inkinen, M., Salmela-Aro, K., Linnanen, J., & Salo, K. (2007). Process-and context-sensitive research on academic knowledge practices: Developing CASS-tools and methods. *Computer Supportive Collaborative Learning: Mice, Minds, and Society. Proceedings of the Seventh International Computer Supported Collaborative Learning Conference*. In C. Chinn, G. Erkens, & S. Puntambekar (Eds.).
3. Muukkonen, H., Inkinen, M., Kosonen, K., Hakkarainen, K., Vesikivi, P., Lachmann, H. & Karlgren, K. (2009). Research on knowledge practices with the Contextual Activity Sampling System. *Computer Supported Collaboration Learning (CSCLS) 2009*. Rhodes, Greece.
4. Csikszentmihalyi, M. & Larson, R. (1987). Validity and reliability of the Experience-Sampling Method. *J Nerv Ment Dis*, 175, 526-536.
5. Bolger, N., Davis, A. & Rafaeli, E. (2003). Diary methods: capturing life as it is lived. *Annu Rev Psychol*, 54, 579-616.
6. Stone, A. A. & Schiffman, S. (2002). Capturing momentary, self-report data: A proposal for reporting guidelines. *Annals of Behavioral Medicine*, 24, 3; 236-243.
7. Feldman Barrett, L. & Barrett, D. J. (2001) An Introduction to Computerized Experience Sampling in Psychology. *Social Science Computer Review*, 19, 175-185.
8. Muukkonen, H., Hakkarainen, K., Inkinen, M., Lonka, K., & Salmela-Aro, K (2008). CASS-methods and tools for investigating higher education knowledge practices. *Proceedings of the International Perspectives in the Learning Sciences: Creating a Learning World, Proceedings of the Eight International Conference for the Learning Sciences (ICLS 2008)*. Utrecht, The Netherlands.
9. Csikszentmihalyi, M. (1990). *Flow, the psychology of optimal experience*. New York: Harperperennial Modern Classics.
10. Fave, A. & Massimini, F. (2005). The Investigation of Optimal Experience and Apathy. *European Psychologist*, 10, 264-274.
11. Paavola, S & Hakkarainen, K. (2005). The knowledge creation metaphor – An emergent epistemological approach to learning. *Science & Education* 14, 537-557.
12. Sfard, A. (1998). On Two Metaphors for Learning and the Dangers of Choosing Just One Educational Researcher, Vol. 27, No. 2. (Mar., 1998), pp. 4-13.
13. World Health Organization (2010). *Framework for Action on Interprofessional Education & Collaborative Practice*. WHO/HRH/HPN/10.3.
14. Hylén, U., Nyholm, H., Mattiasson, A. C. & Ponzer, S. (2007). Interprofessional training in clinical practice on a training ward for healthcare students: a two-year follow-up. *J Interprof Care*, 21, 277-88.

15. Reeves, S., Zwarenstein, M., Goldman, J., Barr, H., Freeth, D., Koppel, I. & Hammick, M. (2010). The effectiveness of interprofessional education: Key findings from a new systematic review. *J Interprof Care*, 24, 230-241.
16. Ponzer, S., Hylin, U., Kusoffsky, A., Lauffs, M., Lonka, K., Mattiasson, A. C. & Nordstrom, G. (2004). Interprofessional training in the context of clinical practice: goals and students' perceptions on clinical education wards. *Med Educ*, 38, 727-36.
17. Beaton, D. E., Bombardier, C., Guillemin, F. & Ferraz, M. B. (2000). Guidelines for the process of cross-cultural adaptation of self-report measures. *Spine (Phila Pa 1976)*, 25, 3186-3191.
18. Watson, D., Clark, L. A. & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: the PANAS scales. *J Pers Soc Psychol*, 54, 1063-70.
19. Graneheim, U. H. & Lundman, B. (2004). Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. *Nurse Educ Today*, 24, 105-112.
20. Polit, D. F. & Beck, C. T. (2008). *Nursing research : generating and assessing evidence for nursing practice*, Philadelphia, Wolters Kluwer Health/lippincott Williams & Wilkins.
21. Rohlfing, K. J., Rhem, M. & Goecke, K. U. (2003). Situatedness: The Interplay between Context(s) and Situation. *Journal of Cognition and Culture*, 3, 132-156.
22. Cormack, D. F. S. (2002). *The Research Process in Nursing*, Oxford, Blackwell Science, Inc.
23. Delany, C. & Watkin, D. (2009). A study of critical reflection in health professional education: 'learning where others are coming from'. *Adv Health Sci Educ Theory Pract*, 14, 411-29.
24. Schön, D. A. (1983). *The Reflective Practitioner: How Professionals Think in Action*, New York, Basic Books.
25. Hektner, J. M., Schmidt, J. A., Csikszentmihalyi, M. (2007). *Experience Sampling Method: Measuring the Quality of Everyday Life*. Sage Publications, Inc.