Application overlapping user profiles to foster reflective learning at work

Angela Fessl, Gudrun Wesiak, and Granit Luzhnica

Know-Center
Inffeldgasse 13
A - 8010 Graz
(afessl, gwesiak, gluzhnica)@know-center.at

Abstract. Reflective learning is an important activity of knowledge-workers in order to improve future working-behaviours. The insights gained by reflective learning are based on re-experiencing and re-evaluating past working situations. One time- and cost-effective way to support reflective learning is the employment of applications that collect data about working processes, store the data in user profiles, and visualise it in order to provide timely feedback to the employees. However, a single application can only capture part of the data that might be relevant for reflection and the parallel use of several applications leads to high demands on the user regarding the interpretation of relationships between several single visualizations. A combined visualisation of data captured by different apps should enhance the support for reflection about the working behaviour and experiences. This paper introduces an overlapping user profile application, which combines and aggregates data captured by various applications. The goal of this overlapping application is to provide higher-level reflection possibilities by combining visualisations of different application data in order to better induce and support reflective learning at work. A first proof-of-concept of such an approach indicates that a combined user profile application and especially it's visualisations can be beneficial with regard to reflective learning and can enhance the awareness about the multiple aspects of a user's work life.

Keywords: Work-place learning, reflective learning, awareness, user profiles, reflective data analytics

1 Introduction

Today's work environments are constantly becoming more complex, globally integrated, and knowledge-centric. This simultaneously leads to a stronger need of employees who are motivated and capable to reflect upon their activities and as a consequence adjust their working practices to new demands. Especially for knowledge-workers, reflective learning is an important activity to re-experience past situations during work and to learn from them in order to improve their future working-behaviour [2]. One possibility to motivate knowledge workers to become reflective practitioners is to support them with corresponding tools

or applications, which could be easily integrated into their daily work-life [14]. These applications have the task to gather data from work processes and to provide guidance for reflection in form of raising awareness and offering triggers with regard to unusual or extraordinary work related experiences or situations. In contrast to formal learning settings, reflective learning at the workplace deals with informal and self-regulated learning, where challenges like no additional working effort, easy integration in daily working routines as well as a clear benefit for knowledge workers have to be considered right from the beginning.

In order to support reflective learning at work, within the EU-funded project MIRROR (http://www.mirror-project.eu) several applications have been developed, which aim at motivating and activating users to reflect upon their individual working experiences. After the reflection process itself, knowledge workers should have gained some benefits or insights for themselves and as consequence derive and apply behavioural changes for future working situations. These changes should permanently improve and facilitate the handling of upcoming similar situations or experiences.

The applications developed within the MIRROR project have been applied within a wide range of working environments (e.g. care homes, hospitals, IT companies, and emergency situations) and support various sets of professionals (e.g. knowledge-workers, nurses, physicians and carers as well as emergency workers). Each of the developed applications collects and gathers different kinds of data and stores them in their corresponding user profiles. This data encompasses on the one hand information about the user. On the other hand it consists of information on users' work processes, which is captured automatically or inserted manually during the user's work. Examples are application switches, application usage and documents used while working on a PC as well as manually inserted data such as the current mood status of the user, individual notes, feedback on different working situations, ratings, scores of serious games or quiz results. The collected data is stored within the applications themselves and for some applications additionally in the so-called MIRROR Spaces Framework [20], an underlying data storage system for exchanging data between applications. In the spaces framework, the user's data is stored in the user profile and is accessible only by its owner. Each of these single applications visualises the data for the user in a sophisticated way with the goal to trigger reflective learning. However, user studies conducted in different environmental settings (e.g. [9], [16]) showed that single applications can only capture part of the data that might be relevant for reflective learning. Participants of these studies asked on the one hand for a better guidance to interpret the data in order to initiate reflection. On the other hand they wanted to see a clearer benefit for themselves, which would serve as motivational trigger to use the application and to reflect about the captured data. Thus, similar to research outcomes from the field of learning analytics, we found that a combination of data is often more adequate for successfully supporting users. Whereas learning analytics addresses self-reflective learning mostly as important aspect of self-regulated learning in formal learning environments, we focus on work-related reflective learning in informal learning environments.

With this paper we want to present a first approach on how to meaningfully combine and visualize data captured by different applications. The goal is to provide a greater variety of reflective learning opportunities in order to facilitate deeper insights on one's working experiences. We are aware that this approach raises privacy and security issues which need to be carefully considered when employing the app in a real working environment. However, for this first approach privacy and security were only of secondary interest, but will of course be treated in upcoming research settings.

Therefore, we developed the so-called "MIRROR Integrated User Profile" application (MUP App) which has the task to integrate, summarise, analyse, and visualise data captured by several different applications in order to induce and support reflective learning at work. For a first proof-of-concept, we used two different applications in parallel, namely KnowSelf and the MoodMap App. KnowSelf automatically captures work activities on a PC, whereas the MoodMap App allows knowledge workers to easily state their moods during a working day. We collected, aggregated, and visualised data from a small sample of knowledge workers to to get a first impression of users' interest and motivation and the app's usefulness. From this we derived the following three research questions:

- RQ1: Are participants interested and willing to use more than one application in parallel with regard to reflective learning?
- RQ2: Does the MUP App as overlapping application facilitate reflection about users' working experiences and contribute to raising awareness of multiple aspects of their work life?
- RQ3: Do participants perceive any individual insights or benefits for themselves?

2 Related Work

2.1 User Profiles

Since the terms user profile and user model are not always used in exactly the same way, it is essential to clarify our understanding and usage of the term user profile, which we base on existing theories regarding user models and on our understanding in MIRROR described by [15]. **User models** in general are models that computer systems have about their users. The data in such user models is automatically captured by the system and is mainly used in information retrieval and intelligent tutoring systems or user-adaptive learning systems (see e.g., [10, 1]). User models, which are utilised in learning environment systems for modeling the learner and the corresponding learning activities, are called **learner models**. These types of user models are created by the systems automatically and are not directly accessible by the users via user interfaces. Furthermore they are used to adapt teaching strategies or to inform the learner about the learning progress as basis for reflective learning. Additionally [3] suggested that learner models should keep data like knowledge, interests, goals, background, and individual traits, thus abstract concepts relevant for learning. In order to

apply a user model or learner model as basis for reflection on one's own learning activities, achievements, or progress towards the individual learning goals, it is necessary to make the models accessible and manageable for the user, which was explicitly suggested by [12] and mentioned in [4, 5, 13].

In MIRROR we prefer the term **user profile** (UP). Although the MIRROR user profile (MUP) is based on theory and research of user models, the term user profile better reflects its mission in MIRROR. First, the purpose of the MUP is to guide and support reflection by mirroring user data in the form of activities, experiences or artefacts of work, notes and insights, moods, work practices, and other concrete data sources back to the user. Secondly, we intended these user profiles to be created and maintained by a mixture of automated methods and manual management, where the process of editing or updating the data may also explicitly trigger reflection.

2.2 Learning Analytics

Although learning analytics is not in focus of our work, several approaches, methodologies and technologies of this research area are closely linked to reflective learning. Learning analytics deals with methods for analysing and detecting patterns within data collected from educational settings or learning environments about the learner, and leverage those methods to support adaptation, personalisation, recommendation, and also reflection. Siemens [21] defined learning analytics as *'the use of intelligent data, learner-produced data, and analysis models to discover information and social connections, and to predict and advise on learning'*. The focus of learning analytics is on the support of the learner in formal learning setting, while in our work the focus is to support the knowledge worker in an informal learning setting. Nevertheless, the parallel to our work is evident. Also approaches like learning dashboards for example described in [8, 19] present an overview of the learner's own learning activities and learning progress, and in relation to colleagues at one glance. Such combined visualisations support self-monitoring for learners and awareness for teachers as well as empowers the learners to reflect on their own activity, and that of their peers. Explicit traces (e.g. the learner's entries in a chat or a discussion forum) and implicit traces (e.g. the learner entering a course or clicking on a document) stored in the corresponding learner profiles serve here as basis for the aggregation and visualisation of the gathered data.

The main focus of learning analytics is to support the learner while learning in an educational setting or learning environment. Although learning analytics includes also reflective learning approaches (e.g. [18, 17]), our work can be clearly distinguished from these approaches by focusing on knowledge workers in real working environments and and to support reflection on working experiences or working artifacts in order to learn from them to improve future work.

2.3 Reflective Learning

Individual reflection takes normally place in every day's life and obviously also during work or work- related situations. Reflection may be triggered by different reasons for example by conflicts or problems, by unexpected experiences or by a person acting in a complete different way in comparison with the individual (external trigger). But also if an individual feels uncomfortable, for something bothers her or an inner voice is nagging, without being able to make this feeling external (internal trigger). As reaction, a reflection process may be triggered with or without the awareness of the person. This reflection should lead to an individual insight or outcome which may be used to guide or adapt future behaviour. Within MIRROR we follow the definition of [2], who define reflective learning as *'those intellectual and affective activities in which individuals engage to explore their experiences in order to lead to new understandings and appreciations'*.

Bringing this together, reflection is both a crucial part of learning and a response to past work experiences. These experiences as well as the behaviours of the individual engaged serve as starting point for the reflective process. The desired outcomes of reflection may lead to personal synthesis, integration of knowledge (internalisation), validation of personal knowledge, a new affective state or the decision to take on actions for future events. To achieve these results the characteristics of the individual (learner) have to be taken into account as well as the intention of the individual self. Individual reflection may occur spontaneous and unconsciously and in any possible situation especially then when it is not expected [6]. Of course it can also be consciously triggered by peers supervisors or by meeting created specifically for that purpose [7]. Within MIRROR we focus to initiate reflective practices with the support of technologies, which might automatically detect unusual working patterns and working behaviours and by making the worker aware of them in form of reflection triggers or explicit reflection guidance e.g. by means of prompts.

3 Examples of MIRROR Applications

In the scope of the MIRROR project a series of applications supporting individual reflection have been developed and evaluated in different settings [16, 9]. Some of the user studies showed that gathering and visualising data captured by single applications is not always enough to initiate reflective learning. To illustrate how the MIRROR applications support reflective learning, we want to shortly introduce two applications, namely KnowSelf and the MoodMap App. The same two applications will later be used as example for a possible combined usage and integration via the MUP App.

KnowSelf automatically captures work activities (used applications and resources together with the exact time of use) on a PC, provides simplistic project and task recording and presents an overview as well as different visualisations of the captured data [16]. Providing these visualisations regarding time use at work should lead to reflection on personal time management and potentially motivate to consider improvements in this respect. The user profile of KnowSelf

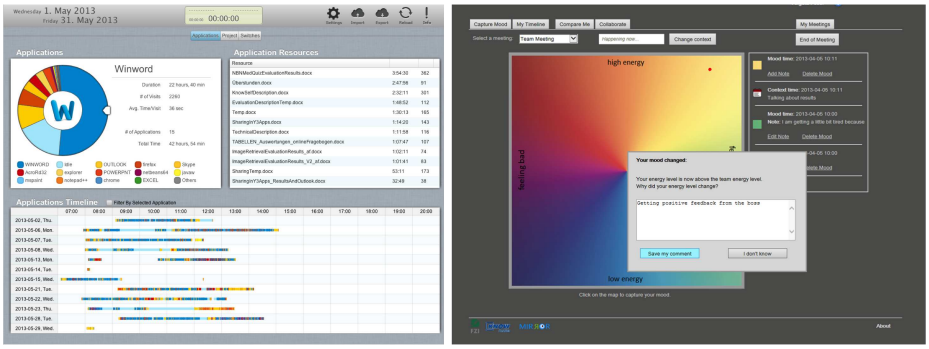

Fig. 1. KnowSelf (left) and MoodMap App (right)

is not a conventional user profile, because it consists only of user activities, but not of information about the users themselves. The application stores all work activities captured on the user's computer, including window focus and title, if applicable the system location (path) of the resource, focus switches, and idle time. Additionally the user can manually record time spent on projects or tasks and save observations. The collected information is displayed on a timeline and as statistics in the form of pie charts.

The **MoodMap App** is a web-based application, which allows knowledge workers to track their mood during a working day or virtual meeting and recapitulate their work experiences afterwards. The MoodMap App provides an easy-to-understand user interface to state individual mood points by simply clicking on a bi-dimensional coloured map. Each mood is composed of two dimensions, namely valence (negative to positive feelings) and arousal (low to high energy) based on the model proposed by [11]. Additionally, it provides several visualisations on an individual as well as collaborative level, to make users reflect on the mood development over time or to provide easy comparison possibilities of one's own mood with the mood of others for example colleagues or team members of the same team. The application related user profile stores information about the user, sharing settings for security and privacy issues as well as individual email settings. Furthermore, individual moods and inherent notes, corresponding meetings, context information of a day or meeting, as well as personal diary entries are stored in the internal user profile of the application.

4 The MIRROR Integrated User Profile (MUP)

Insights from evaluations conducted separately for KnowSelf and the MoodMap App led to the conclusion that single applications capture only part of the data that might be relevant for reflection [9, 16]. Although the developed applications proved to have high potential to trigger reflection at work, we wanted to go one step further. As a first step, we made triggers from different sources easily

accessible to the users, in order to further facilitate the reflective learning experience and help users to get more insights at one glance. Thereupon we developed the MIRROR User Profile (MUP) concept, which focuses on the combination of the captured data and corresponding sophisticated visualisations. An early prototype of the MIRROR User Profile Application (MUP App) was realised and tested with a small sample of knowledge workers.

4.1 Prerequisites for the MIRROR User Profile

In order to efficiently implement a common MIRROR user profile, it is of crucial relevance to use data captured and gathered by several MIRROR applications and not only by a single one. To achieve this, we employed the MIRROR Spaces Framework, an underlying data storage system developed within the MIRROR project to store and exchange data of the applications. For the development of a common user profile based on the MIRROR spaces the following prerequisites have to be considered: assumptions regarding (i) data, (ii) reusability, (iii) sharing, (iv) privacy and security, and (v) accessibility by the user interfaces.

Data stored in the MUP can be divided into three different types, namely personal data about the user, private data, and shared data. Personal data about the user consists of general information about the user (e.g. name or email address) and login information. For the data implicitly captured by the MIRROR applications (e.g. work history in KnowSelf) as well as data explicitly inserted by the user (e.g. mood in the MoodMap) it is essential that the user has full control over her data by deciding for each type of captured data, whether it is private or can be shared.

Reusability is one of the major potential benefits of the MUP. By storing the data according to a predefined data format, applications are able to reuse not only their data but the data captured by other applications and other users as well. Account information can be stored once in the user profile and then be used by all MIRROR applications.

Sharing data is of major relevance for reflection in order to provide possibilities for comparing one's own data with that of colleagues or a whole team. To account for different levels of sharing, settings (e.g. anonymised, sharing within the same team or department) should be very fine-grained.

As mentioned above **privacy and security** are a major concern when storing data in the MIRROR Spaces Framework. It has to be ensured that the privacy settings defined by the users via different applications are always met by all applications, aggregations, and visualisations.

Sharing, privacy and security settings along with other data gathered either explicitly or implicitly by applications, should be **accessible and modifiable** by user-friendly interfaces and visualisations provided by each MIRROR application. This has the advantage, that the user has full control about the data and has the potential to decide on a very fine-grained level, which data she wants to share with whom and which data should be kept private only.

4.2 The MIRROR Integrated User Profile Application

The MIRROR Integrate User Profile Application (MUP App) serves as a bridge between the MIRROR Spaces Framework and various MIRROR applications. It provides services for data administration as well as for directly supporting reflective learning. The latter is achieved by making users aware of unusual or significant behavioural patterns. The MUP App's service can be used by other applications to show and promote reflective learning by presenting combined data aggregated by different applications or from different users.

The tasks of MUP App are two-fold, providing (a) access to the data stored in the corresponding user profiles per user within the MIRROR Spaces Framework and (b) a data analysis service, which aggregates data from different applications (on an individual level) and/or from different users (on a collaborative or organisational level). The aggregated data can be used to raise awareness on relationships between data captured from different applications, make comparisons along a timeline or among different users, and finally detect patterns that are relevant for individual or collaborative reflection. Reasons for reflection can encompass the need for problem solving, decision-making, emotion regulation, or detection of significant deviations between the individual user and a team.

In this first phase of the development we pursue a more general approach directed towards basic types of data that are comparable across different applications. We mostly focus on statistical analysis to extract information on for example the number of different applications used by an individual, on providing a chronological overview of the applications used, on presenting the number of entries in various diaries, and on general information (e.g. when, how often or which data) was captured by each application. The data is presented on different types of charts, which can be selected by the user in order to ensure that the chart fits to the available data. In addition, the user may visualise her data in direct comparison with the data to other users (e.g. her team-members).

For the second phase, we will be concentrating on the different types of data captured by various applications, in order to provide analysis on the combined data. For instance, combining the usage of the MoodMap App with data captured by KnowSelf, might show a relationship between moods and specific working tasks. This would lead to new insights that may be the basis for initiating reflective learning. As an example, the left of Fig. 2 shows the hourly application usage history of a single user for both KnowSelf and the MoodMap App. The picture on the right of Fig. 2 visualises combined application specific data, namely the number of hourly switches between tasks or resources captured by KnowSelf and the corresponding mood of a user, depicted as separate lines for arousal (mood.energy) and valence (mood.feel) by the MoodMap App. For this visualization, mood values from the MoodMap App depicted in Fig. 1 are expressed as numbers between 0 and 100.

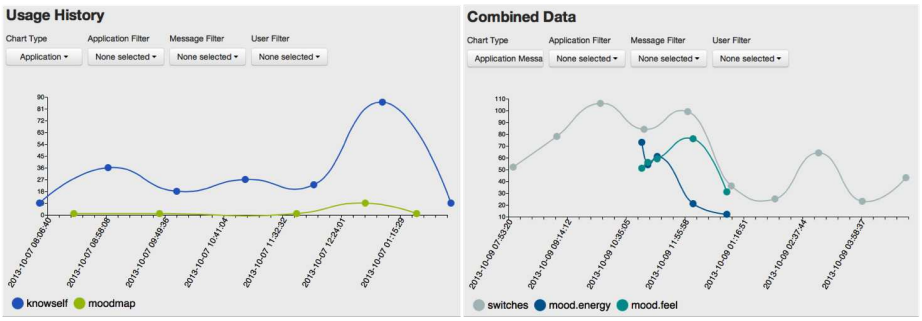

Fig. 2. MUP application with MoodMap and KnowSelf data for a single user

5 Proof of concept

In order to investigate the potential of a common MIRROR user profile as support for reflective learning, we conducted a small combined user study employing the KnowSelf and the MoodMap App in parallel. Although we used only two application for this first evaluation, the MUP App is able to handle all applications that store their data in the common user profile. Based on what we have learned from the separate evaluations, we see this study as first proof-of-concept for the MUP App. The goal was to find out whether a combined analysis of data from both user profiles will i) be accepted by the users, ii) enhance the boost of reflective learning, and iii) provide clearer insights or benefits for the single user.

5.1 Setting

The participating team consisted of 6 knowledge workers (3 women, 3 men), on average aged between 30 and 40, all of them mostly doing computer work. They used the KnowSelf and the MoodMap App in parallel for two weeks during work. Each day, either in the morning or in the evening they were asked to re-evaluate and reflect about their captured data and write down their insights and thoughts directly within one of the two applications. User activities automatically logged by KnowSelf could only be analysed for 5 persons due to technical reasons on one of the PC's. At the end of the trial the participants were asked to fill in a questionnaire and to take part in a semi-structured interview.

The questionnaire covered information regarding features and functionalities of the applications, usage, and reflective learning. During the interview, combined statistics (see Fig. 2) of the captured data were presented and discussed in order to find out the insights and benefits gained for the individual user.

5.2 Results & Discussion

The analysis of the log data of both applications is depicted in Fig. 3. Because of the small sample size only descriptive statistics are presented. As measure of central tendency the median is used for the same reasons. Each data point represents the average mood values (in terms of valence and arousal) of one participant in relation to the application usage and working activities (switching frequency and used resources). Whereas there is no trend to be derived from this small sample for the active use of KnowSelf, the number of moods entered per day seems to increase with higher valence and higher arousal values indicated by the participants (i.e. with a more positive mood). Switching frequency was measured in seconds between switching from one resource to another. Fig. 3 (bottom) shows that higher reported valence seems to be connected to longer times between switches (that is a lower switching frequency) and fewer resources used. Interestingly, the arousal level increases with the number of used resources.

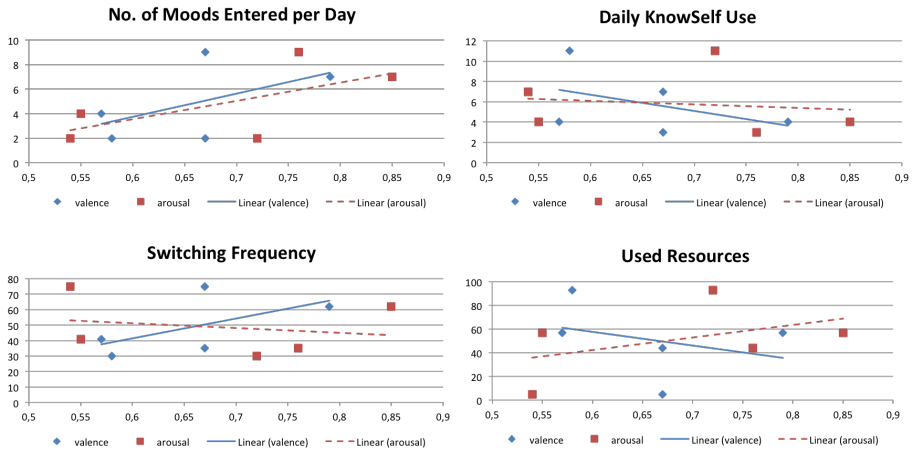

Fig. 3. Relationship between mood (as valence and arousal), application usage and working activities

Analysing the data collected via questionnaires and interviews, we can give first answers to the research questions:

RQ1: Are participants interested and willing to use more than one application in parallel with regard to reflective learning? Ratings from 6 participants answering the questionnaire (using 5pt. agreement scales) indicate that there is an interest in getting support for time-management (*Md* (median) = 4) as well as in capturing one's working activities, own mood, and the team mood (all *Md*=3.5). Participants found the applications easy to use, liked their visualisations, rated the presentation of information as comprehensible (all *Md*=4),

generally liked using the applications and would recommend them to colleagues (for both items Md=4 for KnowSelf and Md=3.5 for MMA, respectively).

RQ2: Does the MUP App as overlapping application facilitate reflection about users' working experiences and contribute to raising awareness of multiple aspects of their work life? The interview results revealed that the combination of data has high potential to trigger reflective learning although we have ambiguous statements in which way. One participant reflected mainly on the number of used applications and its relation to how the level of arousal developed over the day. Another participant mentioned that combined data helped her to detect a working pattern, which occurred especially in the morning. After reading emails the application switches and the arousal level increases, thus she knows that she started to work. Similarly, one of the participants observed that her arousal level is very low in the morning and increases during the day. This was a trigger to compare her arousal level to the average level of her colleagues and reflect upon eventual differences between them. An important feature mentioned by more than one participant was the overlapping visualisation of captured data on the timeline chart. Here the data was understood at one glance, which can facilitate reflective learning and enhance awareness of the multi aspects of their work life. Despite of the different approaches to reflect, for all participants the combination of data captured by both applications was important to understand the relationship between their working activities and moods.

RQ3: Do participants perceive any individual insights or benefits for themselves? Besides the findings already described in relation to RQ2, participants reported some additional insights they gained by reflecting on the captured data provided by the MUP. One participant stated that her arousal level fluctuates during the day. By becoming aware of the falling arousal level she decided to take smaller breaks to better recover during the day. Further insights concerned participants' self-estimations of how they spend their working day. Whereas one participant stated that the captured data confirmed how she estimated the relationship between working activities and mood development, another participant was rather surprised in the first place. Although she was six to seven hours in the office she spent only four hours in front of her computer. Only after comparing this awareness with her dates in her calendar, she could reproduce her day and explain why this happened.

General discussion. In general, this first proof-of concept of the MIRROR Integrated User Profile indicates that such overlapping visualisations can facilitate individual reflective learning and raise overall awareness of users' work life. All six participants used the combined data to reflect on how their working activities are related to mood changes and could gain some individual insights. Nevertheless there a still some points which need further discussion. While KnowSelf captures automatically the resources and applications used on the PC, the moods need to be inserted manually. Having to repeatedly insert a mood in a web based application can distract from the normal working process. One recommendation to alleviate this distraction was to add five different smileys in the system tray to facilitate the mood capturing. Another point for consideration is the

optimal time for reflection. All of the participants perceived the combination of the data captured by the MoodMap App and KnowSelf as useful, because they could check at all times what they were doing during work and how they felt. However, one participant stated that it was not very useful to reflect on how she felt three days ago, but that it was more interesting to become aware of her mood in relation to her work directly while working. For other participants especially the knowledge of how they felt for example three days ago was very important. Especially when the mood could be directly related to the mood note, used applications or used resources. A rather interesting statement from one of the participants was that her working tasks did not influence her mood at all. With respect to the visualisations, the interviews showed that different types of aggregating the data would be useful, so that users could indicate their individual preferences, e.g. to visualise the data along a timeline, to aggregate on an hourly basis, or to offer a summarising view in form a pie chart.

In summary the MUP App provides new visualisations based on data captured by different applications, and therefore offers a multitude of new possibilities for individual interpretations. In our proof of concept, we only combined data of two applications, but also within this small setting we received different approaches on how the participants interpreted the captured data for themselves and what they learned from it. We also mentioned some shortcomings which must be taken into consideration when proceeding with the development of the MUP App. Nevertheless, our findings encourage the assumption that combining data of more than two applications, leads to more meaningful possibilities to interpret the data and to gain more diverse insights for oneself.

6 Conclusions and Outlook

In this paper we presented the new MIRROR integrated User Profile Application, which aims at supporting reflective learning at work. Based on the results from previous user studies, which evaluated single applications, we derived essential requirements for the development of the MUP App and implemented a first prototype. Results from a first small evaluation regarding the parallel usage of two applications indicate that combining data captured by different applications, analysing and visualising them together can further facilitate reflective learning. Furthermore, it can also enhance awareness of the work life by leading the users to get more diverse insights about themselves. Of course, after this first proof-of-concept, user-studies with larger samples and more applications need to follow. Thus, our future work will focus on the integration of further applications developed within the MIRROR project into the MUP App. The goal is to provide different variants of visualising combined data and more sophisticated ways to provide guidance for reflective learning. For example, Fig. 4 combines KnowSelf data with corresponding geo location data captured by another MIRROR App. Thus it makes you aware of your working activities in relation to your working places (e.g. customer visits or travel activities) and can provide more triggers for reflective learning.

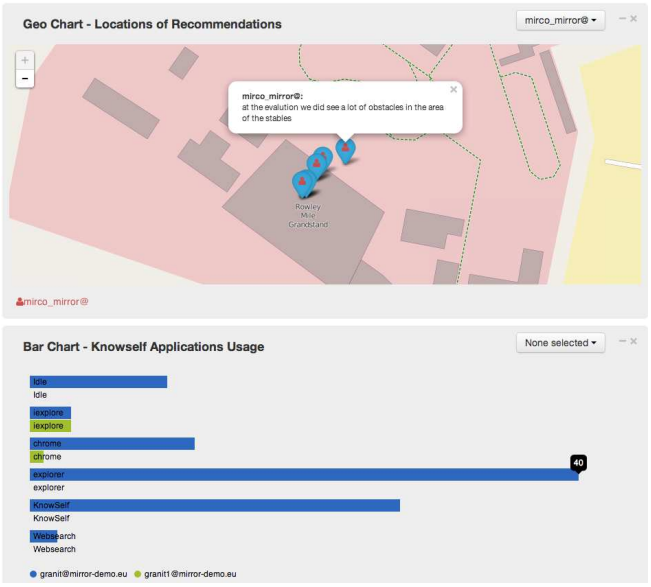

Fig. 4. Further sophisticated visualisations for the MUP App

7 Acknowledgement

The project "MIRROR - Reflective learning at work" is funded under the FP7 of the European Commission (project number 257617). The Know-Center is funded within the Austrian COMET Program - Competence Centers for Excellent Technologies - under the auspices of the Austrian Federal Ministry of Transport, Innovation and Technology, the Austrian Federal Ministry of Economy, Family and Youth and by the State of Styria. COMET is managed by the Austrian Research Promotion Agency FFG.

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