Improving Personalized Feedback at the Workplace with a Learning Analytics enhanced E-portfolio

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ABSTRACT

During workplace based learning, e.g. clinical practice or during an internship, there is an urgent need for solutions to restore and to guarantee the quality of feedback for (becoming) professionals. In continuing education at the workplace the use of Electronic portfolios (EPs) is a crucial means for acquiring the requisite professional knowledge and skills. Although EPs provide a useful approach to view each trainee's progress, often only limited use is made of the rich contextual learning assessment data to support responsive adaptation for more efficient and rewarding training and hence to provide personalized feedback. This contribution advocates that EPs enhanced with a Learning Analytics engine, may increase the quality and efficiency of workplace-based feedback and assessment. This contribution addresses this by outlining an approach that is applied in a European 7th framework project, called WATCHME (www.project-watchme.eu). The aim of the contribution is to provide insight in underlying rationales to improve workplace-based feedback and assessment and how this is applied in an EP environment that is enhanced with Learning Analytics.

Keywords

Learning analytics; workplace-based learning; competencies; electronic portfolios.

1. INTRODUCTION

Feedback at the workplace is crucial for trainees to become professionals. Paralleling the movement towards alternative assessments of students (Boud, 1990; Birenbaum 1996), (becoming) professionals are increasingly assessed using competence-based assessment instruments, such as portfolios. A portfolio contains selected evidence of trainees' learning processes, their performances and products in various contexts, accompanied by supervisors' comments and reflections (Wolf & Dietz, 1998). Depending on its content and mode of presentation an electronic portfolio (E-portfolio) can do justice to the fact that professional practice is complex and context dependent.

In this paper we use Entrustable Professional Activities (EPAs) to describe units of professional practice that underlie workplace-based feedback and assessment (Gilhooly, Schumacher, West & Jones, 2014; Jones, Rosenberg, Gilhooly, & Carraccio, 2011; Ten Cate, 2013). EPAs are tasks or responsibilities entrusted to be executed by an unsupervised learner once sufficient specific competence has been obtained. EPAs are independently executable within a time frame, observable and measurable in their process and outcome, and, therefore, suitable for entrustment decisions. This is a promising route that is now being explored and implemented in several countries across the globe (e.g. USA, Canada, Australia, Singapore, The Netherlands).

So far the implementation of E-portfolios in workplace-based learning is often ineffective; its quality (in terms of validity and reliability) is generally low and moreover the impact on learning is limited (Van Schaik, Plan, & O'Sullivan, 2013). This seems especially the case when the E-portfolios are not tailored to show what really happened in the workplace (Van der Schaaf, Stokking, & Verloop, 2008). Part of this failure may be attributed to a wish to translate competencies, designed as rather theoretical descriptions of professionals, into items in a portfolio for assessment. Furthermore, potential data about trainees' behaviour in the workplace are often underused, because the management of the data is too complex for the trainees and their supervisors. This paper addresses this by outlining an iterative development approach that is applied in a European 7th framework project, called WATCHME (www.project-watchme.eu). The project uses an E-portfolio system that is enhanced with a Learning Analytics (LA) engine to provide personalized (just-in-time) assessment and feedback. LA include the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimising learning and the environments in which it occurs (Clow, 2013; Ferguson, 2012; Siemens & Long, 2011).

The design approach for the LA engine that drives the E-portfolio is of a cyclical nature based on ongoing refinement and improvement of the engine during successive phases of collection, analysis and visualising information (Baker & Yacef, 2008; Elias, 2011). Though LA are driven by a computerised processing of large amounts of data, the analytical process is a "single amalgam of human and machine processing which is instantiated through an interface that both drives and is driven by the whole system, human and machine" (Dron & Anderson, 2009, p. 369). Student Models will be used as a means of analysis, the results of which will lead to two types of feedback: Just-in Time feedback messages and visualization of both individual and aggregated data. In order to provide meaningful just-in-time information, the Student Model should represent the actual internal state of each trainee as well as their actual learning context. For this, it must be able to interpret the contents of the E-portfolio. The Student Model should also contain enough pedagogical knowledge in order to be able to

translate the internal state and context into meaningful messages and information for visualization. Key in enhancing E-portfolios with LA is that data about trainees' workplace performances are linked to assessment and feedback scores. This requires the alignment of a statistical model with a substantive theory, operationalized in EPA descriptions, regarding expertise development in the profession. To this end, an iterative development approach, using various cycles will be applied.

The aim of this contribution is to develop a design for personalized feedback in a LA-driven E-portfolio. The central question is: How can a LA-enhanced E-portfolio improve feedback at the workplace to enhance (becoming) professionals' development?

2. Personalized Feedback

High quality feedback is essential to stimulate (becoming) professionals' EPA development. Feedback can be conceptualised as information provided by an agent regarding aspects of one's performance or understanding. For feedback to be effective certain conditions must hold; the feedback must be given timely and adequately, it needs to be of high quality, and learners should be able to act upon the feedback (Gibbs & Simpson, 2004). Furthermore, there is a large body of research to show that good feedback leads to achieve aimed performances (Nicol & Macfarlane-Dick, 2006). At least three conditions should be fulfilled for feedback to be effective: 1) it gives insight into obtained performances compared to an expected norm, 2) it gives the ability to evaluate and monitor the own process and 3) it gives suggestions to fill the gap between the expected norm and the actual performance (Sadler, 1989; 2010). Hence, helpful feedback states what aimed performances are and how current performance is related to the performances aimed at. Further, it provides action points on how to close the gap between current and aimed performance. Furthermore, effective feedback enhances learning when it provides answers to the following question: Where am I going? How am I going? and Where to next? (Hattie & Timperley, 2007). It is thus important that trainees get acquainted with the goals and 'criteria' of an EPA, infer how they performed and know how to enhance their performance.

Trainees can only achieve development goals when they understand those goals and can assess their progress (Sadler, 1989). One approach that is particularly powerful in clarifying goals and standards has been to provide trainees with rubrics (Dekker-Groen, Van der Schaaf & Stokking, 2012). Rubrics can be effective because they make explicit what is required of trainees' performance, they define a valid standard against which trainees can compare their work and hence, may enhance trainees' further learning.

This contribution focuses on providing trainees personalized feedback on the process of becoming a professional. The feedback module is based on EPAs that go with rubrics that describe entrustability or proficiency levels. It consists of a personalized feedback module (JIT) and a visualization module (VIZ). This JIT and visualization uses Student Models to depict how trainees' perform at several EPAs at the workplace and on a second level reveals their performance on the underlying competencies. The personalized feedback aims to give trainees insight into their obtained score compared with the expected norm (they can infer at what entrustment level they are), it provides them the chance to evaluate and monitor the own process (trainees need to reflect upon their performance) and the exemplar performance (example feedback) gives suggestion upon how to close the gap between the expected norm and the actual performance. Hence, the feedback is based upon the three principles of effective feedback and uses exemplar performance (Sadler, 1989; 2010).

3. Student Model

Decisions on entrustability (or proficiency) levels for EPAs are made on the basis of a set of workplace-based assessments, not using strict addition of scores but using rich, partly narrative, information. This means that a crisp rule-based approach is not feasible whereas a probabilistic approach is able to deal with the uncertainties in this type of decision making. The underlying Student Model needs to be able to advice on (at least):

1. Prediction of entrustability: What is, at this moment, probably the current level of entrustability/proficiency for a trainee in a given EPA? This can be expressed as a probability distribution over the levels x for that EPA given the current evidence: $P(level\ x\ for\ EPA \mid current\ evidence\ in\ portfolio)$ If feasible, a Value-of-Information analysis can be performed to identify the unknown variables that would provide the most information to answer.
2. Selection of feedback: What is the best feedback to select for a given trainee at a given moment?
3. Selection of topic of interest: What EPA, task or competency is at the moment the most of interest for trainee/supervisor?

4. Designing LA-enhanced Electronic Portfolios

The design of a LA-enhanced E-portfolio in our project demanded interdepended phases in which the involved educational and technical partners have to answer specific questions.

Phase 1. Development of EPAs and assessment instruments. Phase 1 started the development cycle by defining the competencies needed and types of evidence (e.g. products and performances) that should go in the E-portfolios for valid workplace-based assessment. Users (experts and trainees) are consulted to generate markers for progress within the professional domain and consensus will be sought to arrive at generalizable weighted markers that will be suitable to translate to Learner Analytics input, i.e. the "Student Models" in phase 3. Main questions to be answered are: what competencies need to be assessed and what types of evidence (e.g. product, performance, processes) should go in the E-portfolios? In previous studies, in which we used a Delphi technique (Linstone & Turoff 1975), stakeholders successfully developed EPAs for the professional fields of medical education, veterinary education and teacher education. See Figure 1 for an example of teacher education.

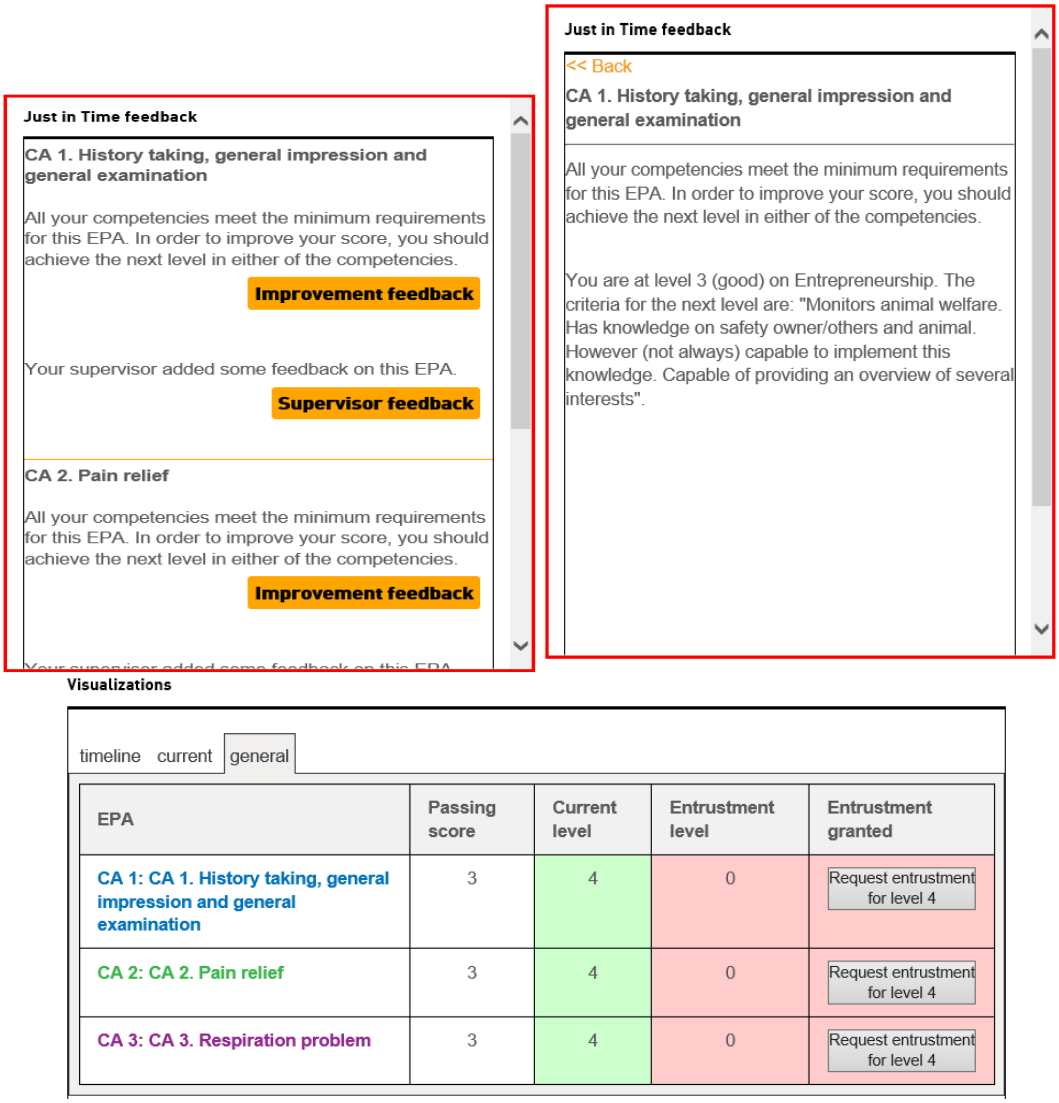
Phase 2. Development of Student Models. Phase 2 took the output of phase 1 and technical considerations, such as scalability, into account. Educational mining tools and techniques are selected that will be deployed to learn, update and store the Student Models. Student Models (SMs) are statistical models that predict trainees' progress based on existing data. They translate the portfolio and assessment data into the progress state of the trainee. As a consequence SMs will predict the actual state of performance of each trainee within their actual workplace based learning context. The part of the SM that describes the educational context is specific for each trainee and needs to be re-constructed frequently, since the actual educational context changes continuously. Given the high levels of uncertainty in the educational domain, probabilistic approaches are appropriate and graphic models such as Bayesian networks support the modular structure most appropriately. Before SMs can be developed, different questions have to be answered amongst the users, e.g.: When do users require feedback? How do users perceive feedback? What timing of feedback is useful?

Phase 3. Development of initial Personalized Feedback Module. This phase addressed the development of initial Personalized feedback module that produces, on the basis of information retrieved from Student Models, feedback to trainee and supervisors. Also visualization modules (VIZ) are developed that will, on the basis of information retrieved from Student Models and portfolio data, produce informative graphical representations of aggregated and individual data, see Figure 2. The detailed designs of JIT and VIZ demand input from the users on questions like: What kind of feedback do they prefer, with what graphically display? What are the time constraints for giving and receiving feedback? What kinds of devices are available when assessment is performed and received? The personalized feedback module will be accessible from the E-portfolio, representing the output of the underlying SMs. The SM is a back-end service in itself and is not available for user interaction in the display, but the JIT and VIZ that are driven by SM are. See Figures 2a-2c. These figures show a possible example of personalized feedback and EPAs attained. The personalized feedback is dynamic and continually receives input from new incoming portfolio data. The final display knows several layers providing extra detailed information when one clicks on a certain graph, message etc. in the display.

EPA 1. Sets learning goals for the whole curriculum and specific lessons

Assessment and evaluation criteria	The teacher does/does not formulate (self formulated) learning goals in connection with specific subject content
	The teacher does/does not make use of SMART (specific, measurable, acceptable, realistic and time related) formulated learning goals.
	The teacher does/does not take into consideration the starting situation of students when formulating learning goals.
Proficiency levels	The teacher takes over the learning goals or course material from others. He/she incidentally considers the starting situation of the students and the connection with specific subject content. The teacher does not check if the learning goals are SMART formulated. *(starting)*
	The teacher regularly checks if the learning goals of others or the course material connect to specific subject content and the starting situation of the students. The teacher checks if the set learning goals are SMART formulated. *(sufficient)*
	The teacher formulates his/her own learning goals, which usually connect to the specific subject content and the starting situation of the students. These learning goals are partially SMART formulated. *(good)*
	The teacher formulates his/her own coherent learning goals, which connect to the specific subject content and the investigated starting situation of the students. The learning goals are SMART formulated. *(Excellent)*
Assessment forms	Lesson plans/series of lessons and student placement evaluation form.
Assessor	Institute and internship supervisor.

Figure 1. Rubrics in Teacher Education



Figures 2a-2c. Personalized feedback at Entrustment level

5. Rationale of Personalized Feedback

The personalized feedback module that we developed in the project is inspired by Nicol and MacFarlane-Dick's seven principles of good feedback practice (2006) that facilitate self-regulation. These principles were translated in the design as follows. Good feedback:

1. Helps clarify what good performance is. For professional development at the workplace the learning goals should be crystal clear in order to stimulate learning and above that should stimulate (learn) trainees to clarify own goals (Sadler, 1989). It is well known that often mismatches occur between supervisors' and trainees' interpretation of assessment criteria and standards, especially when it comes down to complex tasks at the workplace that can be tacit and culture related. An approach that we provided is the development of EPAs connected in rubrics (see Figure 1). Rubrics have proven to be very helpful in clarifying goals and standards and stimulating trainees in goal clarification and goal setting, for instance by involving trainees in the assessment and stimulating discussion and reflection about criteria and standards. This is visualized in the overviews with scores on EPAs and competencies (see Figures 3 and 4).

2. Facilitates the development of self-assessment (reflection) in learning. Our design allows for close monitoring of trainees' progress by visualizing trainees' performance on the EPAs by means of graphs and figures as well as narrative feedback. In this way it provides an overview of students' strengths and points for further development, which can be used for self-assessment and peer assessment and discussion about trainees' portfolio. Further, compiling the portfolio (selecting materials as input for the portfolio) already demands trainees' reflection.

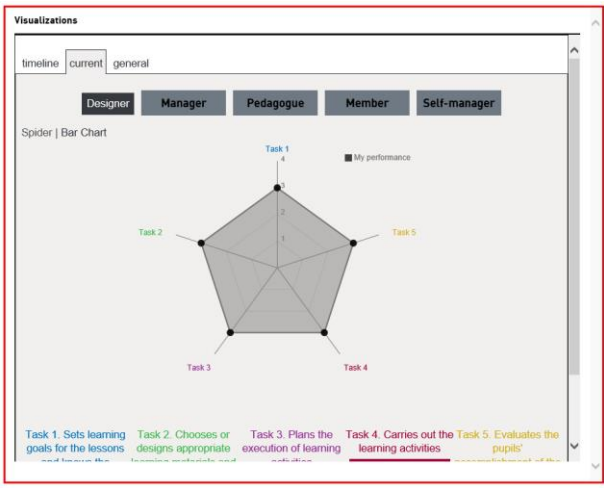


Figure 3. Spider chart view of scores on the EPAs

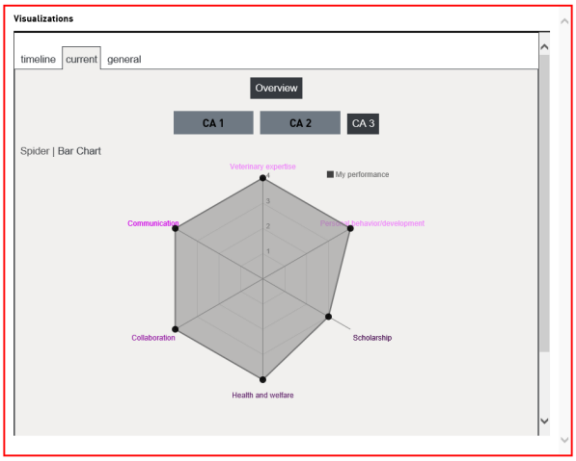


Figure 4. Spider chart view of scores on competencies

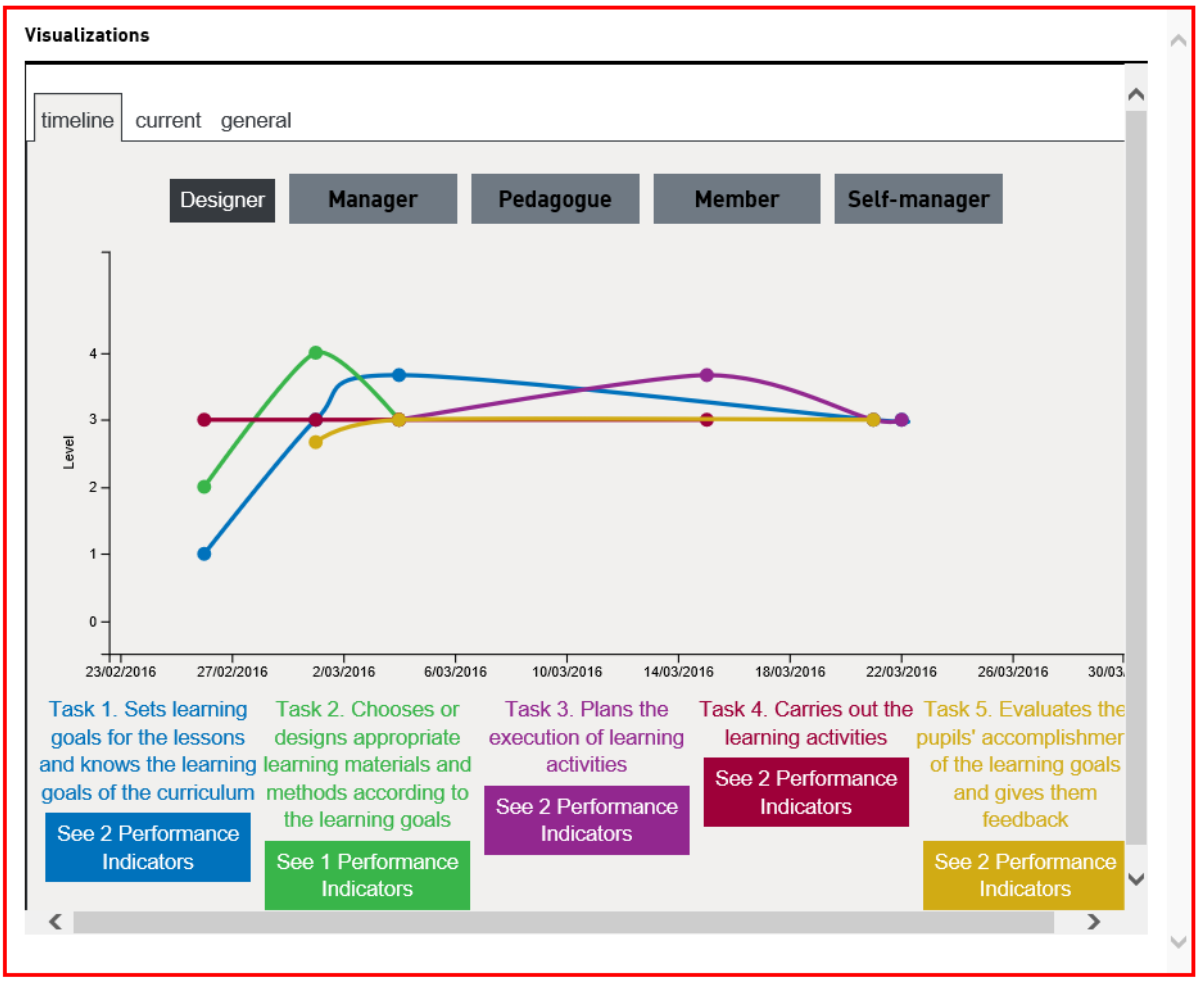


Figure 5. Timeline view of trainees' performance on EPAs (called tasks in this example).

3. Delivers high quality information to trainees about their learning. Trainees need detailed information of high level to monitor and correct their own performance and to take action to improve. In the preliminary personalized feedback module this is enhanced by: (a) linking the feedback to predefined EPAs that includes criteria and standards; (b) ensuring timely feedback by means of underlying SMs that feed into the system; (c) giving trainees advise on their learning and showing (prioritizing) needs for improvement; (d) regulating the amount of feedback by giving trainees the option to click further if they want more detailed information; (e) allowing to upload information in the portfolio system anytime anywhere, which makes the feedback system up to date. See Figure 5 for examples of types of feedback.

4. Encourages teacher and peer dialogue around learning. The system allows for supervisor and peer dialogues about progress and possible improvement. Such dialogues are important to make sure that trainees understand the feedback, can value and verify it and know how to act on it (Van der Schaaf et al., 2008). The E-portfolio environment allows for interaction between supervisors, trainees and peers and has the possibility that several stakeholders upload documents, so that for instance peer feedback can be used as 'evidence' for a trainee's performance.

5. Encourages positive motivational beliefs and self-esteem. Positive motivational beliefs and self-esteem are prerequisite for learning and improved performance. It is known that both benefit most when trainees receive many low-stakes assessment tasks, with immediate feedback for improvement (if needed), rather than receiving few high-stakes summative assessment tasks. The E-portfolio allows the trainee to select and rewrite own pieces of work/documents (drafts and resubmissions) and formative feedback in de long run. The SM instantly updates when new information comes in.

6. Provides opportunities to close the gap between current and desired performance. Feedback in the EP should support trainees to take the next steps to improve their performance. This demands engagement for further improvement and can be stimulated by providing feedback on work in progress, provide feedback in several stages in which feedback (Gibbs, 2004). The E-portfolio allows this.

7. Provides information to teachers that can be used to help shape the teaching. Not only trainees need to be informed about their progress and options for improvements, this also counts for the supervisors. They need to be informed with detailed and quality information about their trainees in order to guide them at the workplace. This especially counts for professional education in which trainees have many supervisors for several internships. These supervisors often do not know what feedback a trainee received from previous supervisors and how trainees' longitudinal progress looks like. The preliminary personalized feedback design feeds into this by a specific portfolio entry for supervisors with long term information about the trainee and the digital option for trainees to ask for supervisor feedback.

Feedback Type	**Example of Aggregated Feedback message (Level 1)**
Improvement	*There is room for improvement for this EPA. Please click on the message to see how you can improve your performance.*
Positive	*You have recently received good scores for this EPA. Please click here to see how you can improve more.*
Trend	*You currently have a trend of decreasing scores for this EPA.*
Supervisor	*Your supervisor added few improvement comments on this EPA.*
Cohort	*Compared to your cohort, you received better scores than your peers on this EPA.*
Gaps	*You have less assessments than your peers on this EPA.*
Feedback Type	Some examples of Detailed Feedback message (Level 2)
Improvement	*You are **level 2** on your **Physical Examination Competency**. To achieve the next level your examination and research should be reasonably complete and technically adequate. Overview of the examination and consistency are reasonably developed.*
Trend	*You were **level 3** on your **Physical Examination Competency** and you dropped on **level 2** during your last assessment. To achieve the next level your examination and research should be reasonably complete and technically adequate. Overview of the examination and consistency are reasonably developed.*
Supervisor	*"You are performing well, but you can take more notes during the examination process." (13/05/2015)*

Figure 6. Examples of detailed feedback messages for each feedback type

6. Discussion

The aim of this contribution was to elucidate how personalized feedback based upon Learning Analytics could be used in an E-portfolio environment. The E-portfolio offers learners (students, trainees, professionals) and their supervisors an environment to monitor and provide evidence of their learning and competency development. The progress of the user can be closely monitored by choosing from amongst several display modes, such as radar, line and bar charts, which are automatically generated by the system. The scores (on the different competencies) used for these visualizations are abstracted form the assessment tools inserted in the portfolio. Other overviews are also displayed, for example numerical overviews of the total inserted forms and an overview of the progress, based on all activities, forms and procedures linked to it. The developed LA-tools will be open source.

7. ACKNOWLEDGMENTS

This study was conducted within the framework of "Workplace-Based e-Assessment Technology for competency-Based Higher Multi-Professional Education" (WATCHME) project supported by the European Commission 7th Framework Programme (grant agreement No. 619349).

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