How do students want their workplace-based feedback visualized in order to support self-regulated learning?

Initial results & reflections from a co-design study in medical education

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Abstract. Developing good self-regulated learning (SRL) skills is highly important for medical students, not only to help them to navigate and succeed at their current study, but to support their continuing professional development and lifelong learning once they enter the workplace. A key component of SRL is the ability to reflect on feedback and to use this to spot gaps in knowledge/skills, identify learning opportunities and plan new learning goals and activities. Technology can help by providing students with tools that scaffold their development of these skills. This paper reports on the co-design of myPAL, a student-facing learning analytics system. Within co-design workshops, we worked with students to improve myPAL. These hands-on, creative workshops involved students in discussion of their current and desired use of feedback, practical interface/visualisation design and prototype use and adaptation. Using this participative approach we have identified one key visualisation and a set of functions/features that students want to be available to help them to review and act on their feedback. In this paper we report and reflect on the co-design approach that has been used, including the observed benefits of taking such an approach as well as its limitations. We also outline the further work that is planned to develop & evaluate the required improvements to myPAL.

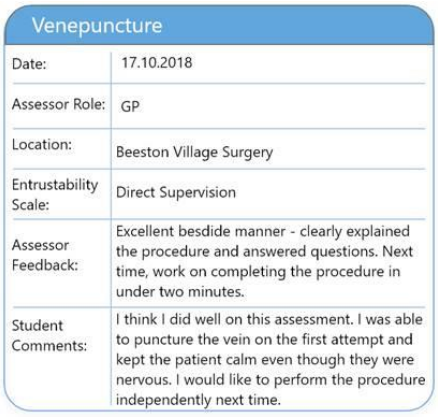
Keywords: co-design, self-regulated learning, visualisations, workplace.

1 Background

Developing good self-regulated learning (SRL) skills is highly important for medical students, not only to help them to succeed at their current study, but to support their continuing professional development & lifelong learning in the workplace.

From a social cognitive perspective, feedback assumes a significant role in SRL and serves the purpose of minimizing the gap between current performance of learners and expected goals (Zimmerman, 2013; Hattie and Timperley, 2007). The cyclical process of SRL highlights the ability to reflect on feedback and to use this to spot gaps in

knowledge/skills, identify learning opportunities and plan new learning goals and activities as a key component (Panadero, 2017; Pintrich, 2000). Medical degree students are provided with a wealth of feedback, which they are encouraged to use in this way (Cho et al., 2017; Sandars and Cleary, 2011). One particularly interesting source of feedback for SRL is workplace-based assessment (WBA) feedback, since this is provided (and potentially used) within the context in which students must be most self-reliant. In these placements students are provided with minimal imposed structure to their learning, since the learning opportunities presented will vary from day-to-day depending on individual clinical settings and the presenting patients. Medical students spend a significant proportion of their study in these workplace settings, since it allows them to observe and practice skills, make links between their classroom-based learning & practice and improve their understanding of the healthcare settings & cultures in which they will eventually work. However, this rich workplace-based learning relies on the students reflecting on their own & others' practice and using these reflections to plan their learning and thus improve their understanding and practice. Typically medical schools and placement organisations will provide some structure and guidance to help students to make the most of these placement experiences.



Venepuncture	
Date:	17.10.2018
Assessor Role:	GP
Location:	Beeston Village Surgery
Entrustability Scale:	Direct Supervision
Assessor Feedback:	Excellent besdide manner - clearly explained the procedure and answered questions. Next time, work on completing the procedure in under two minutes.
Student Comments:	I think I did well on this assessment. I was able to puncture the vein on the first attempt and kept the patient calm even though they were nervous. I would like to perform the procedure independently next time.

Figure 1 Example Completed WBA

For example, in the medical school in which the research was undertaken, students are provided with a list of clinical tasks/procedures with a guidance on the level of entrustability at which they should perform them. Level of entrustability is a scale starting from observation of a skill performed by healthcare staff and moving through supervised performance, unsupervised performance to teaching peers. Students are required to initiate & undertake formative workplace-based assessments (WBAs) to collect feedback from a clinician (see Figure 1) on their performance of these tasks. As part of this process the student is also asked to reflect on the feedback and complete a comment section which could include a learning action plan. The feedback is completed on a WBA app on the student's phone and sent into their university portfolio system. These WBAs provide the potential for the student to engage in meaningful SRL, since initiation and identification of follow-on actions are all in their hands. As such, the number, frequency and timing of engagement with WBA and quality of students' reflective logs become useful measures of SLR behavior.

However, students are in the process of transitioning from highly structured, school learning environments to less structured, self-directed higher education and placement learning environments, and therefore many have not yet fully developed the self-regulated learning skills required to make the most of this feedback (Hughes and Smail,

2014; Juma et al., 2016). Analysis, of the relationship between WBA activities & subsequent academic achievement, has identified that students with poor patterns of engagement with WBAs are at greater risk of failing (Hallam and Fuller, 2017).

2 myPAL – Technology support for SRL

One possible solution to this problem is to provide the students with additional support for self-regulated learning within the technology tools they are already using. myPAL (myPAL, 2017) is a student-facing learning analytics system that has been developed by one medical school in order to bring students' learning data (assessment data, including WBA feedback and, in the future, resource usage) into one system so that the students can more easily review, reflect and act on this feedback. This is a live system already in use by all 5 years of students (approx. 1,500) on the medical degree. However, this is also a system under continuous development and improvement, as we explore ways in which it can be enhanced to provide better support for self-regulated learning. We are guided by a behavior change approach (Michie et al., 2011) and exploring two ways in which the system can 'nudge' students towards engaging in SRL activity. One branch of this work (Piotrkowicz, A. et al., 2017; Piotrkowicz, A et al., 2018) is exploring how we can use data analytics (text analytics, temporal analytics and process mining) to identify patterns in student data and use these as the basis for prompts (questions or suggestions) made to students within the system. In parallel, (the work reported in this paper), we are also exploring how we can improve the data visualisations in myPAL so that the interface facilitates and encourages SRL activity. In behavior change terms this can be seen as an example of environmental restructuring. These two branches of work are intertwined and inform each other, but in this paper we will be focusing on the visualisation co-design work.

3 Co-designing myPAL visualisations

3.1 Objectives

The aims of our co-design work are:

- To better understand our students' current engagement with workplace-based learning & assessment, including their use of myPAL & their SRL activities
- To create designs for improvements to the myPAL visualisations, that have the potential to provide support for SRL activities

In this paper we aim to provide readers with practical ideas & approaches that they can apply in their own work. To this end, we describe in some detail the co-design process that we followed, reflecting on its benefits and limitations, as well as highlighting some open questions. We also identify initial results of what medical students want in terms of technology support for workplace-based SRL, as well as discussing some of the obstacles they encounter within this context. Future work will involve implementing the improvements in the live system and evaluating their impact.

3.2 Approach

We adopted a participative, co-design approach in which we worked with students & tutors to understand current workplace-based learning (WBL) behavior and co-design new visualisations for myPAL. Co-design involves stakeholders in the design process itself in order to help address some of the issues that have led to failures in technology adoption. It recognizes that stakeholders bring a deep understanding of their context, their needs and the opportunities that can then be explored with the developers and it values their ability to create solutions themselves (Sanders and Stappers, 2008; Mor and Winters, 2007). It is an approach that we have found to be useful in a range of healthcare TEL research and development projects (Treasure-Jones and Joynes, 2017)

Participants & Procedure: Our work was based in a UK medical school. It involved two phases of co-design workshops, the second building iteratively on the first. Each workshop lasted between 60-90 minutes. Phase 1 workshops took place between November 2017 and January 2018. Phase 2 workshops all took place in February 2018.

Participants: Students, academic tutors (staff based at the University) and clinical tutors (staff based in the placement settings) were invited to join the co-design workshops. Invites were emailed to all medical students, lead academic tutors from each year and clinical tutors who had engaged with continuing professional development activities around education. Table 1 shows the participation across these different stakeholder groups.

	Y1	Y2	Y3	Y4	Y5	Clinical Tutors	Academic Tutors	Total
Phase 1	3	7	8	7	1	7	6	39
Phase 2	2	7	4	5	1	3	8	30

In Phase 1 separate workshops were held with each group (except for Y4 and Y5 which were combined) for logistical reasons and to help preserve their unique viewpoints. In Phase 2 Y1 and Y2 students were invited to one combined workshop and Y3, 4 and 5 were invited to another. This decision was taken because their perspectives and experience had been judged to be similar following the Phase 1 discussions.

Participants were free to join one or both phases of the work. Sixteen (70%) of the twenty three students from phase 1 returned to take part in phase 2 and three new student participants joined. Two (29%) of the seven clinical tutors from phase 1 returned to take part in phase 2 and one new tutor joined. Three (50%) of the six academic tutors from phase 1 retuned to take part in phase 2 and five new tutors joined. Therefore across both phases of the co-design work we had 48 participants involved, as well as 4 members of the research team.

Phase 1 Co-design Workshops – Procedure. The co-design workshops were designed to be welcoming and informal. The research staff facilitating the workshops were not part of the teaching and assessment team for the medical degree and they encouraged

participants to be very open in their ideas and feedback. To help set the appropriate mood and get people working together each workshop started with an ice breaker game. In phase 1 the focus then moved onto three key questions[1]:

1. How do you currently use myPAL? *(discussion)*
2. How do you approach your workplace-based assessments? *(discussion)*
3. What do you want to find out from myPAL? *(hands-on activity)*

The researchers posed these opening questions and facilitated the resulting discussion. Questions 1 and 2 were posed to help us to understand participants' current experiences and behavior and also to encourage them to think about the context in which the myPAL tool would be used, before moving onto question 3 and attempting to design an interface.

In designing the hands-on part of this workshop (question 3), we faced some important challenges. We set out to design a format that would support participants, with no assumed knowledge of app design, visualisation methods and self-regulated learning, to design complex interfaces to support students in planning their own learning, all within a timeframe of around 45 minutes. In the workshop, we used a visual metaphor of a bowl filled with snippets of student data to exemplify myPAL's role as a data aggregator and its potential to combine data sources to create visualisations and demonstrate patterns. Despite priming participants in this way, we realised that simply presenting participants with a blank sheet of paper could be potentially off-putting. So we created a collection of common visualisation types (x and y axes, badge boards, timelines, etc.) taken from a well-known typography (Shneiderman, 1996), printed and laminated them on A3 paper so that participants could adapt them in accordance with their own ideas. In addition, we also provided blank sheets of A3 paper, pens and craft materials. The researchers were not merely observers in this process, we participated in conversations, idea-generation and drawing, often working through ideas verbally with participants to get them to the stage where they could be drawn on paper. In total 50 visualisations were created in the phase 1 co-design workshops. The full visualisation dataset has been made available (Dent-Spargo et al., 2018).

Phase 1 – Decision-making Procedure. After each phase of co-design (creating ideas), decisions need to be made about which ideas/designs will be taken forward into the next design iteration. This decision-making was undertaken by the myPAL management team. This interdisciplinary team includes medical educators & researchers, TEL researchers, developers, administrators and IT specialists. Together they bring a wide range of perspectives and collectively they are tasked with identifying the most promising work to take forward in terms of valuable educational support, development feasibility & research value.

At the end of phase 1 this team undertook a review and analysis of the 50 created visualisations with the aim of identifying a small number these to be implemented as

[1] For tutors these were slightly rephrased – e.g. for academic tutors question 2 became "How would you ideally like students to approach their workplace-based assessments?" and for all tutors question 3 became "What would you like students to find out from myPAL?"

prototypes and taken into phase 2 of the co-design. In order to do this, the team tagged each visualisation by the questions they felt it was answering. A list of eight questions was created that the team judged to cover all 50 visualisations. The team then calculated which questions were most frequently "asked" (Dent-Spargo et al., 2018) and then focused on the visualisations that covered the 3 most popular questions. As an output of this simple analysis and the resulting discussion (about perceived educational value, usability and ease of development) three participant-designed visualisations were chosen to take into phase 2.

Phase 2 Co-design Procedure. The 3 prototypes that were taken into phase 2 were created as physical paper prototypes and clickable electronic paper prototypes[2]. This meant that we had on the table the physical paper prototypes themselves, which the participants could easily annotate, amend or re-order. However, the participants could also explore the user journey and functionality more interactively by using the electronic paper prototype which was installed on iPads provided to them at the workshop. The reasoning behind this approach was that we wanted to ensure that the message we conveyed was that these were work in progress: designs that participants could still easily adapt or even reject. We felt that if we had gone straight to wireframes then we would have given the impression that the designs were more fixed and further developed than was in fact the case. We did not want to lock-in decisions too early in the process.

The phase 2 workshops started with an ice breaking activity & then moved into an exploration of each of the 3 prototypes in turn. Each prototype was briefly presented, then the participants were given the chance to explore it on the iPad before providing their comments and further ideas. This discussion was structured around 3 questions:

1. Do you feel you understand what this is showing you?
2. How would you use this?
3. If this were someone else's data, what prompting questions would you ask them as they looked at this?

These questions were chosen to help us to identify whether the visualisation was intuitively understandable, whether the students envisaged using this for SRL activities and potential places were nudges/prompts could be added to the interface. Whilst these opening questions were phrased positively, it was also made clear to the participants that they could provide negative feedback as well, which they did. Participants were also encouraged to make changes on the paper versions of the prototypes.

Phase 2 Decision-making Procedure. A series of meetings was held with the myPAL management team to review the feedback collected during the phase 2 co-design workshops. The researchers created and shared a summary of this data with the myPAL management team. This summary identified which visualisation was most positively received across the workshops (this was unanimous) and included a list of changes and additional features/functions which the participants suggested for this visualisation. The myPAL management team collectively reviewed this and prioritized the changes

[2] These clickable electronic paper prototypes were created using marvel https://marvelapp.com

to take into the next stage of co-design. This prioritization again was considered from an educational, research and practical development perspective. Throughout we followed a consensus decision-making process, with decisions agreed, by the group, following consideration and discussion of these different perspectives. The prototype will now be developed into a working visualisation within the development environment of the myPAL system and this visualisation will be explored and used by participants in a third stage of co-design workshops planned for Autumn 2018.

3.3 Data collection

The discussions in all of the co-design workshops were audio-recorded and transcribed. Additionally the artefacts created in the workshops (drawings, notes, annotated visualisations and researchers' fieldwork notes) were all digitized (photographed or scanned) so that they could also be included in to the dataset for later analysis.

3.4 Two stage analysis – for decision-making and for deeper understanding

As has been described earlier, each phase of co-design is followed by a decision-making phase. This decision-making phase involves analyzing the data gathered, but this analysis is undertaken as part of the agile development cycle. As such it has to be completed fairly quickly in order to let development work move forwards. It is therefore done at a high-level, without waiting for the completion of the detailed, qualitative analysis of all the rich data gathered. It relies on the multiple perspectives, brought by the members of the interdisciplinary myPAL management team, in order to pick out key features and messages from the data and use this to take collective decisions about which designs to take to the next development iteration.

However, the rich data we are gathering during these co-design workshops also provides us with the opportunity to undertake a much more detailed qualitative analysis to gain a deeper understanding of the students' approaches to WBAs, their SRL activity and the opportunities and challenges in using TEL to support this. This more detailed analysis will take several months to complete. All the data has been uploaded to NVivo[3] (a qualitative data analysis tool) and the authors of this paper are in the process of undertaking a thematic analysis (Braun and Clarke, 2006) of this data. Some initial reflections are included in the later section of this paper, however the full analysis will be reported in future papers and ideally will also inform later iterations of the myPAL development. We also anticipate that this work will identify other opportunities within the curriculum and the placements to support SRL. We will not be restricting this to technology interventions alone.

[3] NVivo - https://www.qsrinternational.com/nvivo/home

4 Results and discussion

4.1 Initial results – desired visualisations, functionality and use cases

Phase 1: The most popular questions that students wanted the visualisations to answer (based on the myPAL management team's analysis) were:

- How am I doing? (high-level overview)
- How am I progressing?
- What do I need to do?

There was less interest in, and some concerns about, views that would compare their progress to that of their peers. Comparisons to course expectations were less contentious. The sequential stepping through these 3 most popular questions can be seen as helpful for SRL, as students did appear to want to identify and fill gaps in their knowledge. However, this was perhaps more focused on filling required curriculum/assessment gaps, rather than knowledge/skills gaps identified opportunistically through engagement with workplace-based activities.

The three prototypes chosen to take through to phase 2 are shown in Figs 2, 3 & 4.

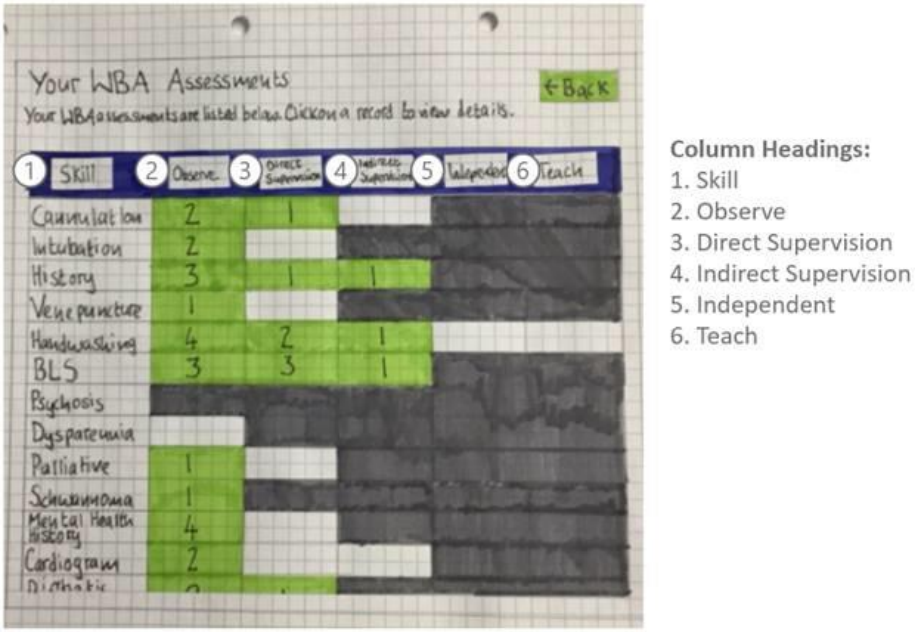


Figure 2 Prototype 1 WBA Skills Overview

Prototype 1 shows an overview of the students' completion of WBAs, with the option to drill-down for more information on each. Prototype 2 shows a timeline view of the students' WBA, with the ability to filter on a range of characteristics. Prototype 3 shows a visualisation that fore-fronts their action planning.

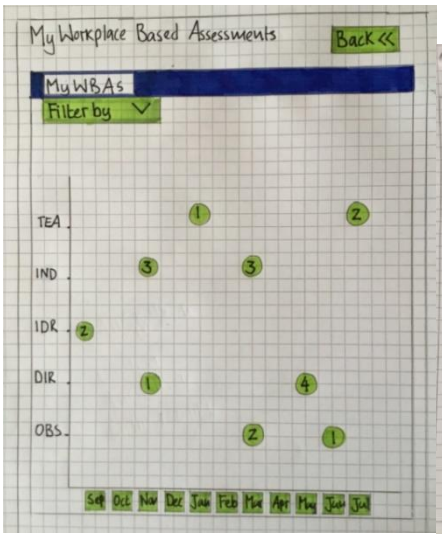


Figure 3 Prototype 2 - Timeline view

Figure 4 Prototype 3 - Action plan view

Phase 2: Based on an initial analysis of the transcripts and on the reports from the researchers involved in the co-design workshops, it was clear that Prototype 1 was perceived by both students and tutors to have the greatest potential to support students' reflection and action on their WBA feedback. It was considered to be easily understood and to provide a clear view that allowed students to compare their current progress against expectations and drill-down to see the feedback. Students reported that they would use it to plan their activities on placements.

Prototype 2 received the least favourable reaction. It was considered to be difficult to interpret. Some of the filtering options were not considered to be helpful or meaningful (e.g. the location of the assessment). The students could not easily envisage a way in which they would use this visualisation to support their learning.

Prototype 3 received mixed comments. It was considered to be useful to be able to fore-front the action planning. However, it was felt that this would be most useful if this calendar view also included all coursework deadlines and other personal tasks – all planning in one place. Yet, at the same time, all the students indicated that they already used other systems (apps, calendars) to keep track of their other tasks and that they would be very unlikely to move all their task management into this interface.

Therefore Protoype 1 was chosen as the visualisation to be developed and taken into the next phase of co-design. However, some changes will be made, based on the suggestions raised in the co-design workshops and the decision of the myPAL management team. These changes include providing filtering and flagging (student suggestions) and providing more prominent display of the feedback and action planning associated with the assessment and a temporal view of progress (tutor suggestions). So in fact the amended Prototype 1 will incorporate the aspects of the other prototypes that were deemed to be useful (meaningful filters, temporal progress and action plan view), whilst keeping its fore-grounding of an overview by skill completion.

4.2 Reflections on the desired support: congruence with theory

The most popular questions students were seeking answers to through visualizations largely coincided with the four main functions for formative feedback which are also compatible with the cyclical process of SLR (Hattie and Timperley, 2007; Panadero, 2017; Pintrich, 2000). The four main functions which coincided with students expectations are a) 'how did I do ?', b) 'where am I going ? (goals)', c) 'How am I going ? (progress towards these goals)', and 'Where should I go next ?'. The observed congruence supports the potential for transferability of our findings to other contexts where feedback from formative WBAs could be digitally collected and processed. Providing visualisations to answer these questions involves some level of digital processing of the basic feedback data, and can be seen as therefore providing 'digital scaffolding' of the SRL process. The technology would be doing some of the analytical or reflective processing that traditionally would be undertaken by the learner themselves in SRL. Therefore we recommend that future work explores the impact of providing such scaffolding and considers when it would be beneficial to fade it out in order to pass greater responsibility and autonomy back to the student.

4.3 Reflections on the co-design process

Providing participants with the opportunity and support to create solutions: Overall we found the co-design process to be rich and dynamic, allowing participants enough structure to feel supported whilst also enabling them to be creative. Many sessions began with a participant claiming they were not creative and could not draw but almost without exception, every member of the workshop was able to contribute something of value in a medium they had not used before. There were however challenges in this approach - participants often suggested ideas that would be difficult to implement either from a development perspective or because they involved data not currently collected by the medical school. This challenge means that managing expectations is a particularly important part of the co-design process. Our approach was to let all ideas be created (none were rejected in the workshops themselves) but to make participants aware of the fact that it would not be possible to implement everything.

Engagement and feelings of ownership: As we have found in previous co-design work (Kämäräinen et al., 2017), we observed that over time many participants developed a strong sense of engagement in the process and a feeling of ownership of the developing solution. One of the tutors commented that: "*I feel really invested in it and I would really like to know what comes of it*" (Clinical Tutor, P2 Workshop). A year 3 student commented that "*I feel I've actually contributed quite a lot as a student <…> that's quite rewarding to have, as a student, knowing that the app is going to include things that I and the majority of the other students would like*". Interestingly another year 3 student felt engaged but brought a different (more critical) perspective "*I was quite enthusiastic about the whole idea by the end of the two meetings <…> In terms of my contribution I think was more of a sceptic <…> I tried to bring a bit of reflection and realism to the situation*." Both of these quotes are from a video that the students made in their own time to contribute to a reflective presentation of the myPAL project (Dent-Spargo, 2018).

The high retention rate between phases 1 and 2 of the co-design (70% of students, 29% of clinical tutors and 50% of academic tutors) also indicates that participants were engaged and committed to the project. This is particularly notable given that all participants (students and tutors) have very heavy workloads and it is therefore difficult to find the time to attend the sessions.

One open question for the co-design approach is whether this feeling of ownership in the solution only extends to those who actively participate in the co-design or whether their fellow students (who did not join the workshops) also regard the final app as a student-designed solution. Another open question is whether the feeling of ownership and engagement persists even if student designs are dropped at the decision stage. We are very aware of the fact that in this participatory study, the students do not in fact participate in the decision-making itself.

In terms of developing tools that are suitable for the wider user group there is potentially also a danger that the students who take part in co-design may not be a representative group. Additionally their growing feelings of ownership of the solution might also make it more difficult for them to provide critical perspective.

Lag between development and research-oriented analysis cycles: As described earlier, we undertook an initial high-level analysis of our rich data after each co-design phase and used this analysis to inform the development decision-making process. This decision was taken since the agile development cycle could not reasonably wait for a detailed qualitative analysis to be undertaken. This approach does introduce a risk that the later qualitative analysis will highlight something that was missed in the decision-making analysis, and thus could led to inefficient development if subsequent changes had to be made. By involving multiple perspectives from the interdisciplinary team in the collective high-level decision-making process we aim to minimize the chance of this happening. However, this is something we will be monitoring in order to assess whether this two-stage analysis is a reasonable compromise or whether it leads to wrong decisions being made and developments having to be backtracked.

4.4 Reflections on students' views on workplace-based learning

We are undertaking a thematic analysis of the rich data collected during the co-design workshops. Our aim is to identify insights into the nature of workplace-based learning, potential limitations in the WBA and feedback process and to potentially identify further opportunities for support for SRL both within and outside myPAL.

A preliminary thematic analysis has been conducted on one of the richest workshop transcripts (P1Y4 - Phase 1, Year 4), which exemplified some of the important observations made across workshops. We share some of these observations below, but note that this is an ongoing piece of work.

Students are rarely able to formally plan their own workplace-based learning as their ability to complete assessments depends on many factors such as the type of placement, the schedules of assessors and the patients available. Students saw workplace-based learning as a *'... dynamic learning process…*' where learning was *'…fluid and on the spot …*'

They considered the chances for formal WBA within the workplace to be '*…very opportunistic…*'. For example, situations where a suitable clinical encounter coincided with a clinician who was *'… nice… willing to do it … and isn't super stressed…*' were *'…hard to find'*. Students also found and agreed that student feedback can be the least priority under certain circumstances, especially *"…when there's a life on the line…*" Yet, within such natural constraints of the workplace students also found that they still have *'… lots of opportunity to volunteer…'* and complete WBA activities.

However, not all of these encounters ensured usefully recorded feedback. It was not uncommon to receive less specific & non-descriptive feedback such as '*practice more*' or '*improve confidence'* which were *'… not really helpful'*. It was felt that in some cases student performance &feedback may be *'… difficult to encapsulate … in an official, written down way*' for the purpose of recording and reviewing. Potentially the WBA app provided by this medical school can help by providing a structure to the feedback and (by imposing minimum character limits) a way to promote longer/richer feedback. However, students felt this didn't necessarily work given the *'…pressures on doctors'*. The option within the WBA app to record feedback verbally was not known by all, and sometimes was impractical as the *'… ward was just too noisy…*'

It was interesting to note however, that specific and constructive feedback was valued and students did report acting on it to *'… try and rectify…*' their deficiencies *'… quite soon*'. This appears to happen because these students make concrete plans for future learning based on useful feedback.

This initial insights suggest that there is potential for technological interventions to support SRL within these real workplace settings, but that technology is likely to be only one part of the solution.

5 Further work

The thematic qualitative analysis of the rich data from the co-design workshops is ongoing. We expect to finish this and have results ready during the summer and there is still the potential for lessons from this analysis to have some influence on the phase 3 co-design work. We recognize that the numbers of students involved is relatively small and so we also plan to design a survey, informed by our qualitative analysis, to collect responses from a much larger set of students about their workplace-based learning approach & use of TEL in order to check and verify the qualitative findings.

The visualisation design that has arisen from these two phases of co-design work now needs to be implemented in the development system and tested/evaluated within a third phase of co-design. The development work is already underway and the next co-design workshops and activities (which will involve using the visualisation on live data and exploring use cases) are planned for Autumn 2018. These workshops should give us the first indications of whether and how this visualisation can support SRL activities connected to these WBAs. Future work will roll this into the live system and evaluate whether it leads to actual changes in SRL practice. Our co-design work has provided us with some indication of current practice, against which we can compare. We can also explore using proxy measures for SRL (such as the data on WBA engagement that is described in Section 1) to measure the impact of the new visualisations. Another

research question, we would be keen to explore in our future work, is whether the ownership of the solution, felt by the students who participated in the co-design, extends to the wider student group and whether that supports adoption.

6 Conclusions

There is a clear need to provide some medical students with additional support to help them develop better self-regulated learning behaviour, particularly in the context of workplace-based learning. This intensive co-design study has resulted in the design of a visualisation and functionality that students and tutors believe could provide additional help. The students placed greatest value on visualisations that could give them an overview of how they were doing, show their progress and signpost what they still needed to do. The preferred visualisation presented an overview focused on skills completion with the option of drilling down to get more detail on feedback, filtering for (and focusing) on certain activities and flagging skills. The co-design approach that was used was successful in supporting both creative activities and feelings of ownership and engagement with the solution. It also created a very rich dataset, which is already yielding more detailed insights into students' workplace-based learning behaviour. There is further work to be done on testing the designed visualisation to see if it does lead to changes in behaviour and further analysis of the rich dataset to help us identify further opportunities to support SRL.

7 Acknowledgements

This work would not have been possible without the support of the whole myPAL team (past and present) and all our co-design participants. We would like to thank them for their support, enthusiasm and creative & critical engagement.

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