

Making Learning Journeys Visible: Towards Supporting Collective Reflection on Graduate Attributes

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Abstract: Although some computer-based systems exist to facilitate the management of capstone projects, it is not really clear how learners can be supported to reflect on the connection between their (past and ongoing) learning experiences, and the graduate attributes (GAs) they are intended to develop. This paper proposes a technological infrastructure, and the epistemic and social scaffolding, for students to collectively reflect on how each of their learning products generated across different units of study contribute to the development of their GAs, in light of a final capstone project. We illustrate the feasibility of our approach through the authentic deployment of the toolset in an immersive environment for supporting teams of final year students to reflect on their GAs development.

Introduction and related work

Capstone projects and units of study are one common to higher education (HE) degrees across universities as they provide students the opportunity to demonstrate their capacity to integrate knowledge and skills acquired and apply them to real-world problems (Holdsworth et al., 2009). *Capstones* are commonly conducted in the final year of a degree to provide the culmination of theoretical and applied work to support learners in successfully joining an increasingly uncertain, evolving and competitive workforce (Dunlap, 2005). Thus, capstones often become critical for integrating previous learning (Fernandez, 2006), assessing progress (van Acker & Bailey, 2011), and reflecting on the graduate attributes (GAs) development (Ras et al., 2007). GAs are a set of generic skills that universities define for developing work ready graduates by providing coherence across all the units of study within a degree (Hager & Holland, 2007). A critical and productive activity identified by Hage and Holland (2007) to develop GAs is to induce learners to *reflect* on their previous learning experiences which can enable them to make visible the tacit knowledge generated by (sometimes) unconscious actions during (apparently isolated) learning tasks, in light of the current practical work and learning context.



Figure 1. Left: Participatory Timeline collaborative interface as a high-level view of learners' posts across units of study. Right: Tablet interface to see blog posts details and associate them to specific Gas.

According to Learning Sciences and classic educational literature, reflection is multi-faceted. For example, reflecting on previous learning experiences allows the learner to revise or even change the interpretation of the meaning of those experiences (Mezirow, 1990). Reflecting on past learning experiences can also promote learners' complex sensemaking through the extraction and articulation of both the content and the skills that were built, which can then be transferred to future situations if similar conditions are likely to be faced (Kolodner et al., 1998). Whilst some reflection is best done individually (Boud et al., 1985), reflecting as a social activity is also enhanced, particularly when learning was facilitated in that social context (Bell & Davis, 2000). It is thus fair to say that it makes sense for capstone experiences to have a strong reflection component because learners are expected to apply what they have previously learnt to contexts beyond the original situations in which learning happened (Holdsworth, et al., 2009; Ras, et al., 2007). In fact, several tools and pedagogical approaches are commonly put in place for encouraging learners to reflect in capstones, including keeping journals (Hmelo-Silver,

2004), creating wiki pages (Ras, et al., 2007), or writing reports (Holdsworth, wet al., 2009). However, whilst these may work well for promoting individual reflection, it has been stated that more scaffolded mechanisms are needed to ensure effective collective reflection (Hmelo-Silver, 2004). Similarly, there exist tools that support the mapping of curriculum and the learning designs with GAs (Thompson, 2007), but these are often focused on mapping assessment tasks with GAs rather than focusing on promoting learners' reflection. In sum, it is not clear how students can reflect on the connection between their previous learning experiences and the development of their GAs, particularly in their final year, once they have passed through various units of study that sometimes may appear disconnected from a learner point of view.

In this paper, we describe our first steps towards providing the toolset and the epistemic scaffolding to make learning evidence across units of study visible, interactive and traceable for promoting collective reflection in terms of GA development. We present a fully functional prototype which was designed in close collaboration with the coordination team of a university degree and deployed in an authentic final year capstone experience. The contribution of the paper is the rationale behind the design of the tool and its associated pedagogical scaffolding. We illustrate the potential usefulness of the tool by briefly describing the preliminary experience of a team of final year students reflecting retrospectively and prospectively on their GAs development, with the tool being deployed in a technology-rich immersive environment.

Learning context and participatory consultation

Although capstones are orchestrated differently in each HE degree, we decided to understand and define the reflection needs of learners in a specific learning context: a Master's degree of Data Science offered by the University of Technology Sydney (UTS). This is a 2-year full-time degree aimed at equipping graduates with an understanding of the potential of analytics to transform practice through industry experiences, real-world projects and self-directed learning. The degree features two final year capstone units of study where learners are asked to be involved in independent online work, mentoring, peer feedback and industry experience. A common practice in this degree is that learners are asked to keep a (WordPress) personal blog during their whole degree. Blogging has been increasingly used in HE to facilitate student collaborative learning (Kuo et al., 2017), thus this is not an uncommon pedagogical practice. In this degree the learning designs of most units of study include various blogging-based tasks. At the beginning of their enrolment, learners get access to an open peer-sourced WordPress multisite platform where they can individually produce educational resources, generate academic reports, comment on each other's pieces of work, or share reflections. The blogging platform is also intended to function as a repository of community-knowledge; and as an environment for engaging peers and industry contacts to showcase the development of the five GAs of this degree. Close consultation with the degree coordinator and the team of teachers in charge of the final year capstone projects led to the identification of the following considerations that the design of the reflection toolset and pedagogical scaffolding must consider:

1. It is critical for learners to engage with peers while reflecting on past learning experiences given the highly collaborative active participation that most units of study encourage.
2. It is critical for learners to show how their key work supports the development of the GAs and, also to gain awareness of the GAs that may be less developed.
3. There is a need for learners to rapidly visualise and navigate through all the content they have generated across units of study to be more mindful about their learning journeys in light of the capstone experience.
4. There is a need of a tangible final product of the reflection that learners can take away or share with others.

Toolset design

As a result of the design considerations listed above, we created a fully-functional prototype that we call the *Participatory Timeline* which includes a collaborative and an individual interfaces (Figure 1, left and right respectively). The collaborative timeline highlights milestones or critical events recorded by the learners. In this case, it connects to the WordPress API to get all the content from specific learners' blogs and displays them according to the time they were published. This way, learners can scroll and rapidly and visually navigate through all the content they generated in the past years or months. Each blog is presented in the timeline as a container of the original title, text and keywords chosen by the learner. Learners can interact with this Participatory Timeline directly via a web browser on their personal computer or via a large screen for group exploration. Additionally, we designed the timeline to be also displayed in an immersive facility located at UTS called the Data Arena (see Figure 2, left). This is a state of the art 360-degree immersive data visualisation facility that is purposely built to allow groups of people to interact with data. It is a 10-meters of diameter cylindrical space where the timeline can be displayed continuously around the learners. The space is also equipped with an omnitrack, optical motion

capture system consisting of 12 infrared movement cameras. We took advantage of this facility to enhance the exploration of learners' blogs by also designing an individual interface pictured in Figure 1 (right) that can be operated from a tablet device. This tool allows learners to walk around the Data Arena space, each holding a tablet device, to explore a blog's content in detail. Learners can select blog posts from a list automatically filtered according to their physical position in relation to the timeline. This is achieved by attaching infrared trackers to the tablets that serve to track the learner's position. In this way, learners interact with the timeline, initially, using their body's proximity in relation to the timeline (see Figure 2, right-above). Then, learners can tap on a specific blog to read the textual content, and look at the images, graphs and media they or other learners created. The interface allows them to tag each blog post according to the GAs that they consider that post contributes to. The Participatory Timeline can also run on an interactive tabletop placed at the middle of the Data Arena space (see Figure 2, left). This tabletop version features a set of *filters* that can be used by learners to hide and show posts according to the GA tagging that they have performed using the tablet interface (see buttons at the left of Figure 1, left).

Epistemic design and authentic pilot study

The teaching team designed a scaffolded reflection task within the final capstone unit of study for learners to collaboratively reflect on how the learning activities performed as part of the degree (across units of study) matched the GAs they were intended to develop. Learners were asked to respond the following focus question: *"How do the posts I/we have created in [the WordPress platform] during the previous year can serve as evidence of my/our Graduate Attributes development?"* This task was subdivided into three subtasks.

Part 1- Exploration and gathering (5-10 min), learners were asked to individually hold one of the tablets and walk around the Data Arena to explore to identify the location of particular posts written by themselves or others that can serve as evidence of GAs development as a preparation for the next part.

Part 2 - Collective matching of GAs (20 min), learners were asked to work with the rest of the team to define a strategy to specify what posts provide evidence of GAs development. For this, they had to explicitly associate the selected posts with specific GAs using the tablet *tagging* functionality (see Figure 1, right).

Part 3- Collective reflective screen casting (20 min), learners were asked to develop a coherent story demonstrating the development of their GAs over time. Then, learners were asked to highlight both the GAs that have been strongly and weakly developed thus far, the actions that can be taken forward, and the potential role and limitations of reflecting on the blog posts. The intended output is a collaborative screencast recorded at the Data Arena using the interactive tabletop located at the centre of the learning space (see Figure 2, right-below).

Authentic deployment example

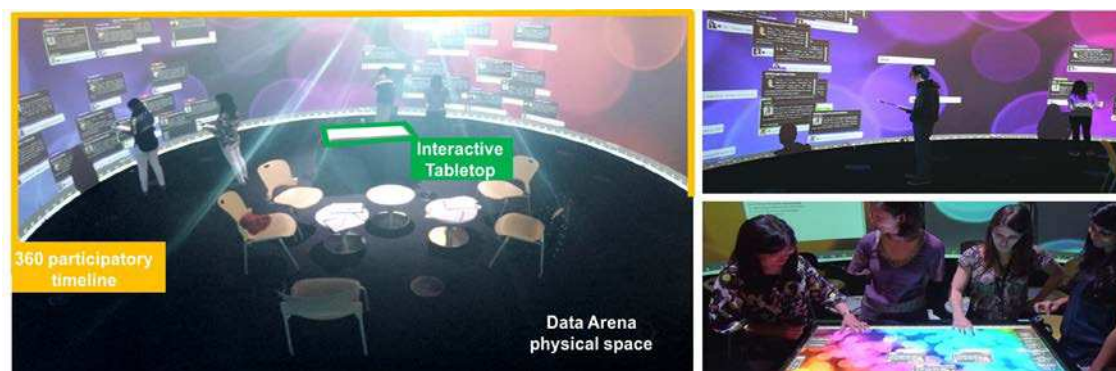


Figure 2. Left: The Participatory Timeline deployed in the Data Arena. Right-above: a learner interacting with the timeline through his proximity to posts and the tablet. Right-below: a team of four learners recording a collective screencast.

The prototype and the pedagogical practice are being deployed as part of the final capstone experience of the Master degree mentioned above. We illustrate the potential usefulness of the system by showcasing the preliminary experience of one team composed of four master students, who successfully completed the reflection task described above. For this session, the content from their four blog sites was loaded onto the Participatory Timeline in the Data Arena. This preliminary exploration suggested that learners found it useful that the task was scaffolded. In words of one of the learners, *"scaffolding the task into three distinct phases guided us through a gradual progression, giving me time to think before starting to discuss on how to match GAs with particular blogs"*. Moreover, although the Data Arena space is intended to foster collaboration, actual collaboration occurred mostly at the tabletop. For example, while exploring the interface using the tablets, the team naturally split in two,

interacting in pairs (e.g. see Figure 2, left), sometimes sharing one tablet to explore the same content. One of the learners explained this as follows “*the timeline allowed us to explore different blog posts. Doing the same in a large screen would have forced all of us to comment on the same post at the same time as we did for recording the reflective screencast. In the timeline, each of us could decide to individually explore posts but also we could keep awareness of what others were doing, make comments and show things to others*”. At the tabletop, learners spent some time to reflect among themselves before pressing the *record* button to produce the final reflection output. Learners agreed that this discussion was the “*the core of the collaboration exercise*” (as stated by one learner) since it allowed them to reach common understanding of the state of each of their GAs development journeys. Learners generated a collective screencast successfully after just one attempt. They expressed lots of interest in getting this as a digital artefact (see final output of this team in <https://youtu.be/VuxKr7v1zL4>) to make it available to the wider community of students. Learners also appreciated the possibilities facilitated by the immersive physical space, described by one student as follows: “*being able to see the posts spread on a timeline was fantastic, plus the interactivity via our body location, was great*”. Overall, results of these preliminary explorations towards supporting learners to collectively reflect on their GAs development are encouraging. The intention was nicely summed up by one of the learners as follows: “*this exercise is good to understand how our blogs reflect certain GAs. If I would be using only the current online system I wouldn’t have been able to connect blogs to the GAs properly*”.

Conclusion and future work

Making the connection between learning tasks and GAs is, in many cases, made explicit in the teacher’s design, but not necessarily easily grasped by learners in practice. The development of reflective and critical thinking skills is vital for the current uncertain and evolving professional workforce. Thus, this work should be seen as an initial step towards much work that needs to be done in this area. Future work in this line of research certainly includes exploring the strategies to scale up this approach. Currently, the Participatory Timeline can be accessible online 24/7 via any device desktop, tablets, mobiles. The main challenge is how it can scale up to support other learning scenarios that may use additional sources of learning evidence beyond blogging. Current work is exploring how to integrate other sources of student’s learning outputs (e.g. concept maps, reports, presentations) and learners’ media footprint (such as twitter, slack channels, etc).

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