Co-designing Learning Analytics Tools with Learners

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Abstract: There is an increasing interest in the use of learning analytics by individual educators and also at different institutional levels. However, problems such as low satisfaction, steep learning curves, misalignment, and other barriers to adoption have already been reported. From a learner-centred design perspective, these problems can, to a certain extent, be explained in terms of the lack of involvement of learners and educators in the design of the tools that are intended to support their learning and/or teaching. Based on co-design principles, we explore the critical role of giving voice to learners and their teachers — stakeholders who are often neglected but who will ultimately be the main beneficiaries (or otherwise) of learning analytics tools. This chapter discusses a set of co-design tools and techniques that can be put into practice to increase the likelihood of successful deployment of learning analytics into classrooms, institutions and learning spaces. This chapter presents: a) an overview of how Design Thinking may help in the co-design process of learning analytics; b) a brief review of the current literature exploring co-design for education and learning analytics; and c) illustrative examples, from our firsthand empirical work, focused on co-designing learning analytics tools with learners.

1 Introduction

Designers of any computer system always have imagined users in mind. The focus of this chapter is how we maximise the chances that their imaginations are aligned with reality. How can learning analytics system designers better understand the different scenarios where learning is happening, what drives learners' motivation, and the varied expectations of the different stakeholders? The misrepresentation of learners' and teachers' needs and motivations is a problem that ultimately affects adoption, as it has been communicated in recent reports (Gasevic., Pardo., & Dawson., 2016; Iaqat, Mohsen, & Gašević, 2013). To overcome the challenge of designing tools that lack the voice of the final users, communities from technology-enhanced learning (Chen, Mashhadi, Ang, & Harkrider, 1999), human-computer interaction (Barendregt, Bekker, Eriksson, & Torgersson, 2016) and technology design (Day & Croxton, 1993) have proposed techniques to include user participation in the different stages of the design process.

The terms **Participatory Design (PD)** and **Co-design** have often been used by different communities to describe processes that give stakeholders a key role in the whole design journey (Simonsen & Robertson, 2012). Co-design is commonly considered a structured process that investigates users' opinions, their intentions and the context in which a tool will be used (Lee, 2008). Nowadays, co-design has become a well-established approach to facilitate the inclusion of the different stakeholders needs in the design process. While some research areas use the terms PD and co-

design interchangeably, for this chapter, we define co-design as *an approach where learners, educators, institutions, researchers, developers and designers are all included across different stages of the design process, from exploration to actual implementation*.

In educational settings, designers and developers commonly rely on teams of visual designers, business specialists and educational theorists who produce educational innovations (Herold, 2015). In some cases, educational designers only enact specific roles such as instructional designer, educational or curriculum designer, while others engage in both design work and its enactment as teachers, learners, or library media specialists. In general, it is not clear how these different roles aim to make the design process more inclusive towards the main beneficiaries of those learning innovations. In short, the final educational tools (or critical parts of them) are often envisaged and developed by actors other than the learners and teachers themselves. The key concern in educational contexts should be: *how can designers give voice to learners or educators when deciding the features of the systems, the tools, the pedagogical elements and the data analytics that will suit better their particular learning context.*

While co-design is not a new research area, applying it to learning analytics still requires a better understanding in terms of how to apply co-design tools and techniques in educational contexts that are *data-intensive*, and its relation to *learning design* (John Avella, Mansureh Kebritchi, Sandra Nunn, & Therese Kanai, 2015). Nevertheless, given that there is already substantial empirical work on co-design in well-established areas such as education, psychology and human-computer interaction, we can build on what others have learnt.

This chapter discusses a set of co-design tools and techniques that can be put into practice to involve *learners* in the design process, with the aim of increasing the likelihood of successful deployment of learning analytics into classrooms, institutions and learning spaces. In this way, we explore the critical role of giving an active voice to those stakeholders who are often neglected but who will ultimately be the main beneficiaries (or otherwise) of the learning analytics software and the practices that emerge around it. The chapter is mainly written for educators, but also for learning designers, learning scientists, technology designers and learning analytics researchers interested in co-designing learning analytics innovations by including learners in the loop. Although we focus our attention on learners, the co-design process should include other critical stakeholders such as educators, developers, researchers, product designers and learning designers.

The chapter is structured as follows. Section 2 presents an overview of how Design Thinking and the co-design process can be applied for learning analytics tools. Section 3 presents a brief review of the current literature exploring co-design in educational and learning analytics contexts. Section 4 describes a series of co-design

tools and techniques with illustrative examples from our firsthand empirical work. Section 5 describes the lessons learnt from our current projects. The chapter concludes with a discussion of avenues for future work in Section 6.

2 Applying Design Thinking to a Co-design Process

One of the particular challenges in learning analytics design is to define what data and analytics are important for empowering learners and/or educators, and how the insights from these data can be communicated more effectively. In general, the co-design and participatory design approaches focus on how the interactions occur between stakeholders and how the design process benefits from these interactions (Tone Bratteteig & Wagner, 2016). Using a co-design approach based on a well-established design practice such as **Design Thinking** also invites designers to use mixed methods and establish different roles for participants. Applying an iterative design process can enable the designer to create a continuous feedback loop so that the development process can indeed solve an authentic need (Sharp et al., 2007). For example, in order to obtain early feedback from learners, prototypes, mock-ups and technology immersion techniques (e.g. software simulations) can be used to give a feel of the functional and aesthetic aspects of the system being designed.

Design Thinking is a way of embedding the notion of iterative design into the design process. Coming up with ideas, building and testing in a short period of time is what Design Thinking brings to the table in comparison to other iterative processes (Ellingsen, 2016). In terms of innovation through iterations, Design Thinking specifies three main stages (Koh, Chai, Wong, & Hong, 2015): *understanding, creation and delivery* (see inner square in Figure 1). The iterative process starts with creating empathy and defining goals/expectations from stakeholders. This first part of the process can be exploratory and in some cases may set the tone of the project for the next stages (IDEO, 2016).

Building on the Design Thinking definition by Ellingsen (2016) and (IDEO, 2016), we consider that user inclusion is sometimes overlooked in later stages of the co-design process. While the human-centred mindset is very evident in the first stage of the design thinking process (understanding), at the final stages, most of the design responsibilities are put on the hands of the design team (Brown, 2010). Additionally, after releasing a product, some teams cut responsibility from the project which thereby diminishes the benefits from using Design Thinking in first place (Nussbaum, 2011). For this reason, we suggest that an extra stage may be needed, which we define as *Support,* where involvement and sustainability are considered critical factors to keep a co-design project alive.

As we can see in Figure 1, the process we recommend includes Ellingsen's double diamond (Ellingsen, 2016; IDEO, 2016), an additional stage (Support) and an overarching iterative process focused on *Inclusion*. This latter element is intended to

remind designers that paying attention to inclusion should run through every stage of the process to ensure user involvement, commitment and negotiation while, at the same time, making sure that users' voices are being heard.

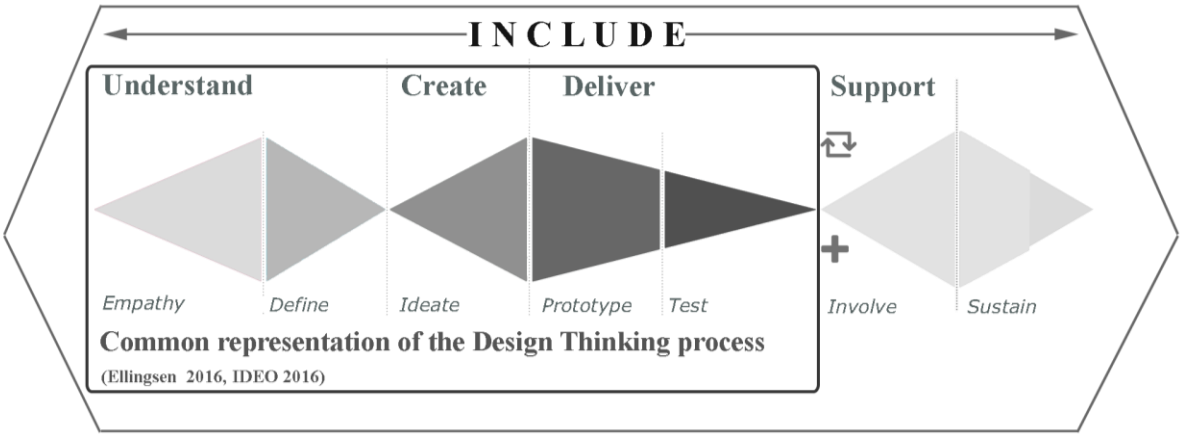

Figure 1 Support and inclusion added to the Design Thinking process for co-design (Ellingsen, 2016).

With *Inclusion* and *Support* specified in our co-design process, we can use the benefits from Design Thinking to build complex artefacts like learning analytics tools, in a gradual way that is iteratively informed by stakeholders. Bringing this approach to learning analytics may require additions to the co-design process in terms of data and educational aspects. These are explained in the next section.

3 Research in Co-design for Learning Analytics

Co-design techniques have started to attract the attention of some researchers and practitioners within the learning analytics community, especially for learner consultation (Holstein, McLaren, & Aleven, 2017; McPherson, Tong, Fatt, & Liu, 2016; Roberts., Howell., & Seaman., 2016), to understand privacy concerns (Slade & Prinsloo, 2015), for tailoring support for learners (Madeline Huberth, Nicole Michelotti, & McKay, 2013), for designing learning activities (Könings, Seidel, & van Merriënboer, 2014) and for designing dashboards (Corrin & Barba, 2015).

In education, there has been some research pointing out the potential of using participatory methods to help identify or define goals, pedagogical expectations and ways to assess learning, giving voice to the multiple stakeholders. For example, the study done by Tanes, Arnold, King, and Remnet (2011) indicated learning analytics systems need to be designed to support deep insights into processes of relevance and align learning outcomes with learners' perspectives to give some meaning to those outcomes.

The first attempts to bring a co-design approach to the learning analytics community have been focused on the first phases of the process, where the *understanding* and *definition* stages happen. For example, Holstein et al. (2017) merged fabulation (a fictional exploration of particular situations) and user scenarios to understand teachers' needs and expectations. By bringing the unthinkable into

representation, fabulation can elicit imaginative responses to any number of issues (Gough, 2004), inviting participants to speculate without constraint. Another example of creating understanding is running consultations with learners by conducting focus groups and interviews to establish differences among cohorts of learners (McPherson et al., 2016; Roberts. et al., 2016).

We can also find a few examples in learning analytics that have focused on the later stages of the design process and stakeholder perceptions on learning practices like instructional design. For example, Könings et al. (2014) reported the use of follow-up co-design sessions as a way to integrate student perspectives on current learning environments, information gathered from focus groups, and interviews resulted in new proposals that could lead to a better learning experience in secondary education Cook-Sather (2014) used a similar approach to work with undergraduate students and faculty members on improving teaching and learning practices. In terms of privacy and data management, Slade and Prinsloo (2015) used a form of user consultation to understand concerns and improve the way privacy management was being done inside the systems at their university.

The preliminary works mentioned above seem to suggest that when co-designing learning analytics with learners (and other stakeholders) it is worthwhile to draw on participants from different areas at every stage in the process as needed, in this case at least leaners can provide useful information on every stage. Figure 2 presents the co-design process suggested in Figure 1 with additional elements that are critical for co-designing learning analytics. The first additional group of elements are the actors of the learning analytics process. In each stage of the co-design process, participants become actors, sometimes fulfilling different roles based on the particular context being investigated. This does not mean that actors must be in the same sessions at the same time, but should be consulted as part of the feedback process.

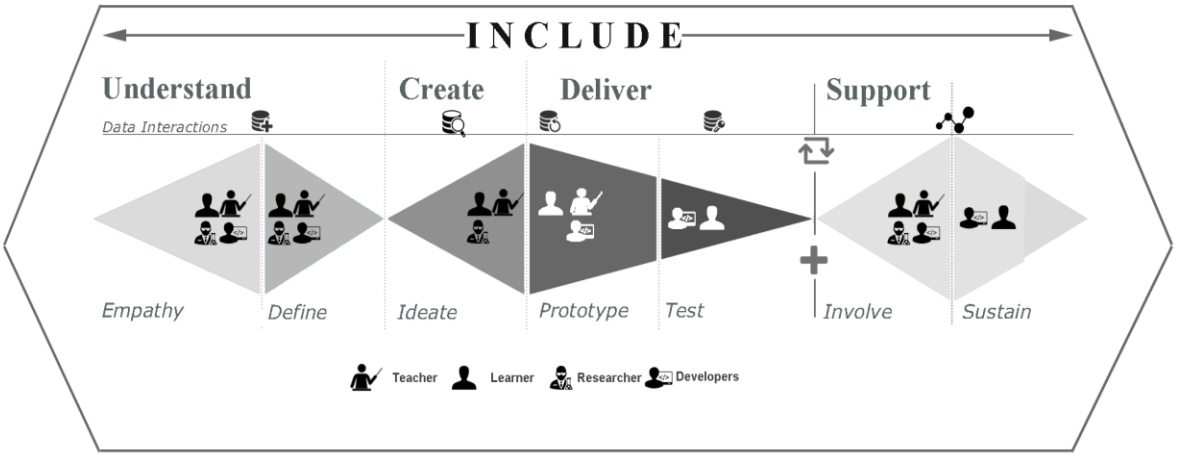

Figure 2. Interaction design process and roles

The second additional element is an extra layer we refer to as *data interactions* that may drive many of the decisions for a learning analytics innovation. In learning

analytics development projects, designers may often be required to work with different data sources to design an effective information ecosystem. Some learning analytics innovations may make use of simple measurements from standardised tests, observations from the tutor, and/or logged interactions with the educational system (Jisc, 2016), while other projects may require to build more complex data structures based on statistics and probability models. In the examples that follow, we illustrate how conversation about data can be included in co-design sessions.

4 Tools and Techniques for Co-design in Learning Analytics

Co-design toolkits and processes that have not been developed specifically for educational contexts can be very useful resources for generating new ideas for learning analytics co-design. However, if we are to make best use of the insights one can glean from a co-design session involving non-designers, it is important to pick the proper tools and techniques and adapt them in a way they can be used by non-designers (i.e. future learners, teachers or developers) to express their reasoning behind the learning processes (Sanders, 1999) and the data-related issues. It is important to note that learners may not understand how to use or give their voice. Therefore, as part of the iterative design process, some explanations and training should be considered.

This section describes a set of tools and techniques that can be used for creating understanding, defining characteristics, and building prototypes in a learning analytics project. We provide a brief description, an explanation of the purpose and exemplars from our first-hand experience for the following tools and techniques used in co-design: *persona profile, user journey, focus group, knowledge mapping* and *prototyping*.

4.1 Persona Profile

Definition: A Persona profile, or in a learning analytics context, a learner persona. Persona profiling is a technique used to model and summarise critical information about people who may be involved in the learning ecosystem. The persona may have some input to, receive some output from, or affect the function of the artefact being designed. Thus, a learner persona is a hypothetical learner who is representative of a number of potential learners, educators, etc. The purpose is to generalise and cover a significant portion of the potential users or people who may play an active role in the successful deployment of the learning analytics tool. This can facilitate the design process by bounding the scope to a limited, manageable set of personas, rather than a vague population.

Purpose in designing learning analytics: Defining what kind of learners are meant to be supported with the learning analytics tool should be the first step in the design process. There is a common consideration within the learning analytics field, that each stakeholder can play multiple roles at different times in the learning

ecosystem (G. Morgan, 2016). Thus, it is critical to cover every role involved in the learning process in the most accurate way possible. For this, we can use a graphic representation with the most useful information provided by real learners. The final result of a Persona represents the output of the initial investigation about the potential actors which are relevant for the system and is intended to look like a real person. According to Xiang Zhang (2016), Personas must help the designer answer three basic questions: *what are the learner's needs, what kinds of limitations do they have, and what are their expectations?*

The more information that can be obtained about learners the more representative the resulting Persona profiles will be. In terms of co-design, it is possible to invite people to build Persona profiles or create their own representations that can be merged later into different examples. Inspired by Cooper, Reimann, Cronin, and Noessel (2014)'s work, we suggest that a basic persona profile for learning analytics purposes can be described using the following sections:

- **Basic information.** This can include demographic details such as geographical area, age, residence, country or social class. This information can provide a quick way to identify possible similarities between learners, or basic segmentation groups without reading the whole profile.
- **Learning experience.** This refers to the academic background. Some characteristics that learners may have in common can be elicited from this information. This may help the design team to generate understanding about the context where learners generate new knowledge.
- **Personality.** Choosing the personality traits for this profile can be a complex task to do without the user perspective. For this, learners, academics and any other stakeholders may be asked to define themselves using a set of words related to their personalities. We can use more than one word for this factor and make simple relationships between more than one trait.
- **Expectations.** This section is one of the most useful specifications for the system. It provides an overview of what the persona expects and wants from the learning analytics tool. An explicit statement of expectations may be helpful in scenarios where prototypes are being tested. We must remember that the purpose of this profile is to create as much understanding as possible and provide support in the design of a learning analytics tool that truly fulfils the actors' expectations.
- **Learning goals.** Aligned to the expectations, learners have their own learning goals that can be paired with the teacher's goal definition. These examples can range from something really open (such as learning how to communicate) to something really specific in the long run (such as becoming a good lawyer).
- **Likes & dislikes.** This represents what the learners' preferences are, not only related to learning but also to general things like what to do in the leisure time, what kind of media they prefer to what kind of food they dislike.

- **Devices & platforms.** This section refers to the devices and platforms that are familiar to the learner. For example, we can define if the learner typically uses certain platforms over others. This section may also provide information about tool expertise. By co-designing with learners, it may be clearer what device or platform should be prioritised for the deployment of the learning analytics tool.
- **Key quotes.** Simulate a Persona comment to give him/her an attitude and create some kind of familiarity towards the representation.
- **Institution relationship:** This section specifies what kind of relationship the user has with the institution. It is critical for the whole learning ecosystem and the learning analytics tool design to define the level of trust and identity of each actor in relation to their institution.
- **Picture.** A picture of the persona can illustrate their personality and lifestyle.

Example: An example of co-creating user personas can be seen in Figure 3. In building this Persona, participants discussed the basic characteristics of currents learners inside their program, and completed the sections in a free form using sketching and labels. If participants suggested many different characteristics this could motivate two different profiles. The final result was discussed between the researcher and participants. To document the result, we translated this into a cleaner digital version to be shared across the team. Other participants like educators also gave direct feedback to supplement the structure. This representation also proved useful when introducing new stakeholders to the learning analytics project.

Figure 3. Co-creating Personas. Left: a group of learner filling the field of a Persona profile. Right: Digital version of the Persona profile refined by a designer based on learners' output.

4.2 Learner Journeys

Definition: Setting a common vision and sharing the same goals across stakeholders can be a difficult task if we cannot understand the context where the analytic tool will be used. Learner journeys can help to generate an image of the whole learning or usage process (Mears, 2017). A co-design implementation of this requires some simple elements so participants can build their own journey. These elements are:

- **Context:** Specify where are the users (e.g. classroom, home, library, etc.) and what is around them (monitors, books, desks, etc.). This can also include any external factors, which may be distracting them.
- **Progression:** How every step is connected and any other possible connection at the same time.
- **Emotion:** Emotions are an important part of interaction design. Actors can experience different emotions that should be assigned to every step like concern, engaged, bored, annoyed, anxious or satisfied.
- **Devices**: The devices being used by the users at any moment, optionally including their level of expertise and the device's technical capabilities.
- **Functionality:** Learners and educators can specify what functions they are expecting from the learning analytics system.
- **Data interaction:** Define if any data is required at a given step, for instance, a search query, saving data, a software update, making sense of a visualisation.

Purpose in designing learning analytics: This technique can help to identify possible functionality at a high level by understanding the key tasks that need to be accomplished by learners. This representation can help designers understand learner behaviour and how users are going to interact with the learning analytics system. On the same journey representation, we can add where learners interact with data and what kind of information they get in order to help them achieve their goals. In this case, interaction design can help to identify the flow of information and the nature of context where learners may use the learning analytics tool (Maria Mendiburo, Brian Sulcer, & Ted Hasselbring, 2014).

The output of this activity allows participants to produce a visualisation over time in different learning scenarios. Learners are able to map their experience with the current process and researchers can use this information to set better scenarios where the learning analytics tool can be used.

Example: An example learner journey can be seen in Figure 4, which is a synthesis the designer reported back to the students based on their own sketching work and learners' comments. In this activity, the researcher asked participants (learners) to describe their daily routine and explain their expectations from the learning analytics system. The expert/researcher provided the proper annotation useful for documentation purposes, including icons and representations. In this case, an expert specified data interactions inside the diagram, including what processes are happening in terms of data like fetch/read/update or deploy. In this figure, participants separated their usual day into four sections (before class, during the class, library and at home). Most learners in our cases start their day reading material on mobile devices/laptops which is a pleasant experience noted as an emotion on top. During the day, different interactions produce diverse emotions (for example, feeling nervous

the moment the class starts). Data interactions can also be pointed as opportunities for tracking, recording or delivering data to learners. When mapping interactions between learners, we can trace the overall experience by setting the learning space and moment where it happens. In this example, pleasant interactions commonly occur when having group conversations, but not in front of the professor.

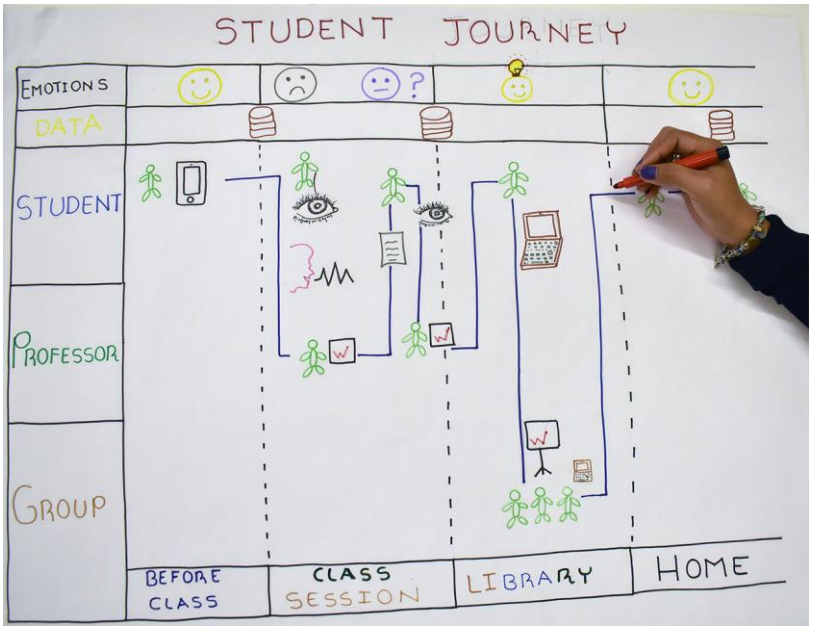

Figure 4. Learner journey for learning analytics made by a group of learners for our sessions.

4.3 Focus Group

Definition: This technique can provide great insights into learners' attitudes/opinions towards specific topics. The potential of focus group sessions is the ability to get a collective view on the problem and concerns, in contrast to information gathered from simple surveys where we generally ask closed questions that may limit the feedback that can be provide by participants. In addition to this, it is possible to get more in-depth information conducting individual interviews. Conducting interviews should be implemented if resources and time are available without compromising the project (Wilson, 1997).

Purpose in designing learning analytics: The main strength in using focus group sessions as a co-design technique is its effectiveness for collecting ideas that can be used for improvement and for identifying popular opinions among learners. They are also much more flexible than surveys or scales because they allow for questions, clarifications and follow-up questions to probe vague or unexpected responses (Krueger & Casey, 2014). In cases where more people are involved besides learners and instructors, it is necessary to ensure that the questions do represent their interests.

The main goal in conducting a focus group is to provide a channel for learners to communicate using open-ended question and avoiding short answers. The session should start with a clear set of instructions and a quick explanation about the topic to

be discussed. In the case of having learning analytics as the main topic, it can be helpful to provide an explanation of what is learning analytics, why is relevant for the session, what is the intention behind gathering these data and what concerns do actors have about the process. After this, we should allow some time for unanticipated questions.

This technique is intended to be for qualitative purposes, so usually numbers and percentages are not appropriate and should not be included in the final report. The report should be descriptive and present the meaning of the data as opposed to a simple overview (Mellon, 2014). Some classic approaches to analyse focus group sessions include:

- **Classical content analysis:** This method includes assigning codes to particular sections for the script. Each code allows the researcher to identify whether each participant refers to something of particular interest and assess whether each group is giving feedback on certain code (D. L. Morgan, 1998).
- **Keywords-in-context:** This method helps to identify the context of specific words or sentences. The importance in context for words in this approach is based on what's behind user intentions when using them (Fielding, Lee, & Lee, 1998).
- **Discourse analysis:** This analysis requires choosing segments from the conversation and looking for cultural associations on their use. In more explicit analysis, it is possible to look for rhetorical moves and accountability (Jørgensen & Phillips, 2002).

At the end, a report can be generated to include the final interpretation of group statements. This interpretation should be built following a descriptive process, providing meaning to the data and personal interpretation based on the facilitator's expertise. Involving specialists from different areas in education can be helpful when interpreting comments specially to avoid biases influencing the interpretation (Onwuegbuzie, Dickinson, Leech, & Zoran, 2009).

Example: A focus group session should be a place where participants feel comfortable when attending the session so be sure to establish pauses and time to discuss off topic things in your script. Seating arrangement is important to promote face-to-face interactions as seen in Figure 5. In this particular session, we started discussing general things like opinions on assignments and life outside of the classroom, this helped to build trust and setting a good mood for the session.

Figure 5. Six of our learners engaged in a focus group session.

4.4 Knowledge Mapping

Definition: Knowledge Mapping is a technique commonly used as an approach to make visible how a group understands key ideas and their connections. When facilitated well, mapping can enable the communication among observers with differing backgrounds at multiple levels of detail, and includes *mind maps, concept maps, dialogue maps* and *argument maps* (Okada, Shum, & Sherborne, 2014). Maps constructed by participants together with pens and large sheets of paper are participatory in the sense that everyone can contribute, and a map of branches radiating from a central node can grow more easily with multiple authors than a textual list. If a visual hypertext software tool is used, nodes can be textual notes, or links to documents, images or videos (Hanewald & Ifenthaler, 2014), but unless it is a synchronous, collaborative application, it may be less participatory in terms of who can contribute easily. Previous research demonstrates that it can be challenging for a facilitator to do real-time knowledge mapping of a team conversation in support of co-design, but once developed as a skill, can add significant value to the team and help integrate their knowledge (A. Selvin & Shum, 2014; A. M. Selvin & Buckingham Shum, 2002)

Purpose in designing learning analytics: Knowledge mapping for learning analytics can start with a basic form of mind mapping, and can be used to capture the team's understanding of many topics. For example, the branches might be: specifying who is the person responsible for an information source; explaining how the data can be accessed or acquired; defining how information should be handled; defining where data will be stored; and describing if and how information will be visualised. Some examples of similar collaborative approaches can be found in recent literature like collaborative knowledge mapping (Pavel Krbálek & Vacek, 2011) that can be done with experts and learners in different sessions, providing two different perspectives on what is important.

Example: As seen in the example knowledge map depicted in Figure 6, participants of this group mapped where they can get new knowledge for a particular course in algorithms. The final distribution gave us an idea of what form of knowledge

and resources are they dealing with. In later stages, we used this representation to map opportunities where improvement can be made.

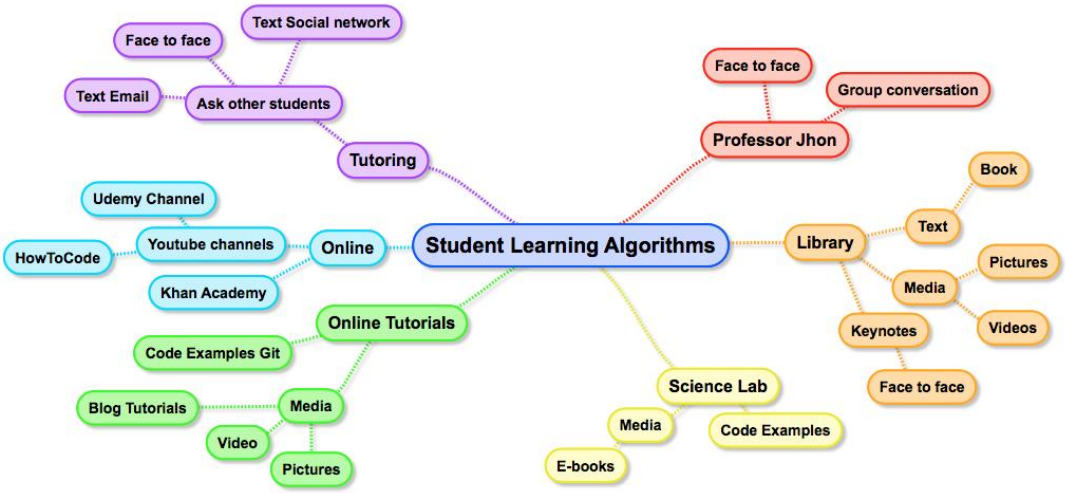

Figure 6. Output of the knowledge mapping activity generated by learners in one of our sessions.

4.5 Sketching and Prototyping

Definition: The making process where ideas acquire a visual representation is an opportunity for co-designers to engage beyond the ideation process. Prototyping may be useful to enable participants to communicate in a non-traditional way. This approach can invite learners to communicate their needs and expectations (Gaver, Dunne, & Pacenti, 1999).

Purpose in designing learning analytics: For educational purposes sketching and prototyping benefit from research actions conducted in the first exploratory part. Reflection and interpretation are the main objectives when building together a first prototype helping all learners involved in understanding what are they looking for in visual representations (Luckin et al., 2013).

A Sketch-in is an alternative group activity in which learners use sketching to resolve design problems together. This activity can be done in quick sessions using basic drawing materials like post-its, paper sheets and whiteboards. Sketches can be in a low fidelity setting only to illustrate concepts as we can see in Figure 7; also it is possible to demonstrate user interaction by implementing techniques like Wizard of Oz (Hanington & Martin, 2012) where simulation is being done without an actual product working.

Example: By sketching their own products, learners can express complex ideas in order to translate them into prototypes. What we have learnt from other areas where prototyping is massively used can be implemented in learning analytics design,

especially for developing new data visualisations. In the example shown in Figure 7, learners built their own representations to design a mobile app for tracking improvement. We provided some basic charts and plots as guidelines to express what they want to see. The result is a first visual representation containing main features expected after conducting the first implementation. These features ranged from colours, chart types, notification and labels on screen,

Figure 7. A group of our learners co-creating a low fidelity prototype for our mobile application related to personal feedback.

5 Putting Co-design into Practice

A co-design process for learning analytics is being conducted within one program at the University of Technology Sydney as part of a strategy for improving their engagement with tools and artefacts designed to support their learning. A core goal of this project is to design the means (e.g. a tool and its associated context of use) for helping learners to develop their graduate attributes for their course. By providing a timely feedback we can provoke reflection and generate understanding about their personal progress. Most of the examples illustrated in the previous section correspond to the scenarios where we have applied different co-design tools to involve learners in the learning analytics design process.

5.1 Case study: Co-design sessions with learners.

The project commenced with a group of learners from our Master in Data Science and Innovation (MDSI) program participating in co-designing sessions. First, we conducted a series of focus groups (see Section 4.3, e.g. Figure 5) as part of the *understanding* and *definition* stages of the Design Thinking process. The key challenge encountered in these first design sessions was the negotiation process required for the study participants with different backgrounds to explain their different (and sometimes contradicting) concerns and needs in terms of analytics provided, surveillance worries, progress, assessment and expectations.

Following the focus groups, we asked the same group of learners to collaborate building a persona profile (see Section 4.1, e.g. Figure 3) describing the most relevant personal characteristics. This was used to define what kind of device would be good for delivering feedback to each of them and better understand the context where the solution should operate. After this, they were asked to map the materials required to develop knowledge related attributes using a short representation of knowledge mapping (see Section 4.4, e.g. Figure 6). From this, some participants realised that other learners commonly use additional resources to supplement their learning after classes, which resulted in another group conversation about what other alternative resources should be included. Once we generated some understanding about the challenges, ideas started to emerge during the discussion. Based on these ideas, learners then decided which visual characteristics must be included by building a low fidelity prototype of a candidate learning analytics dashboard to support awareness of graduate attributes development (see Section 4.5 e.g. Figure 7).

5.2 Challenges and lessons learnt

As part of this collaborative co-design process, we (as researchers) faced a series of issues. First, we faced the challenge of making decisions based on (sometimes quite divergent) participants feedback and faculty expectations. After gathering enough information, we ended up with many (sometimes contrasting) ideas and representations. As a result, some of them had to be discarded. This is aligned with our iterative process based on Design Thinking. An expected output after gathering information from students during the two first Design Thinking stages (Understanding and Definition) is a consolidated first design proposal. This means, the leading actor of the design process (e.g. researchers or designers), need to both consider all stakeholders' voices and focus on certain ideas in order to keep the design process flowing towards the next stage. A practical way to manage the required decision making is to use voting or ranking mechanisms to allow the design team to move forward to the following stages whilst promoting agreement. For example, some ideas may seem to be really important for students but teachers may not find them pedagogically adequate or even feasible. In the end, the most interesting ideas should be relevant for everyone involved, and sufficiently fleshed out to allow the project to move on to the next stage of design work.

Another challenge is related to participants' availability. Some sessions require careful scheduling in order to allow students to participate while, at the same time, keep the project within the planned calendar for completion. In cases where students could not participate, individual feedback and interviews helped us extract additional information. The most important thing is to keep students involved even if this means making changes in the schedule or in the original plan. Communication before and after the sessions has to be dynamic. The most useful action to do is to set more than one channel to send messages via email, social media or group chats to participants.

Keeping these communication channels open is also critical for managing a third challenge: walking the fine line between remaining open to ideas as they emerge and keeping co-design sessions (and the project as a whole on track). Co-design seeks to remain very responsive to the insights and understandings that emerge through the design stages. When working with learners, educators and designers have to remain sensitive to the interests of students, while also ensuring they can glean from the sessions what is needed to move forward. In our project, we used the tools and techniques described in the previous section of this chapter to elicit understandings about the data and the analytics that would best support student learning, but at all times we needed the learners to be free to imagine from their perspective and not ours. Thus, we had to be careful not to presuppose any particular outcome. When trying to keep a project on track this can be an enormous challenge. Alongside the frequent contact with our learners, regular referential conversations within the team helps both student and team goals to shape the project.

One final overall challenge during the co-design process is the mechanism used for analysis. Most of the information gathered from co-design sessions is qualitative. Thus, designers or researchers need to spend time trying to extract some knowledge from the sessions in order to take meaningful actions. Each particular co-design tool may require a specific qualitative analysis methodology or framework for extracting knowledge. The more tools and techniques to be used during the first stages the more analysis time is required to distil critical information useful for design.

5.3 Tools and techniques for this study

The tools and techniques proposed in the previous sections can be used at different stages of the co-design process and can be tailored to the kind of information to be obtained from the actors at any time. For example, focus group sessions can be conducted at the initial stages of the project to generate understanding but also iteratively to involve actors along all the stages of the co-design process. Similarly, low fidelity prototyping can also be conducted at any stage with different purposes such as generating understanding, test new ideas, or delivering multiple alternatives. As we can see in **Figure 8. Tools and techniques for a co-design process used to involve MDSI learners at UTS to design learning analytics means to support the development of their graduate attributes.**, we propose to use these tools and techniques during along the different stages of the co-design process to gather different information and keep the actors (e.g. the MDSI learners in our case) in the design loop.

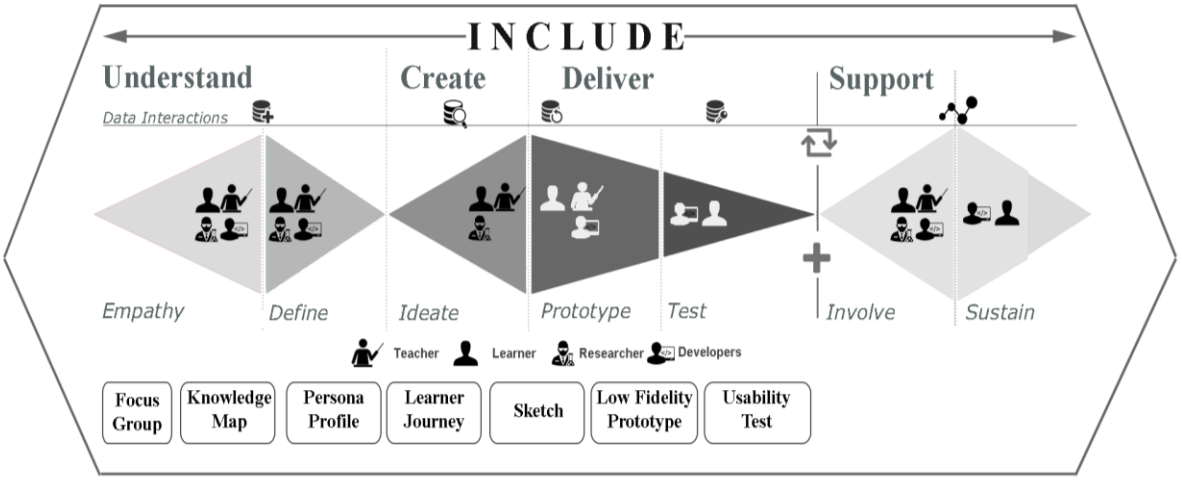

Figure 8. Tools and techniques for a co-design process used to involve MDSI learners at UTS to design learning analytics means to support the development of their graduate attributes.

6 Conclusion

Research in learning analytics is relatively new and, as it develops, new challenges will emerge. There are already concerns that learning analytics innovations will become just another genre of educational tools being imposed on teachers and learners. Imposing educational tools needs to be avoided since it may mean that the tools are not aligned with current pedagogical needs, practical challenges, or learning designs if they do not include learners as co-designers. This situation needs to be avoided if the ultimate goal is to promote wider institutional adoption in order to support learning effectively.

This chapter illustrated how a series of tools and techniques can be applied for co-designing learning analytics innovations. We propose that the co-design process can be grounded in Design Thinking stages, with the additional consideration of: i) the actors that are relevant in educational settings; ii) the role of data; and iii) the need for inclusion and sustained support to involve learners during the whole design process. Co-design and participation is critical to give voice to all actors. Understanding the basics of co-design can be a first step on the way for participatory innovation in learning analytics since it can create a wider array of possibilities, methods and tools.

References

Barendregt, W., Bekker, T. M., Eriksson, E., & Torgersson, O. (2016). *Legitimate Participation in the Classroom Context: Adding Learning Goals to Participatory Design*. Paper presented at the Proceedings of the The 15th International Conference on Interaction Design and Children, Manchester, United Kingdom.

Brown, T. (2010). Design Thinking for Social Innovation. *Development Outreach, 12*(1), 29-43. doi:10.1596/1020-797x_12_1_29

Chen, A.-Y., Mashhadi, A., Ang, D., & Harkrider, N. (1999). Cultural Issues in the Design of Technology-Enhanced Learning Systems. *British Journal of Educational Technology, 30*(3), 217-230. doi:10.1111/1467-8535.00111

Cook-Sather, A. (2014). Multiplying perspectives and improving practice: what can happen when undergraduate students collaborate with college faculty to explore teaching and learning. *Instructional Science, 42*(1), 31-46. doi:10.1007/s11251-013-9292-3

Cooper, A., Reimann, R., Cronin, D., & Noessel, C. (2014). *About Face: The Essentials of Interaction Design*: Wiley.
Corrin, L., & Barba, P. d. (2015). *How do students interpret feedback delivered via dashboards?* Paper presented at the Proceedings of the Fifth International Conference on Learning Analytics And Knowledge, Poughkeepsie, New York.
Day, G., & Croxton, S. (1993). Appropriate Technology, Participatory Technology Design, and the Environment. *Journal of Design History, 6*(3), 179-183.
Ellingsen, M. (2016). Design Thinking in a Day. Retrieved from http://designthinking.co.nz/design-thinking-in-a-day/
Fielding, N. G. G., Lee, N. F. R. M., & Lee, P. R. M. (1998). *Computer Analysis and Qualitative Research*: Sage Publications (CA).
Gasevic., D., Pardo., A., & Dawson., S. (2016). *How do we start? State and Directions of Learning Analytics Adoption* (978-82-93172-37-6). Retrieved from
Gaver, B., Dunne, T., & Pacenti, E. (1999). Design: Cultural probes. *interactions, 6*(1), 21-29. doi:10.1145/291224.291235
Gough, N. (2004). RhizomANTically Becoming-Cyborg: Performing posthuman pedagogies. *Educational Philosophy and Theory, 36*(3), 253-265. doi:10.1111/j.1469-5812.2004.00066.x
Hanewald, R., & Ifenthaler, D. (2014). Digital Knowledge Mapping in Educational Contexts. In D. Ifenthaler & R. Hanewald (Eds.), *Digital Knowledge Maps in Education: Technology-Enhanced Support for Teachers and Learners* (pp. 3-15). New York, NY: Springer New York.
Hanington, B., & Martin, B. (2012). *Universal Methods of Design: 100 Ways to Research Complex Problems, Develop Innovative Ideas, and Design Effective Solutions*: Rockport Publishers.
Herold, B. (2015). Why ed tech is not transforming how teachers teach. *Education Week, 34*(35), 8.
Holstein, K., McLaren, B. M., & Aleven, V. (2017). *Intelligent tutors as teachers' aides: exploring teacher needs for real-time analytics in blended classrooms*. Paper presented at the Proceedings of the Seventh International Learning Analytics & Knowledge Conference, Vancouver, British Columbia, Canada.
Iaqat, A., Mohsen, A., & Gašević, D. (2013). Factors Influencing Beliefs for Adoption of a Learning Analytics Tool: An Empirical Study. *Computers & Education, 62*, 130-148. doi:10.1016/j.compedu.2012.10.023
IDEO. (2016). *Design Thinking for Educators* (IDEO Ed. First ed. Vol. 1). https://designthinkingforeducators.com/toolkit/: IDEO.
Jisc. (2016). Effective learning analytics. *Effective Learning Analytics.* Retrieved from https://www.jisc.ac.uk/rd/projects/effective-learning-analytics
John Avella, Mansureh Kebritchi, Sandra Nunn, & Therese Kanai. (2015). Learning Analytics Methods, Benefits, and Challenges in Higher Education: A Systematic Literature Review. *Learning Analytics Methods, Benefits, and Challenges in Higher Education: A Systematic Literature Review, 1*, 1-18. Retrieved from olj.onlinelearningconsortium.org website: https://olj.onlinelearningconsortium.org/index.php/olj/article/view/790/201
Jørgensen, M. W., & Phillips, L. J. (2002). *Discourse Analysis as Theory and Method*: SAGE Publications.
Koh, J. H. L., Chai, C. S., Wong, B., & Hong, H. Y. (2015). *Design Thinking for Education: Conceptions and Applications in Teaching and Learning*: Springer Singapore.
Könings, K. D., Seidel, T., & van Merriënboer, J. J. G. (2014). Participatory design of learning environments: integrating perspectives of students, teachers, and designers. *Instructional Science, 42*(1), 1-9. doi:10.1007/s11251-013-9305-2
Krueger, R. A., & Casey, M. A. (2014). *Focus Groups: A Practical Guide for Applied Research*: SAGE Publications.
Lee, Y. (2008). Design participation tactics: the challenges and new roles for designers in the co-design process. *CoDesign, 4*(1), 31-50. doi:10.1080/15710880701875613

Luckin, R., Puntambekar, S., Goodyear, P., Grabowski, B. L., Underwood, J., & Winters, N. (2013). *Handbook of Design in Educational Technology*: Taylor & Francis.
Madeline Huberth, Nicole Michelotti, & McKay, T. (2013). E2Coach: Tailoring Support for Students in Introductory STEM Courses. *Case Studies, 12*(1). Retrieved from http://er.educause.edu/articles/2013/12/e2coach-tailoring-support-for-students-in-introductory-stem-courses website: educause.edu
Maria Mendiburo, Brian Sulcer, & Ted Hasselbring. (2014). *Interaction design for improved analytics*. Paper presented at the Fourth International Conference on Learning Analytics And Knowledge, Indiana, USA.
McPherson, J., Tong, H. L., Fatt, S. J., & Liu, D. (2016). *Student perspectives on data provision and use: starting to unpack disciplinary differences.* Paper presented at the Proceedings of the Sixth International Conference on Learning Analytics & Knowledge, NY, USA.
Mears, C. (2017). User Journeys – The Beginner's Guide. *UX Basics.* Retrieved from http://theuxreview.co.uk/user-journeys-beginners-guide/
Mellon, C. (2014). Using Focus groups to get student feedback. *Enhancing Education.* Retrieved from http://www.cmu.edu/teaching/assessment/howto/assessteaching/focusGroups.html
Morgan, D. L. (1998). *The Focus Group Guidebook*: SAGE Publications.
Morgan, G. (2016). Learning Analytics in Higher Education. *Learning Analytics, 1*, 44. Retrieved from https://library.educause.edu/resources/2016/2/learning-analytics-in-higher-education
Nussbaum, B. (2011). Design Thinking Is A Failed Experiment. So What's Next? *5 minute Read.* Retrieved from https://www.fastcodesign.com/1663558/design-thinking-is-a-failed-experiment-so-whats-next
Okada, A., Shum, S. B., & Sherborne, T. (2014). *Knowledge Cartography: Software Tools and Mapping Techniques*: Springer London.
Onwuegbuzie, A. J., Dickinson, W. B., Leech, N. L., & Zoran, A. G. (2009). A Qualitative Framework for Collecting and Analyzing Data in Focus Group Research. *International Journal of Qualitative Methods, 8*(3), 1-21. doi:10.1177/160940690900800301
Pavel Krbálek, & Vacek, M. (2011). *Collaborative knowledge mapping*. Paper presented at the Proceedings of the 11th International Conference on Knowledge Management and Knowledge Technologies, Graz, Austria.
Roberts., L. D., Howell., J., & Seaman., K. (2016). Student Attitudes toward Learning Analytics in Higher Education: "the fitbit version of the learning world".
Sanders, E. B.-N. (1999). Postdesign and participatory culture. *Proceedings of Useful and Critical: The Position of Research in Design. University of Art and Design, Helsinki*.
Selvin, A., & Shum, S. B. (2014). *Constructing Knowledge Art: An Experiential Perspective on Crafting Participatory Representations*: Morgan & Claypool Publishers.
Selvin, A. M., & Buckingham Shum, S. J. (2002). Rapid knowledge construction: a case study in corporate contingency planning using collaborative hypermedia. *Knowledge and Process Management, 9*(2), 119-128. doi:10.1002/kpm.140
Simonsen, J., & Robertson, T. (2012). *Routledge international handbook of participatory design*: Routledge.
Slade, S., & Prinsloo, P. (2015). Student perspectives on the use of their data: between intrusion, surveillance and care. *Student perspectives on the use of their data: between intrusion, surveillance and care*, 291-300.
Tanes, Z., Arnold, K. E., King, A. S., & Remnet, M. A. (2011). Using Signals for appropriate feedback: Perceptions and practices. *Computers & Education, 57*(4), 2414-2422. doi:http://dx.doi.org/10.1016/j.compedu.2011.05.016
Tone Bratteteig, & Wagner, I. (2016). *What is a participatory design result?* Paper presented at the 14th Participatory Design Conference, Aarhus, Denmark.
Wilson, V. (1997). Focus Groups: A Useful Qualitative Method for Educational Research? *British Educational Research Journal, 23*(2), 209-224.

Xiang Zhang, H.-F. B. (2016). *Data-driven Personas: Constructing Archetypal Users with Clickstreams and User Telemetry*. Paper presented at the CHI'2016, Santa Clara, California.