Designing LADs that promote sensemaking: a participatory tool

Madjid Sadallah[1], Jean-Marie Gilliot[1], Sébastien Iksal[2], Katia Quelennec[3], Mathieu Vermeulen[4], Laurent Neyssensas[5], Olivier Aubert[6], and Rémi Venant[2]

[1] IMT Atlantique, Lab-STICC UMR CNRS 6285, F-29238 Brest, France
madjid.sadallah@imt-atlantique.fr, jm.gilliot@imt-atlantique.fr
[2] University of Le Mans, Avenue Olivier Messiaen, 72085 Le Mans, France
sebastien.iksal@univ-lemans.fr, remi.venant@univ-lemans.fr
[3] Sorbonne Université and Univ. Lille, F59000 Lille, France
katia.quelennec@univ-lille.fr
[4] Center for Digital Systems, IMT Nord Europe, Univ. Lille, F-59000 Lille, France
mathieu.vermeulen@imt-nord-europe.fr
[5] Ecole de Design Nantes Atlantique, 44306 Nantes, France
l.neyssensas@lecolededesign.com
[6] LS2N - UMR 6004 CNRS, Nantes Université
olivier.aubert@univ-nantes.fr

Abstract. Learning Analytics Dashboards (LADs) are data visualization tools built to empower teachers and learners to make purposeful decisions that impact the learning process. Due to their relatively recent emergence and the scarcity of studies on their design principles, dashboard design remains a major area of investigation in learning analytics research, and large scale diffusion to their stakeholders remains limited. We promote human-centered approaches for LADs design since their success in terms of acceptance and adoption greatly depends on the level of stakeholder involvement in their design. In this paper, we present a tool to support the participatory design of LADs. First experiments during a pilot study with teachers demonstrate that the proposed tool encourages group work, and in-depth exploration of LADs use.

Keywords: Learning Analytics · Dashboards · Participatory design · Sensemaking

1 Introduction

Learning Analytics Dashboards (LADs) are visualization tools designed to enable teachers and learners to make relevant decisions that impact the learning process [10]. Although they have received increasing interest in recent years, large scale diffusion to their stakeholders remains limited. We argue that reasons are multiple: (1) scarcity of studies on their design principles due to the their relative recent emergence [7]; (2) difficulty to design effective LADs without involving stakeholders [5]; (3) lack of relevant expertise and visual literacy among stakeholders [17] ; and (4) failure of LADs to turn insights into action as

the processes by which people use these representations for insight seeking and decision-making are still not well understood [19].

According to research, the success of dashboards in terms of acceptance and adoption, and more globally of any LA innovation, greatly depends on the level of stakeholder involvement in the design process [9]. This has motivated the increasing focus of the LA research community on Human-Centered Design (HCD) approaches and the emergence of the Human-Centered Learning Analytics (HCLA) [3]. *Participatory design* (or *co-design*) is a popular approach in HCLA. It derived from user-centered design as a particular case of co-creation where designers who are trained in creativity work together with non-designers during the design process. In LA, it is defined 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* [15]. Although LA academics and practitioners are increasingly acknowledging the relevance of HCD methods such as participatory design, their integration into learning analytics has been slow and is still not yet widespread [16], and approaches to achieving this remain unclear [6, 2].
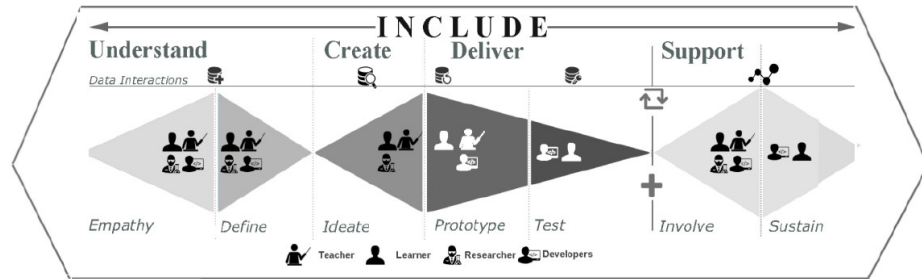

Fig. 1: Interaction co-design process and roles for LA [15]

We aim to instrument more specifically for LADs the co-design process adapted to LA and proposed in [15] (figure 1). Its activities are iterated to refine the needs and get closer to the desired solution. In a previous work [4], *Understand* phase was established and has been continuously refined through extensive interaction with different stakeholders. In this paper, we focus more specifically on the *Create* phase. We propose a participatory design tool intended to enable, promote and enhance the accurate and insightful expression of key design elements and requirements (including visualization and idea generation). As recent research on dashboards demonstrates, the sensemaking dimension is pivotal in the construction of relevant dashboards [14]. We thus propose to make this dimension explicit in LAD design.

The remainder of this paper begins with a review of relevant research. It then introduces the proposed participatory design toolkit and briefly describes a case study that illustrates the use of the design tool, before concluding.

2   Background and related work

2.1   Participatory design of LADs

Participatory design promotes consensus building and the convergence of the different stakeholders on the main objective of the dashboard, encourages collective innovation and creativity, and anticipates possible adoption obstacles or usage difficulties. While some examples of successful use for co-design of dashboards are reported in the literature [16], the LA community still lacks tools specific to the needs of LA stakeholders to effectively communicate and understand the design components [2, 6]. Popular methods being implemented include workshops and focus groups [1], learning personas [15], and card-based co-design [2]. *Workshops and focus groups* are used to derive design ideas and identify stakeholder opinions. *Learning personas* allow modeling and summarizing essential information about the people who are likely to be involved in the learning ecosystem. *Card-based co-design* provides a common basis for understanding and communication between stakeholders, supports creative combinations of information and ideas, and enhance collaboration and combined creativity [12].

2.2   Supporting sensemaking with LADs

LADs support and augment human cognition by offering visualizations of learning data [19]. As it is important to know how the user makes sense of the information delivered with LADs, researchers start focusing on how sensemaking occurs with such tools [13]. Proposed models to investigate interaction and sensemaking with LADs tend to break down the process into phases that go from perceiving the dashboard to taking and implementing actions. For instance, the model described in [18] defines four steps: awareness, reflection, sensemaking and action. The steps defined by these models are similar to the levels of situational awareness (SA) investigated by the naturalistic movement to explore human decisions [8]: *perception* of environmental elements in a volume of time and space, *comprehension* of their meaning, and *projection* of their state in the near future. In this paper, we consider sensemaking as the process of constructing situational awareness through which a course of action is developed [11], and interaction as the means by which users draw meaning from LADs.

3   LAD participatory design's support

3.1   Description of the participatory design toolkit

To be effective, a participatory design method needs to be properly instrumented. We therefore designed the PaDLAD (*PArticipatory Design of Learning Analytics Dashboards*)[7] toolkit to support users in better expressing their expectations and needs. Our aim is to foster collaborative workshops. We distinguish three phases

---

[7] https://padlad.github.io/Participatory-Design-ToolkitV2/en/

(a) Identification board

(b) DataViz board
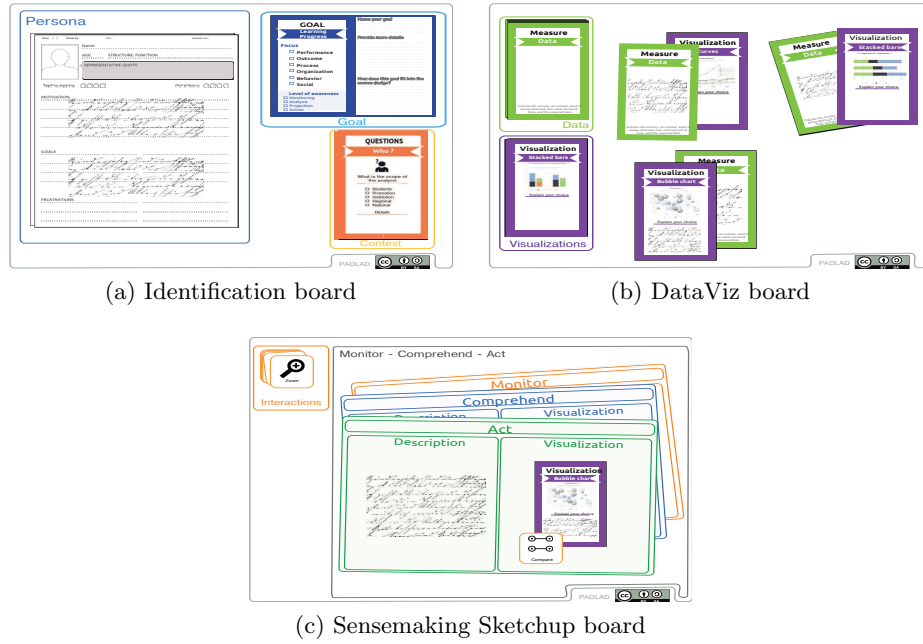

(c) Sensemaking Sketchup board

Fig. 2: Participatory Design Toolkit

to support the process: (1) *Identification* of the LAD's context and goal; (2) *Data & Visualization* to explore useful data; and (3) *Sensemaking Sketchup* to explore LAD organization and interaction to support sensemaking. These phases are materialized by dedicated boards that group various cards (figure 2).

Identification board. This board is based on the definition of a persona to personify and describe the stakeholders (their expertise, visual literacy, etc.). The goal being essential for ideation, we dedicate a specific domain card to support its expression. Depending on their profiles (learners, teachers, etc.), participants express their goal and relate it to focus and situation awareness level.

Data & visualization board. Participants are invited to identify relevant data that are useful to attain their goal. They fill a specific data card for each. They are also invited to associate visualizations they feel relevant. For this, a set of technology cards proposing classical visualizations is provided.

Sensemaking Sketchup board. The sketching phase supports sensemaking in three ways. First, to foster browsing the Situation Awareness levels, mockups of different colors are used: red for monitoring, blue for analyzing and green for action. Participants have to associate data and visualizations with the different mockups. Second, technology cards are provided to help participants associate interaction options to the LAD. Third, a storyboard form is attached to each mockup to describe the sensemaking process.
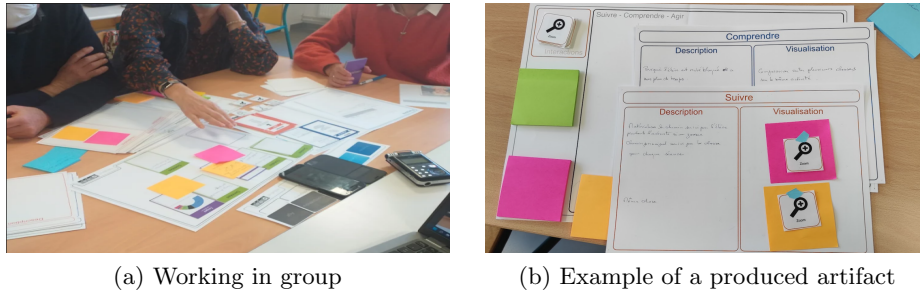
(a) Working in group   (b) Example of a produced artifact

Fig. 3: A participatory design workshop using the proposed toolkit

3.2 Ideation workshop using the toolkit

The design session starts with negotiating a goal and setting up the persona (figure 3a). Next, participants should work collaboratively to make use of the various boards, cards, and other layouts designed to facilitate the expression of their needs, and to support their creativity. The sequence in which these actions are addressed does not matter, as the participants may have prior ideas (data you want to use, a dashboard you want to use...). Nevertheless, the following order is of interest by default: Who wants to do what, with what data and how to access it to track the achievement of a goal, understand what is happening and act to better fulfill their goal. The more content users can express, the more readily the corresponding dashboard can be created. If they are not inspired by a particular section at a given time, they should not get stuck on it; they can come back to it later. Finally, the session resulted in a potential design represented as filled-in cards arranged in the different boards (figure 3b).

3.3 A use case

To experiment with the proposed design tool in a real educational setting, we organized a workshop with secondary school teachers. Participants were six teachers (3 male, 3 female), one administrator (male), one instructional designer (female), and three researchers (2 male, 1 female) who played the role of facilitators.

The main challenge encountered during the ideation phase was the negotiation process necessary to establish a persona. This reflects the different and sometimes conflicting personality traits, challenges, needs and aspirations of the participants. Once the description of the persona has been established, the participants moved on to the definition of the pursued goal. They agreed to consider *learning progress*, to focus on the *process* with a *situational awareness level* going from monitoring to planning. Their aim was to adapt their teaching according to the obtained feedback and to develop equality among students.

The participants used the context description cards to express the willingness to consider in-class data of students of each session individually and in combination, and to share the dashboard with the teaching staff. The clear specification

of the identification board helped the group in building the target picture using the DataViz board, and simplified the choice of data and visualization to be used. Nevertheless, the different levels of visual literacy have led to debates about which visual representations are most appropriate. The participants felt and expressed the need to be supported in this phase. Finally, the participants constructed the different views of the dashboard following the reasoning stage. Once they had understood the rationale, they found this approach to conceptualizing a dashboard intuitive since it reflects and even materializes the steps of the reasoning and allows them to project themselves into real use scenarios.

4   Conclusion

In this contribution, we proposed PaDLAD, a tool specifically designed to support LAD co-design by promoting a more precise decomposition of the intended goals, including situation awareness level. We combine personas profile to express user needs and ideation card to promote domain needs, and sketching to enable prototyping. A first experiment demonstrated that innovative proposals and LA adoption are possible with teachers, using a participatory approach. Believing that this kind of tools are contextual, we plan to specialize and test the tool in different contexts, with different audiences, and for different purposes. For example, level of situation awareness may be expressed as monitoring, analysis, and decision-making at a governance or institutional level, but will rather be: awareness, reflection and feedback for the student. Adoption of different participatory tools may also vary according to different audiences. To conclude, collecting LAD proposals from users and practitioners may bring out new needs and unveil new intended goals that should be shared with the learning community.

5   Acknowledgment

References

1. Ahn, J., Campos, F., Hays, M., DiGiacomo, D.: Designing in context: Reaching beyond usability in learning analytics dashboard design. Journal of Learning Analytics **6**(2), 70–85 (2019)

2. Alvarez, C.P., Martinez-Maldonado, R., Shum, S.B.: La-deck: A card-based learning analytics co-design tool. In: Proceedings of the tenth international conference on learning analytics & knowledge. pp. 63–72 (2020)
3. Buckingham Shum, S., Ferguson, R., Martinez-Maldonado, R.: Human-centred learning analytics. Journal of Learning Analytics **6**(2), 1–9 (2019)
4. Dabbebi, I., Iksal, S., Gilliot, J.M., May, M., Garlatti, S.: Towards adaptive dashboards for learning analytic: An approach for conceptual design and implementation. In: 9th International Conference on Computer Supported Education (CSEDU 2017). pp. 120–131 (2017)
5. Dimitriadis, Y., Martínez-Maldonado, R., Wiley, K.: Human-centered design principles for actionable learning analytics. In: Research on E-Learning and ICT in Education, pp. 277–296. Springer (2021)
6. Dollinger, M., Liu, D., Arthars, N., Lodge, J.M.: Working together in learning analytics towards the co-creation of value. Journal of Learning Analytics **6**(2), 10–26 (2019)
7. Echeverria, V., Martinez-Maldonado, R., Granda, R., Chiluiza, K., Conati, C., Shum, S.B.: Driving data storytelling from learning design. In: Proceedings of the 8th International Conference on Learning Analytics & Knowledge. pp. 131–140. ACM (2018)
8. Endsley, M.: Toward a theory of situation awareness in dynamic systems: Situation awareness. Human factors **37**(1), 32–64 (1995)
9. Holstein, K., McLaren, B.M., Aleven, V.: Intelligent tutors as teachers' aides: Exploring teacher needs for real-time analytics in blended classrooms. In: Proceedings of the 7th International Learning Analytics and Knowledge Conference. pp. 257–266. ACM, New York, NY, USA (2017)
10. Jivet, I., Scheffel, M., Drachsler, H., Specht, M.: Awareness is not enough: Pitfalls of learning analytics dashboards in the educational practice. In: Lavoué, É., Drachsler, H., Verbert, K., Broisin, J., Pérez-Sanagustín, M. (eds.) Data Driven Approaches in Digital Education. pp. 82–96. Springer International Publishing, Cham (2017)
11. Klein, G., Moon, B., Hoffman, R.R.: Making sense of sensemaking 1: Alternative perspectives. IEEE intelligent systems **21**(4), 70–73 (2006)
12. Lucero, A., Dalsgaard, P., Halskov, K., Buur, J.: Designing with cards. In: Collaboration in Creative Design, pp. 75–95. Springer (2016)
13. Nguyen, H., Campos, F., Ahn, J.: Discovering generative uncertainty in learning analytics dashboards. In: Visualizations and Dashboards for Learning Analytics, pp. 457–475. Springer (2021)
14. Pozdniakov, S., Martinez-Maldonado, R., Tsai, Y.S., Cukurova, M., Bartindale, T., Chen, P., Marshall, H., Richardson, D., Gasevic, D.: The question-driven dashboard: How can we design analytics interfaces aligned to teachers' inquiry? In: Proceedings of the 12th International Learning Analytics and Knowledge Conference. pp. 175–185 (2022)
15. Prieto-Alvarez, C.G., Martinez-Maldonado, R., Anderson, T.D.: Co-designing learning analytics tools with learners. In: Lodge, J.M., Horvath, J.C., Corrin, L. (eds.) Learning Analytics in the Classroom, pp. 93–110. Routledge, Abingdon, Oxon ; New York, NY : Routledge, 2019., 1 edn. (Oct 2018)
16. Sarmiento, J.P., Wise, A.F.: Participatory and co-design of learning analytics: An initial review of the literature. In: Proceedings of the 12th International Learning Analytics and Knowledge Conference. pp. 535–541 (2022)
17. Schwendimann, B.A., Rodriguez-Triana, M.J., Vozniuk, A., Prieto, L.P., Boroujeni, M.S., Holzer, A., Gillet, D., Dillenbourg, P.: Perceiving learning at a glance: A

systematic literature review of learning dashboard research. IEEE Transactions on Learning Technologies **10**(1), 30–41 (2017)

18. Verbert, K., Duval, E., Klerkx, J., Govaerts, S., Santos, J.L.: Learning analytics dashboard applications. American Behavioral Scientist **57**, 1500 – 1509 (2013)

19. Verbert, K., Ochoa, X., De Croon, R., Dourado, R.A., De Laet, T.: Learning analytics dashboards: the past, the present and the future. In: Proceedings of the 10th International Conference on Learning Analytics & Knowledge. pp. 35–40 (2020)