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Designing a Moodle Plugin for Promoting Learners' Self-regulated Learning in Blended Learning

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Abstract.

After the COVID-19 pandemic, universities moved towards online and Blended Learning (BL) modes to offer greater curricular flexibility. Yet, recent research shows that students have difficulties regulating their learning strategies to adapt to the different learning modes that BL entails, which mixes face-to-face with online activities taking place in different learning contexts and environments. Prior work on Self-Regulated Learning (SRL) has explored the use of dashboard-based scaffolds for supporting students' learning strategies. However, most existing solutions are designed for supporting students in online settings (i.e., MOOCs), disregarding the teachers' role in BL settings and the support they need to moni-tor and promote students' SRL. This paper presents the design process followed for transforming a tool designed for supporting students' SRL in MOOCs into a Moodle plugin for BL. Following a design-based research methodological app-roach, we describe all the phases conducted for identifying the most appropriate indicators and visualizations for supporting SRL in BL practices, implementing and evaluating a first prototype. Results of a local evaluation with 114 teachers and a broad evaluation with 311 students shed some light on the type of indicators, dashboards and functionalities that should be considered when designing solutions for supporting SRL in BL settings.

Keywords:
Blended learning · Self-regulated learning · Dashboards · Learning analytics · Design-based research

1 Introduction

After the COVID-19 pandemic, Higher Education Institutions (HEIs) are especially interested in fostering students' SRL skills because of the transformation towards a more flexible Blended Learning (BL) models of learning and instruction. BL combines *traditional face-to-face (f2f) with online activities* taking place in different learning

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environments and contexts [1] which has been proven an effective method for supporting students' SRL [1, 2]. However, recent research points out that some students show difficulties in regulating their learning strategies in BL, since they must vary their learning strategies depending on the learning mode (online or face-to-face) [2–4].

To support learners in their SRL process, researchers have proposed different approaches [5], being tools based on dashboards the most frequent. These solutions transform trace data into "actionable insights" to foster students' meta-reflection, self-monitoring and produce behavioral changes [6]. So far, most of this prior work have been conducted in online settings in which students have low interaction with teacher, such in Massive Open Online Courses (MOOCs) [7], but very few have been proposed for BL (i.e., [8–10]). These studies suggest that dashboards could be a good approach for supporting SRL strategies, being goal setting, strategic planning, time management and monitoring the SRL processes proved as the more effective for promoting students' motivation, and impact in course performance.

However, these solutions entail two important limitations when applied in BL. First, they are focused mainly in providing students' support disregarding the teachers' role, even when prior literature stresses the essential role they play in BL [11]. Second, only some tools have been designed taking as a basis theoretical models of SRL, which makes it difficult to evaluate their actual impact on learners' behavior when evaluated in actual learning scenarios. Thus, there is a need to expand the diversity of tools for supporting self-regulation in BL, considering not only the students, but also the teachers, offering dashboards that could help them do timely interventions to promote self-regulated behaviors.

1.1 Contribution, Research Questions and Methodology

This paper presents the design process followed for transforming a previous plugin designed for supporting SRL in MOOCs called NoteMyProgress MOOC (NMP MOOC) [12] into a Plugin for Moodle aimed at supporting SRL in BL courses. The NMP MOOC is a web application that complements the Coursera MOOC platform to support students' SRL through interactive visualizations. The result of this transformation is the plugin NMP for Moodle, which includes visualizations for both teachers and students.

For the design of NMP Moodle we followed the Design Based Research (DBR) methodological approach [13]. This approach mixes empirical research on education with theories oriented towards the design of learning environments, from the analysis and design to the implementation and evaluation. To apply the DBR methodological approach, we used the Interactive Learning Design (ILD) framework [14]. The ILD framework organizes the research process into four phases: (1) *Informed exploration*, in which we studied the needs, available theories and audience of the tool; (2) *Enactment*, phase in which the design of a tool is proposed and implemented; (3) *Evaluation of local impact*, which aims at evaluating the impact of the intervention at a local level, focusing on particular research questions for that context; and (4) *Evaluation of broader impact*, which considers the analysis of the technological intervention into a wider audience. Figure 1 shows how the ILD methodology was implemented for the design and evaluation of the new version of NMP Moodle. The following link includes all the collected data

and its analysis in the different phases: https://osf.io/w2p83/. Two **research questions** guided the whole process:

- **(RQ1) What are the indicators and visualizations that should be included in a tool for supporting SRL in BL settings?** The objective was to identify the dashboards and indicators in prior work (including NMP MOOC) that could serve as a basis for proposing a tool for BL settings.
- **(RQ2) How a prototype of a tool including the identified indicators is perceived by the end-users in terms of usability and sense making?** The objective was to evaluate the meaningfulness of the dashboards, in terms of usability and sense making, produced for both teachers and students.

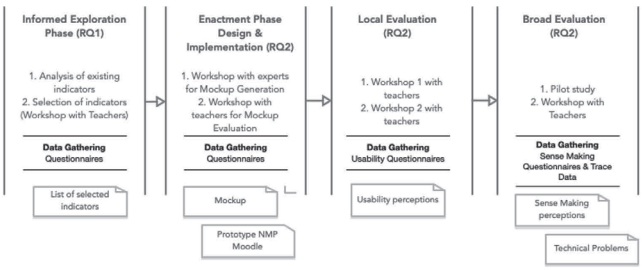

Fig. 1. Cycles of the ILD framework conducted for developing and evaluating NMP Moodle.

2 Informed Exploration Phase

The main objective of the **Informed Exploration phase** was to identify what indicators to include in the dashboards of the NMP Moodle for supporting SRL in a BL course considering both teachers and students (related with RQ1). Specifically, we conducted an analysis of existing indicators used in existing proposals and platforms to identify the indicators to be used in teachers' and students' dashboards. This process was structured into two phases: (1) an analytical phase; and (2) a selection phase.

Phase 1. Analysis of Existing Indicators. In this phase, we conducted an exhaustive analysis of the indicators used in NMP MOOC, in the Coursera dashboards (platform in which NMP MOOC was evaluated), and in existing Moodle plugins designed for supporting teachers in students' monitoring (such as SmartKlass, Dropout Detective dashboard, Plugin Analytics, GISMO, Intelliboard moodle dashboard). The NMP MOOC was included in the analysis for identifying what indicators to be used in students' dashboards, while the analysis of the Coursera dashboards and Moodle plugins were selected for the indicators to be used in teachers' dashboards.

As a result, we obtained a list of indicators organized and classified according to the categories defined in Schwendimann et al. (2017) [15] (i.e., Action-related; Content-related, Results-related, Social-related, Context-related and Learner-related). A total of 135 indicators were identified (See https://osf.io/kez2d/) in this first phase. From these 135 indicators, some of them appeared only in one of the tools, while others appeared in sevarl tools. 61 were used in the Coursera teachers' dashboards and included, among others: students with difficulties, number of events per day, students who did not submit an evaluation, students' progress in the course. 28 were in the Moodle plugins, which included information such as: the number of evaluations performed by the learner per day, individual assessments, number of students with difficulties or average grades. 59 were included in NMP MOOC, which included information for students such as: time spent during the week, numbers of started activities, numbers of completed activities, number of sessions per week, among others.

Phase 2. Selection of Indicators. With the list of indicators obtained in the analysis, we generated an instrument to collect information on teachers' feedback needs in a BL context (See https://osf.io/u8dnz/). The survey included 11 questions to identify what teachers expect from a tool for supporting their BL practices, the functionalities that they consider relevant to include in the tool, and the indicators that they would expect to see in the dashboards of this tool. In addition, we included 11 questions (5 closed and 6 open ended) asking about their experience with BL courses and their expectations of using a tool for supporting them in this type of learning setting. A total of 40 teachers (out of 50) from 20 Latin American universities from 10 countries that belong to the LALA community[1] participated in the survey.

The answers to the questionnaire were analyzed by 3 researchers, but only the answers to close questions Q8, Q9, and Q10 were considered for this study. These questions are related with the expectations of the teachers regarding a tool for supporting SRL in BL, the functionalities they would like to include and the indicators that should be considered. The results (See https://osf.io/tpn5b) indicate that over 70% of the teachers wanted a tool: (1) for monitoring and evaluating learners during the learning process; (2) with visual graphs to display the data; (3) with indicators about students' progress; (4) for identifying students at risk and add indicators about their interaction with the course content to provide them with timely feedback.

[1] LALA SIG: https://www.solaresearch.org/community/sigs/lala-sig/.

Table 1. Summary Table of the selected indicators to be included in the NMP Moodle in relation with the SRL process they support (GS: Goal Setting; SP: Strategic Planning; TM: Time Management; and SE: Self-Evaluation). See the extended list of indicators: https://osf.io/6ux5r/.

#	Indicator	GS	SP	TM	SE
1–3	Planned Time to spend by week/resource/activity	X	X	X	
4–6	Average time spent by students per week/resource/activity			X	X
7–15	Average time spent by high/middle/low performance students by week/resource/activity			X	X
16–18	Time spent per student per week/resource/activity			X	X
19–24	Number of students' interactions per resource/activity per day/week/hour				X
25	Resources with the fewest interactions				X
26	Average attempt by assessment				X
27	Students' grade per evaluation				X
28,29	Percentage of progress of a student per week/ on the course				X

2.1 Results of the Informed Exploration Phase

Three researchers cross-analyzed the results to extract a set of indicators that could support teachers in their BL practices and support students' SRL processes. Specifically, they selected from the list of indicators in Phase 1 those which aligned with the expectations, functionalities and indicators requested by the teachers in the questionnaire (Q8, Q9 and Q10) and related them to the SRL processes that they could support. The result was a list of 29 indicators to be included in the first version of the tool NMP Moodle. Table 1 includes the selected indicators as well as the SRL processes they are associated with for both teachers and students. The indicators for the students were extracted from NMP MOOC tool. The list includes the 29 indicators to support Goal Setting, Strategic Planning, Time management, and Self-evaluation.

3 Design

The main objective of this phase was to extract the design requirements of a NMP Moodle plugin considering the indicators and functionalities identified in the Informed Exploration phase. This phase was structured into two different phases: (1) a workshop with Experts for Mockup generation; and (2) a workshop with teachers for Mockups evaluation. The objective of the workshops was to produce mockups of the dashboards to be implemented in NMP Moodle plugin. For this purpose, both workshops were designed according to the framework for Creative Visualization-Opportunities Workshops proposed by Kerzner et al. (2018) [16], which offers a set of steps for guiding the production of visual dashboard mockups.

Both workshops were structured into three activities. (1) A "workshop opening" to set the stage and engage the participants. In both workshops, the opening was organized to inform the participants about the objective of the workshop, the problem addressed and the relevance of the results. To motivate creativity and make the participants aware of the expectations of the design, they were presented with the list of needs and indicators extracted from the Informed Exploration phase and discussed them to have a full perspective of the problem. (2) A "workshop core" to encourage the participants to explore different visualizations for addressing the requirements discussed in the previous phase and produce mockups to represent them. (3) A "workshop closure" in which the organizers close the session with the main outcomes (See the procedures for the workshops in https://osf.io/vnf6d/).

Six professionals in dashboard development, visualization design and human-computer interaction participated **in the Workshop with Experts for Mockup generation**. In this case, the "workshop core" was structured into three activities. In **Activity 1**, and as a form of elicit visualization opportunities and explore different solutions, participants were provided with a document with a list of numbered visualizations used in Coursera, Moodle and NMP 1.0 that were related with the needs extracted from the Informed Exploration phase. This document was accompanied by two other documents for classifying the visualizations according to both, the identified needs/goals, and the indicators. Individually, participants should indicate which of the proposed visualizations addressed each need and to which indicators they related to. The results of classifying the different visualizations are available in the supplementary Material (https://osf.io/86qd7/). In **Activity 2**, the participants were grouped in pairs to discuss the advantages and disadvantages of each of the analyzed visualizations. Finally, in **Activity 3**, each pair was asked to propose three dashboard mockups with visualization to meet the explored requirements following a co-design process. Participants could design dashboards containing one or more visualizations in the same view, include several indicators in the same visualization and propose functionalities of interactivity with the visualizations to meet the requirements. All the visualizations produced in this activity are provided in the supplementary material https://osf.io/86qd7. With the data collected from this workshop, we proposed a final dashboard capturing the discussed indicators and some of the visualization proposals. See the resulting dashboard proposal at: https://osf.io/t5dcy/. This dashboard mockup was used as a basis for the workshop with teachers.

15 teachers from 6 different universities participated in the **workshop with teachers for Mockups evaluation.** The "workshop core" consisted of analyzing the mockup resulting from the Experts WS. First, each participant individually analyzed the experts' proposal and filled in the same questionnaire used for the Experts WS for indicating whether the proposed dashboard answers the teachers' needs and whether the visualizations included all the required indicators. Then, the participants were distributed in groups of 2–3 people to discuss the advantages and disadvantages of the mockup and propose a new one (See proposals https://osf.io/9vk2r). Finally, each group presented their approach and discussed with the rest.

3.1 Results of the Design Phase

Two researchers analyzed the results of the different dashboards and proposals and defined a list of visualization and functionalities to be included in the tool. For this, all the mockups proposed by the teachers were considered to decide the final views and functionalities to be implemented. The views and associated functionalities were defined in a generic way and considering how to adapt to the Moodle Platform requirements. For the students' perspective, we kept those visualizations and indicators that were proven more useful in the NMP MOOC version as well as some of the suggested indicators proposed by the teachers about students' progress in the course. For selecting the most appropriate visualizations for each indicator, we kept those which were more frequently proposed by the experts and validated by the teachers.

We also considered in the final design two main suggestions proposed by the teachers. First, to use the model red-yellow-green model in the graphs as a form of alert to guide the teachers on identifying those students with problems. This was proposed to address a teacher suggestion: "*There is a lack of display and alarm about what is going wrong, display of information about at-risk students, identification of content and assessments where students are notoriously having learning problems*". The colors were not explicitly evaluated during the design phases, but were chosen using the most standard model employed in occidental cultures to indicate that everything is good (green), there's some risk (yellow) and there are troubles (red). Second, the graphs were designed with interactive properties a suggested by a teacher to: (1) provide more deep information about an indicator in a graph, and (2) send specific and personalized feedback to students.

Table 2 includes the list of requirements for both the teachers' and students' views and the final indicators included in each view. Notice that not all the indicators from the 29 proposed were considered in this first version of the tool.

Table 2. Design requirements of teachers' and students' view. (GS: Goal Setting; SP: Strategic Planning; TM: Time Management; and SE: Self-Evaluation) (T: Teacher; S: Student)

Visualization & functionalities	Description	SRL processes supported & indicators
Week plan (T)	View to allow teachers organize their course resources according to the different weeks. This view should allow teachers to define the planned time per week according to the resources associated to provide a reference point to the students	SRL Proc: GS; TM Indicators: Minutes to be dedicated per week; Content goal

(*continued*)

Table 2. (*continued*)

Visualization & functionalities	Description	SRL processes supported & indicators
General view (T&S)	View including course aggregated indicators about students' progress and time spent on the course	SRL Proc: TM; Indicators: Percentage of progress of a student on the course; Number of students' sessions of different length (less than 30 min, between 30 and 60 min, more than 60 min) per week; Time spent by a student per week and session; Planned time vs student mean time on platform
Study Sessions (T&S)	Views for visualizing students' time management process, showing where and how they allocate the time in the course. The time has to be organized by students' study session. In this case, a study session is defined as the time since the student connects to the platform for the first time and interacts with resources until there is an inactivity period over 30 min	SRL Proc.: TM; Indicators: Average time spent by students per week; Average time spent high/mid/low performance students per week/resource/activity
Assignments (T)	Views for visualizing students' interaction with the course resources. Functionalities to send feedback to students according to their interactions	SRL Proc.: SP; SE Indicators: Number of interactions by resource category/activity by week; Resources with fewer interactions; Tasks on time, late and pending; Course contents accessed
Grades (T)	Views for visualizing the students' grades on the course. Functionality to send feedback to students' according to their performance	SRL Proc.: SP Time spent by a student per week; Grade of student by evaluation; Percentage of progress of a student on the course; Number of interactions by category by week; Questionnaires actions (correct answers, partially right, incorrect, in blank, no graded); Questionnaires rating

(*continued*)

Table 2. (*continued*)

Visualization & functionalities	Description	SRL processes supported & indicators
Assessments (T&S)	Grades and activity with the different assessments of the course	SRL Proc.: SP; SE Number of interactions by category by week; Grade of student by evaluation; Questionnaires actions (correct answers, partially right, incorrect, in blank, no graded); Questionnaires rating
Dropouts/Academic performance (T)	View including course aggregated indicators about the performance of students organized by risk of dropping depending on their progress	SRL Proc.: SE; SP Average time spent by students per week; Number of interactions by category by week; Grade of student by evaluation; Percentage of progress of a student by week; Percentage of progress of a student on the course; Time invested on platform; Number of sessions; Overall grade; Course content accessed overall; Student grades vs course mean

Implementation
The main objective of this phase was to implement a first version of the tool considering the requirements extracted from the design phase. This section presents the NMP Moodle plugin that was implemented as a first prototype.

3.2 Description of the Tool

The NMP Moodle provides teachers and students with dashboards for supporting the following SRL strategies in BL contexts: Goal Setting, Strategic Planning, Time management, Self-evaluation, and Monitoring. All the views and functionalities present in the current version of the tool were defined in the Design phase (Table 2). We describe in what follows the some of its features to exemplify how the design method was incorporated for the purpose of supporting SRL.

For supporting **Time Management**, the teachers count with several functionalities and visualizations. First, there is a functionality for planning the course weekly or thematically. With this functionality, teachers can assign the course content to a week (or section) of the course and allocate a reference dedication time (in hours) for the students to invest. This functionality was generated in order to create the indicators about the students' time management in the course highlighted as relevant in the Informed Exploration

Phase (indicators #1 to 18 in Table 1). Second, NMP includes different visualizations to represent the indicators in Table 1. For example, teachers can see indicators about how much time in average students spend in the course per week compared with what they planned (Fig. 2(a)), when students connected for a learning session (Fig. 2(b)) and the number of study sessions organized by length in minutes (less than 30; more than 30 and less than 60; and more than 60). These visualizations were defined taking into consideration the results of the Design phase, in which experts proposed using hit maps for representing students' sessions and bars to compare the time invested compared with the time expected. Teachers can also access to the same information about a particular student. The same information is provided in the students' view, but personalized for each student. In this case, students could see the indicators and visualizations showing their time management indicators as well as the average indicators of the course as a reference point.

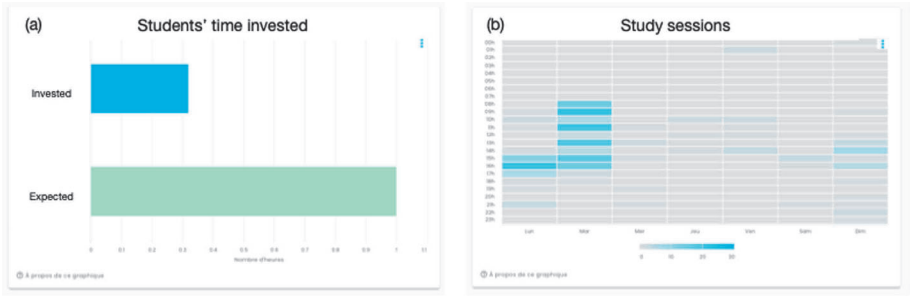

Fig. 2. Teachers' view. Visualizations offered for supporting time management. (a) Time invested by the students in the course (blue) vs. the time expected by the teacher (green). (c) Study sessions in a week. The dark squares represent the timeslots with the highest number of sessions. (Color figure online)

For supporting **Strategic Planning**, teachers' view includes information about the indicators identified in the Informed Exploration Phase (indicators #1 to 3 in Table 1), which are mainly related the students' activity with the course resources and activities. On the one hand, it includes visualizations in the form of bar charts representing which resources students consulted the most (green) and which the least (red). This allows the teacher to have an idea of what the most interesting resources are. A similar visualization is proposed for showing which students submitted the assignments on time (green), late (yellow) or which did not submit (red). Bar charts were selected as the best representation because it was one of the most recurrent proposals in the experts' mockups, and which were later validated by the teachers (see Sect. 3.1). Also, the graphs are interactive and organize students in colors (red, green and yellow) to let teachers click on a particular group and send a personalized e-mail in a form of feedback. Similar graphs are used to represent a summary of the students' grades for the grading activities of the course (Fig. 3a). In this case, bar charts are used to represent the questions that were answered correctly or incorrectly. When selecting one of the grading activities, the teachers see the grade distribution for that activity, as well as the best and worst marks (Fig. 3b). It

always takes the latest mark in case the assessment activity can be done several times. As for the time management support, the teachers' view for supporting strategic planning offers this same information about each student individually so as to follow up students with difficulties.

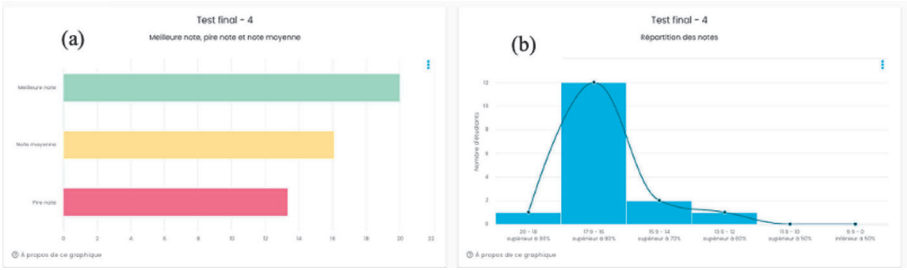

Fig. 3. Grade's view from Teachers' view. Visualizations offered to one of the graded activities in the course.

Finally, the students' view offers the same visualizations but only for the students accessing the information. In this case, students can access the list of completed and completed list of resources (marked in green and red, respectively) and the grades obtained compared with the average of the course.

4 Local Evaluation

A local evaluation was conducted **to understand how teachers perceived the indicators and visualizations used in the prototype NMP Moodle in terms of usability and sense making (related with RQ2)**. For this local evaluation, we organized two workshop rounds with teachers. Some of the results are already available in a previous publication [17].

The first workshop (WS1) was conducted with 78 teachers from different universities from Ecuador. The workshop was framed within a 10-week online diploma in Digital Teaching for Higher Education. The workshop was run in the 4th week. The objective of this week was to learn about the different types of BL Models existing in the literature. It lasted 6 h. As part of the course, the teacher presented the NMP Moodle tool as a tool to support these types of pedagogical models. For one hour, the teachers had the opportunity to explore the tool and explain how its use could be integrated in the Blended Learning course they designed in the first part of the session. After that, teachers were grouped in teams of 6 people and asked to reflect about the different visualizations. A total of 14 visualizations were evaluated related to the different indicators: week plan (1 visualization), general views (3 visualizations), study sessions (3 visualizations), assignments (1 visualization), grades (3 visualizations), and academic performance (3 visualizations). For each visualization, each group was asked to complete a form with 7 questions about the clarity of the information provided (See https://osf.io/v9tdb/).

The second workshop (WS2) was organized into two sessions, one online and one face-to-face. A total of 35 teachers from 4 different French Engineering Schools participated in these sessions. In both sessions (1 h length) the organizers presented the NMP

Moodle tool to the teachers (15 min) and then, asked them to interact with the tool during 45 min for conducting the following tasks: (1) interact with the tool with a test account populated with data and answer a series of questions about what do they observe in each view; and (2) organize their own courses in Moodle so as to use the tool in the following semesters.

At the end of both workshops, teachers were asked to answer the "sense making" questionnaire, obtaining a total of 41 answers. This questionnaire was designed combining questionnaires defined in prior research to evaluate Learning Analytics Dashboards: the Evaluation Framework of Quality Indicators for Learning Analytics (EFLA) [18] and the work by [19], which studies how learners' goals and self-regulated learning skills influence dashboards sense-making as well as the notion of transparency, not included in EFLA. The result was a questionnaire with 17 questions related with: (1) Transparency on the data collection; (2) Transparency of Dashboard Design and Explain ability; (3) Data & Reference frames; (4) Impact for learning/teaching and (5) Support for action. You can see the references considered for each item in the supplementary material https://osf.io/rcjpw/.

4.1 Results Local Evaluation

Two results were extracted from analyzing the questionnaire of WS1 about the different visualizations (See analyzed data https://osf.io/9anhw/). First, **teachers consider that the 14 graphs proposed in NMP Moodle are good for monitoring student's interaction the course resources and their commitment with the course** (Partial Result 1 – **PR1**)**.** Second, the **tool lacks:** (1) **flexibility** for assigning objectives to topics and not weeks, and (2) **visualizations** for **monitoring** students' activity when working in **groups** and activity (**PR2**).

The results of analyzing the sense making questionnaire show that **most of the teachers make sense of the information and dashboards provided (PR3)**, obtaining 3,28 marks over 4 (See analyzed data https://osf.io/3w2ty/). Teachers found that the tool is transparent in term of the data collection and the dashboard design (>95% answers between 3 and 4; mean 3.309/4) and offers a good support for teaching and learning (>92% answers between 3 and 4; mean 3.306/4). The teachers also consider that the dashboards provided can support efficient teaching and help adapting their teaching processes (>92% answers between 3 and 4; mean 3.309/4). It was less clear in the tool who has access to the data, what elements are presented and how they relate to each other (85% with values between 3 and 4; mean 3.189/4).

5 Broad Evaluation

A pilot study was conducted as a broad evaluating **to understand how students perceived the prototype NMP Moodle in terms of usability and sense making (related with RQ2)**. The pilot was run in 2 courses at a Technological University (1) at a second-year course in Databases (Course 1); and a first year of a course in Basics on Informatics (Course 2). A total of 311 students (119 from Course 1 and 192 from Course 2) and 2

teachers participated in this pilot study. The students do not have an expertise in informatics but the two teachers have. Both courses were designed as a Blended Learning course. Students participated in 1,5 h face-to-face lessons once a week and were asked to complete several online activities and projects at home planned for 1–2 h dedication. In both cases, the NMP tool was introduced by the project in the middle of the course in a face-to-face session, presented as a tool to help students organize their activities and tasks in the course. The Course 1 lasted 16 weeks and the Course 2, 12 weeks.

For understanding students' perception about the tool (RQ2), we asked them to answer the sense making questionnaire and analyzed those questions that were evaluated with the highest and lowest values. Also, we analyzed the logfiles collecting information about how students interacted with the NMP Moodle tool to see how they adopted the tool. For the logfile analysis we counted the number of interactions per visualization and the percentage of students that adopted the tool. 86 students out of 90 answered the sense making questionnaire and give its consent to use the collected data.

5.1 Results Broad Evaluation

Regarding the student's use of NMP and their perception about the tool, we found two different results. First, **the information provided with the NMP Moodle tool is not enough for supporting students' actions and helping them support their learning process** (**PR4**) (See results sense making https://osf.io/f3xy2/). Students' overall evaluation of the sense making was 2,8 over 4. They evaluated better those items related with Transparency on data collection (73% between 2–3), Transparency on LAD Design and explainability (71% between 2–3); and Data Frame & References (74% between 2–3), than those related with Impact for Learning and Support for action (64% between 2–3 for both items). Second, even of the usage of the NMP Moodle tool was not mandatory, **most of the students used it and preferred those visualizations related with Strategic Planning (PR5).** The NMP Moodle log-data registered a total of 91 unique interactions in Course 1 and 150 in Course 2 (76,47% and 78,12% of students, respectively). From these interactions, we observe that, in both courses, most of the interactions are registered on those visualizations related with strategic planning and time management (see Table 3).

Table 3. Counts of the number of students' interactions with NMP (SP: Strategic Planning; TM: Time Management; and SD: Standard Deviation)

Course	Total amount of actions	Mean active days	NMP action	Count	Mean
Course 1	91	91 (SD = 1.13)	SP	91	15.25 (SD = 14.81)
			TM	78	13.27 (SD = 11.15)
Course 2	150	150 (SD = 3.09)	SP	149	17.17 (SD = 14.00)
			TM	137	13.54 (SD = 12.05)

In addition to these results, we also identified some technical and usage problems when scaling up the tool. First, in terms of installation related problems, technicians from 3 different universities agree that, even if NMP is compatible with Moodle versions 3 and 4 **the tool should be implemented according to the requirements proposed by the Moodle community for plugin development.** This will avoid installing an external database for collecting log data (currently it requires MongoDB), and the use of other programming languages apart from PHP for avoiding security holes. In terms of usage, the **tool needs a functionality for viewing/deleting users' data for being fully compliant with the EU General Data Protection Regulation (GDPR) rules and data privacy.**

6 Summary of Results and Future Work

This paper presents the Design Based Research process followed for creating a Plugin for Moodle aimed at supporting SRL in BL courses. From the whole process, we addressed two research questions, which results could serve as an inspiration for those researchers willing to propose solutions for supporting SRL strategies in BL settings. **Regarding RQ1 about the type of indicators and visualizations to be used**, we identified through different workshops with experts and teachers: (1) the types of indicators needed for supporting goal setting, strategic planning, time management and self-evaluation SRL processes; and (2) a set of visualizations for representing them. Based on these indicators and visualizations, we implemented a first prototype of the NMP Moodle tool to be evaluated in actual contexts. Regarding the **RQ2 about the usability and sense making perception of the end users about the tool**. We run a local evaluation with 114 teachers and a broad evaluation with 311 students. Results indicate that teachers valued positively the information provided with the tool as good and clear to monitor students' activity, progress and engagement with the course (PR1, PR3). However, some improvements should be done to improve the tool from both the teacher and student perspective. First, changes should be made for teachers to flexibly adapt their objectives to the topics and modules as well as functionalities to monitor students' activity when working in group (PR2). Second, students used the tool mainly used for Strategic Planning (PR5), visualizations should be improved for helping them to make sense of the data for supporting their learning process (PR4), which they valued lower than the teachers. This last result could be due to the functionalities offered to the students in its current version, which only include self-awareness interactive graphs, but not much information about what actions to improve or what information is relevant to promote behavioral changes. Finally, some changes are required to facilitate its installation and adoption at scale. The tool should be updated to conform with the design structure of a standard Moodle Plugin and with the RGPD directions.

This study has also some limitations that will be addressed in future work. On the one hand, in the Design Phases of the methodology, we have mainly worked with teachers and students were only included for the broad evaluation. This could have caused the lower acceptance of the tool from the students' side. Future work will include focus groups and sessions for better design the students' side. On the other hand, we run the broad evaluation with only two courses for analyzing the usage and usability problems

of the tool, but not its effect on students' behavior. To complement this study, we plan to run large-scale and long-term studies for analyzing how students' and teachers use the tool in actual learning context and its impact on their strategies. Finally, we plan to improve the sense making instrument and validate it with users in different contexts.

We believe that the results obtained in this work could benefit other researchers in the community. Firstly, we expect that indicators and visualizations extracted from our empirical study could serve as an inspiration for designing new tools with similar purposes. Second, we think that the instruments and methods employed could also serve other researchers to validate their own solutions and run comparative studies. Finally, we hope that the process described could serve as an example of how to apply the Design Based Research approach to adapt an existing tool to another context.

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