Drill-down and drill-through dashboard for Master Program Chairing in e-learning

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Abstract: Chairing online Master Programmes requires constant monitoring and decision-making, amidst diversified data and ongoing processes. If misunderstood or misinterpreted, poor decisions may result, as well as lost opportunities to support enrolled students. Decision-making can be supported by dashboards, but there are few prototypes which underwent limited evaluation. We focus on identifying and prototyping efficient visualisation and interaction methods for such a dashboard, to offer online Master Program chairs opportunities for better analysis and decision-making. Design science research was conducted: evaluate and revise an existing prototype; evaluate the revised prototype with master program chairs; design, implementation, and evaluation of a final prototype, again involving master program chairs. The final prototype dashboard provides a way for Master Program chairs to visualize and interact with Master Program data, to support improved analysis of information and quick identification of problems, towards better decision-making.

Keywords: E-learning Dashboards, Learning Management Systems, Data Visualisation, Program Coordination, Program Chairing

Título: Painel de instrumentos com aprofundamento direto e transverso para coordenação de cursos de mestrado em regime de e-learning

Resumo: A coordenação de cursos de mestrado online requer constante acompanhamento e tomada de decisões, com dados diversificados e processos em curso. Se mal interpretados, podem advir decisões inadequadas ou perderem-se oportunidades de apoiar os alunos do curso. Existem painéis de instrumentos de apoio, mas poucos protótipos, carentes de avaliação aprofundada. Focámo-nos na identificação e prototipagem de métodos de visualização e interação para um destes painéis, visando proporcionar aos coordenadores de cursos de mestrado online oportunidades para melhor tomada de decisão. Conduzimos iterações de investigação por ciência da conceção: avaliação e reformulação de protótipo existente; avaliação do protótipo revisto por coordenadores de cursos de mestrado; conceção, implementação e avaliação de protótipo final, novamente envolvendo coordenadores de cursos. O protótipo final constitui uma forma de coordenadores de curso visualizarem e interagirem com os dados do curso, apoiando melhor análise e rápida identificação de problemas, visando melhor tomada de decisões.

Palavras-chave: painéis de instrumentos de e-learning, sistemas de gestão da aprendizagem, visualização de dados, coordenação de curso

1.   Introduction

The remote nature of chairing online master programs of studies raises specific awareness problems. As with face-to-face programs, chairs strive to make the students' experience smooth and according to expectations. However, there are no intuitive insights on attendance levels from witnessing higher or lower presence of students on campus, nor impromptu encounters with students and faculty members providing access to ongoing rumours and their perspective on social dynamics – i.e., the "watercooler effect" (DiFonzo, 2008). The successful management of online programs thus depends on regular monitoring of large amounts of online data, mostly within the institutional Learning Management System (LMS), such as Moodle, Blackboard, or Canvas. This monitoring aims to detect irregular variances or circumstance, and intervene, if necessary.

Dashboards are a common approach to provide decision-makers with the information they need in face of such complex data. However, program chairing dashboards is an area of application with few examples, with limited actual evaluation of their rationale and effectiveness, a situation that a previous research effort tackled by creating a prototype program chairing dashboard via design science research (Costa e Silva et al., 2020). In parallel, a literature survey effort sought to identify the relevant indicators for decision-making by online program chairs, with the aim of informing the development of data visualisation and interaction systems, such as dashboards (Viegas, 2022).

This work will present an improved dashboard prototype to support the chairing of online master programs. It employed design science research (DSR) to further the previous prototype by Costa e Silva et al. (2020). We analysed the original prototype from a Human-Computer Interaction perspective and combined that with Viega's survey on indicators (2022), as a base to inform a first DSR iteration, yielding a low-tech prototype. This low-tech prototype was evaluated by chairs of online master programs, and the results used to produce a functional prototype, which was again subjected to evaluation by chairs. The results indicate that the final prototype embodies more adequate design options to support decision-making by chairs of online programs of studies and provides clues for further improvements.

2.   Chairing of online master programs
2.a. Program chairing

With the constant growth of online programs of study and distance learning, many variations arise, and educational models also evolve in parallel (Schlemmer et al., 2020). Thus, knowing what makes a dashboard useful for the management of those programs is contingent to understanding the roles of program chairs and their actual tasks. These roles, under names such as "program chair", "program director" or "program coordinator" are extensive and vary a lot from university to university but with some common denominators (Viegas, 2022), such as: proposing the creation or dissolution of courses; ensuring compliance with the objectives defined for the program, for its courses and for academic activities, while meeting the criteria of scientific and pedagogical effectiveness and efficiency; and contributing to the proper functioning of the program, of its courses and of academic activities in general.

Education professionals take on two roles throughout the process. When designing a learning activity, the role of Learning Designer: crafting an IAP, specifying its learning objectives, assembling learning activities in a graph, providing configuration data for

them, and mapping the activities' learning analytics with the IAP's learning objectives. When deploying an IAP, the role of Teacher/Trainer: using the IAP "as is" or adapting its configuration data and learning analytics mapping and considering the actual learners who will pursue it. Deployment is completed by Inven!RA, which requests each Activity Provider to create a specific instance of their activities included in the IAP and generates a link for the Teacher/Trainer to include and configure in its preferred Learning Management System, as IAP entry points for learners.

2.b. Data Visualisation and interaction

Data Visualisation has been among humans since prehistoric times (Aparicio & Costa, 2015). Without it there would be a lot of information that would not be understood or lost in time. It is defined as "a graphical, animated, or video presentation of data and the results of data analysis" (Sharda et al., 2014) and can be regarded as information visualisation. Enormous amounts of data being generated every day, and whenever users look at raw data their brain first needs to interpret it for information, then try to comprehend it to develop knowledge, and finally try contextualizing it to attain wisdom (Chen et al., 2009).

Humans, who are constantly being influenced by their surroundings and who have a constant need to understand it, developed visual patterns to interpret their context, such as: when things are closer or further away from one another; when things move up and down; when things are bigger or smaller, when things are taller or shorter. Those interpretations from their everyday life are also be transferred to decision-making, with long has relied on visualization strategies (Rieber, 1995). Even though data visualisation is useful, it is imperative that it is clear what information needs to be shown as it can become misleading. The right data "just presented misleadingly (…) can lead people to draw incorrect conclusions" (McCollam, 2022). Therefore, while data visualisation is essential, bringing efficient ways of displaying data, making it easier for users to traverse from interpretation to wisdom, it is crucial to present data in a non-biased way to minimize de likelihood of drawing wrong conclusions.

Static visualisations (e.g., pictures or graphs) do not allow users to explore data, what is there is what the user gets. When analysing a data set there are questions that arise and could be solved if the user could perform a simple interaction, a change in perspective. Thus, adding interacting techniques levels up the benefits of general visualisation (Klerkx et al., 2017).

It is very important to know the users of the dashboard so that it is known what type of actions they want or need such as: adding more information with communication systems, hyperlinks to see more information, drill-down or drill-through capabilities to obtain more details, e.g., making comparisons (Pappas & Whitman, 2011). Interaction with data will help provide the information the user needs, with the benefit of not adding more space to the display. There is a long set of different types of interactions, such as tooltips, expansion or collapsing of visuals, data brushing or interactive highlighting, among others (ibid.).

2.c. Learning Analytics Dashboards

Over the last few years, the educational industry benefited from the constant evolution of learning analytics and technology. These areas came together, creating dashboards to improve or at least understand the learning process. Learning Analytics was originally

defined by George Siemens, for the 1st International Conference on Learning Analytics and Knowledge, as "*the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimising learning and the environments in which it occurs*" (Siemens, 2010). Apart from the gathered data, it also includes the development of metrics and the different techniques of displaying the data (Lee et al., 2020).

Learning dashboards, defined as "*a single display that aggregates different indicators about learner(s), learning process(es) and/or learning context(s) into one or multiple visualizations*" (Schwendimann et al., 2017) are a common way of reporting this data (Verbert et al., 2020). The main goals of learning analytics dashboards are to deliver feedback about learning processes and activities, give the opportunities of better decision-making, and help students by supporting motivation and preventing drop-out (Klerkx et al., 2017).

2.d. Similar Systems for program chairing

There are not many systems aimed at supporting program chairs, but rather targeting teaching staff and/or students. At most, some features may be included in systems meant for the management structure, i.e., roles other than program chairs. This was shown in a review by Costa e Silva (2020), albeit pointing out that there might be the case that academic articles are not being written existing software systems to support program chairing.

We could find only three such systems: the "Learning Analytics Tool for chief decision making bodies" (LATch), by Doneva et al. (2020); the Academic Decision Making Model (Vanessa Niet et al., 2016), and the SIDE system at UTAD university (Barbosa et al., 2011). Apart, of course from the previous developed prototype from which we developed our own (Costa e Silva et al., 2020).

LATch is a software tool that was created to fit the needs of academic decision-making bodies (program managers, deans, rectors) in Bulgaria. It allows the monitoring of learning processes to make data-driven decisions in time, improving their institutional and educational processes. It provides different types of data depending on the user's role. For deans and rectors, it allows the comparison of certain several with previous years, the identification of trends in student activities and grades in each program, and the tracking of students' drop-out rates. For program managers, it allows tracking students' activity and their visits to resources, compare students' activity to that of students in previous years, track students' progress on activities, control the scheduling of the materials, and completion of activities, among others.

The Academic Decision Making Model was created with the objective of serving as a support tool to solve academic problems for the managers of higher education institutions in Latin America. This project can be divided in two models: the Graduation Project Management Model and the Academic Performance Module. The first model is more related to the documental management of graduation projects, the assignment of the supervisors and examiners to those projects and the monitoring of their evaluation. However, the Academic Performance Module, allows managers to see courses passed per each student, the level of progress made by students, students' average marks by semester, course, teacher, the comparison of the progress made by a student to the rest of the students and the comparison of the student grade average to the rest of the students.

SIDE was developed at the UTAD university in Portugal to support students, teaching staff, and program chairs, providing information via a Web portal for services such as schedule management, class attendance, management of teaching service, individual student status analysis (grade tables, class participation, class enrolment).

Although the LATch system has much more information to display than the Academic Decision Making Model or SIDE, all systems have features that are important when the subject is program chairing but all are very broad and general, and mostly concerned with administrative aspects (attendance, grades, etc.).

By comparing these three systems to the one upon which are basing this work, the core difference if Costa e Silva's approach to focus on non-administrative aspects. Instead, her Drill-down Dashboard for Coordination of Master Programmes in Engineering focused on a core task of program chairs, preventing dropout (Costa e Silva et al., 2020). The core novelty of the system for the educational area is that it was a learning analytics dashboard specially designed to support program chairs. It was grounded on identifying relevant tasks for them, looking for available data to supports those tasks, and developing visualisations from those date to provide task-oriented information. Specifically, several indicators are used to display the adequate information that program chairs require, enabling them to see the distribution of the students' participation in each activity type and the students' grades in each activity evaluated in the course, the distribution of students by percentage of participated activities in the course, the comparison of the activities done in a course to the rest of the courses, where the student is situated on each type of activities, in comparison to other students, the distribution of the students' grades and participation in the courses, among others.
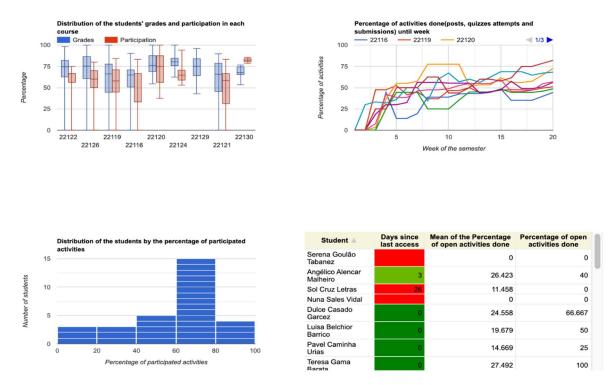

Figure 1 – Original Program View (data and names were randomly generated for illustration purposes only – not actual students)

3. Original Prototype: Costa e Silva's Drill-down Dashboard for Coordination of Master Programmes in Engineering

This previous effort to tackle program chairing e-learning dashboards offered three perspectives (Costa e Silva et al., 2020): the overall program view, individual courses views, and individual students views. These are explained below.
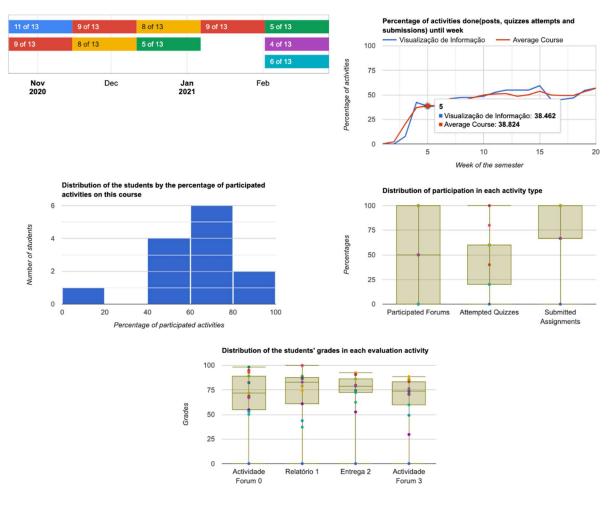

Figure 2 – Original Course View (data were randomly generated for illustration purposes only).

The Program View has four displays (fig. 1) that provide chairs with information on: students' grades and participation on the various courses; percentage of activities completed along the semester, distribution of individual students per quintile of activity participation; and individual students' most recent access to the LMS. The Course View has five displays (fig. 2) that enable chairs to contrast the status of an individual course with the overall status of the other courses in the program. It visualises information about the timeline of activities and their completion rates; the percentage of activities completed along the semester; the distribution of individual students per quintile of participation in course activities; the distribution os students' participation per activity type (forums, quizzes, assignments) and the distribution of students' grades per each graded activity. The Student View has four displays (fig. 3), enabling analysis of a particular student by: participation in individual activities along the semester in each of its courses; how the level of participation in activities evolved along the semester, compared to the average of all other students; percentage of participation/attempts/submitted/ontime activities of the

student in the context of the overall class of students; and each of their grades in every evaluated activity of every course as well as the matching percentile. Each of these Views enable drilling: by clicking on a course in the program view, for instance, one navigates to the specific course view. By clicking on a student, to that specific student's view.

The original prototype was implemented as a Web application using Node.js and Express.js for its backbone. Templates were implemented with Pug.js, the visuals with Google Charts, and data was manipulated with D3.js. It relied on an SQLite database and obtained its data from the Moodle LMS via Moodle's Web Services.
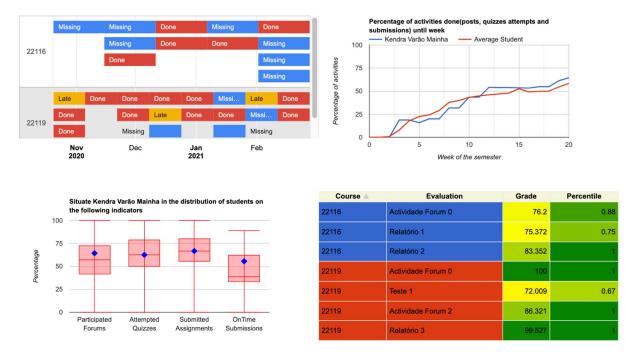

Figure 3 – Original Student View (data and names were randomly generated for illustration purposes only)

4.   Evaluation

4.a.   Original Prototype Evaluation

As a first approach, an evaluation to the original prototype was made, based on current literature on data visualisation and dashboard interactions, which resulted in the identification of 12 issues. These issues were mostly related to the lack of captions, axes, and titles in several graphs, but also with the difficulty of identifying individual courses in the Program View, since they were presented by id, not a readable acronym or full name. These issues might lead to shortcomings on users' interpretation of the information in the affected visualisations.

Thus, straightforward solutions for these issues where implemented, changing course ids to their full name or short name, adding titles and captions as needed. This was the basis for the first iteration, the Revised Prototype.

4.b.   Revised Prototype Evaluation

To evaluate the Revised Prototype, four Master Program chairs from Universidade de Trás-os-Montes e Alto Douro (UTAD) and Universidade Aberta (UAb) were invited by email for videoconferencing interviews. The interviewees were selected on the criteria of

having prior experience chairing Master Programs. A factor in selection was that both universities were deploying a new online-only master program in informatics engineering and thus had an interest in contributing to the development of tools to assist the program chairing role.

Apart from evaluating the revised prototype, this interview was conducted with the objective of attaining extra data, the interviewees' requirements and needs, that could be used to further improve the prototype. Thus, there were three parts to the interview: the first one with questions related to the activities performed by a Master Program Chair, the second for evaluation of the prototype, and the third about missing indicators in the prototype.

Regarding missing indicators, it was unanimous that enrolment regimens of students (full time vs. part time) are required, due to their impact on the number of courses being attended. Also, three of the four chairs requested ways to conduct longitudinal follow-up of students. No other missing indicators were identified.

Table 1 – Categories of the pieces of evidence from the evaluation of the revised prototype

Category	Description
Layout improvement	Pieces of evidence about general feedback about the aspect of the whole prototype and the navigation between views.
Missing information	Pieces of evidence about information that would be useful to take into consideration when analysing the program and is missing.
Distracting information	Pieces of evidence about extraneous information that can divert the attention from important information.
Graph improvement	Pieces of evidence about improvement suggestions to the graphs for more readily understanding of the information.
Lack of coherence	Pieces of evidence about situations when the information presented (or its organization in components) did have the same meaning across different graphs.
Colour mislabelling	Pieces of evidence about situations where colours would be interpreted according to cultural common meanings or connotations, when they shouldn't (e.g., red interpreted as alarm when it was not meant to carry any such meaning).
Extra features	Pieces of evidence about suggestions of extra features.
Phrase mislabelling	Pieces of evidence about poor choices of phrasing in labels.

Regarding the evaluation of the prototype, 51 pieces of evidence were extracted from transcribed interviews, organized in 8 categories (table 1). These pieces of evidence were subjected to thematic analysis, resulting in the identification of 31 different problems. The full lists of pieces of evidence and problems can be found in the dissertation supporting this work (Senra Viana, 2022). The most mentioned problem was that in some visualizations the numbers had too many significant digits. Other highly mentioned problems were the difficulty of not knowing how to navigate to other Views; and no visual differentiation between activities, making it difficult to understand which activities were being represented. Other less mentioned problems included the size of the graphs not adjusting dynamically to the size of the browser window; the unpolished aesthetic of dashboard overall; the request for inclusion in the current indicators of further data items about courses and students; the need of a global view of all enrolled students; too much information in some of the indicators; misinterpretations about some elements; colours being wrongly associated with meanings when simply meant to distinguish elements; and some components were wrongly labelled or found to be distracting.

5. Final Prototype

5.a. Description

Using the solutions designed to overcome the 31 problems, the Final Prototype was implemented. To render explicit the existence of different views, we added a navigation bar. For a more professional look, we included the logo of the program of studies in this navigation bar. We also created a general view of all enrolled students, including enrolment regimen, and a list of all the courses, to enable immediate navigation to each of them. The navigation bar and the general view of all students are shown in figure 4.

Student	Days since last access	Mean of the Percentage of open activities done	Percentage of open activities done	Course Edition	Enrollment Regime
Mercês Marinho Filipe	0	32.8	75	2ª	tempo parcial
Avelino Lousã Imperial	1	20.5	100	3ª	tempo parcial
Eliel Borja Alencar		0	0	2ª	tempo parcial
Avelino Moreira França	15	9.6	0	5ª	tempo parcial
Victória Saraiva Proença	0	23.1	66.7	6ª	tempo parcial
Ryan Calçada Marçal	0	20.2	100	6ª	tempo parcial
Emilie Quintana Baptista	0	16.2	66.7	6ª	tempo parcial
Raúl Matos Figueiredo	16	6.7	0	6ª	tempo parcial
Andressa Moreira Malheiro	25	4.7	0	6ª	tempo integral
Teresa Cruz Proença	0	22.4	50	6ª	tempo integral
Camila Espinosa Ulhoa	0	19	100	6ª	tempo parcial
Imran Rosário Caminha	0	34	66.7	6ª	tempo parcial
Telmo Baptista Robalo	0	21	50	6ª	tempo parcial
Mercês Barrico Carvalhal	0	17.8	50	6ª	tempo parcial
Jordan Moreira Tabanez	14	16.6	0	6ª	tempo parcial
Mercês Proença Tabanez	0	17.2	50	6ª	tempo integral
Kendra Café Figueira	24	15.4	0	6ª	tempo integral
Luísa Garcez Meireles	1	22.5	75	6ª	tempo integral
Andressa Azambuja Marinho	2	29.6	0	6ª	tempo parcial
Kailany Saraiva Cisneiros	6	7.7	0	6ª	tempo parcial
Alexandro Caminha Carvalho	0	25.6	50	6ª	tempo parcial
Sílvia Caminha Tabanez		0	0	4ª	tempo parcial
Emilie Robalo Garcez	0	34.2	100	6ª	tempo parcial
Enrique Zagalo Baptista	4	35.7	100	6ª	tempo integral

Figure 4 - Final Prototype: Navigation bar and general view of all students

(data and names were randomly generated for illustration purposes only)

The problem with static graph sizes was fixed, by making them responsive (adapt dynamically to the size of the browser window). For problems about having too much information in graphs that might distract chairs from relevant, a poll was conducted with

the interviewed chairs, to determine whether to eliminate the extra information or not, and resulted in not being removed. Regarding misinterpretation of components and colours, legends were added to clarify the intended meaning of those components and colours.
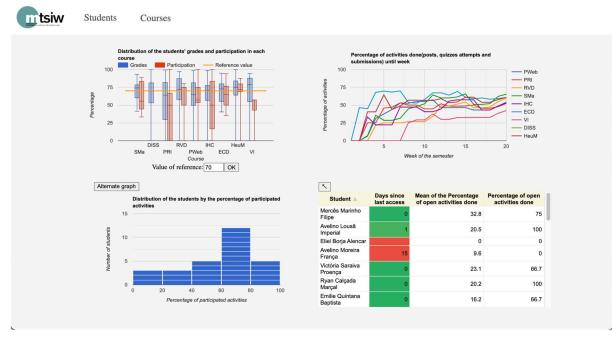

Figure 5 - Final Prototype: Program View

(data and names were randomly generated for illustration purposes only)
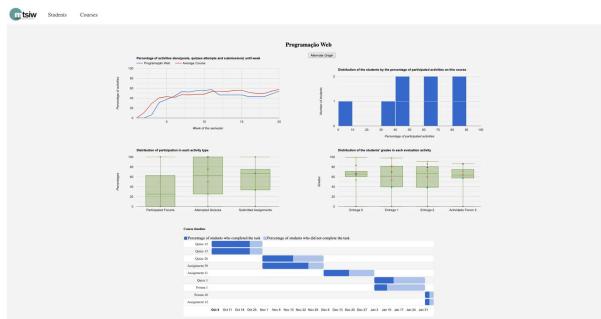

Figure 6 - Final Prototype: Course View

(data and names were randomly generated for illustration purposes only)

Although most of the problems were solved with this process, some were not, because further studies were required to clarify criteria on what should be shown. This was the case, for example, about problems requesting more (unspecific) information about students and courses.

The final Program View, Course View and Student View are shown in figures 5, 6 and 7, respectively.

In the general view of all students (fig. 4) the list of enrolled students (first column), is paired with overall status information about each (all columns can be used for sorting): the number of days since the student last accessed the e-learning platform, with red-to-green colour labelling to highlight drop-out risk situations; the course average participation on the open (available) activities that the student has available, and the percentage of available activities actually done by the student. The two final columns show edition of the program that the student is enrolled in, and the enrolment regimen (part time vs. full time). The rows can be drilled through to each student's individual view.

In the Program View (fig. 5), the top left graph shows the distribution of students' grades and participation in each course. The chair can drilldown to each course by clicking directly on its name or bars in the graph. Program chairs can also define an ad hoc reference value, which shows on the chart as a horizontal yellow line. The top right graph shows the percentage of activities done in each course in every week of the semester. Courses can be hidden or shown clicking on their names, to compare only similar courses or even for better seeing the progress of only a specific course. The bottom left graph shows the distribution of the students by quintile of participated activities. It can be changed to a pie chart graph in the "Alternate graph" button above it, to enable comparison of proportions between quintiles. The "stacked" bar chart shown in fig. 5 has enables quick identification of students in each quintile, by mouse hovering, and drilldown to the matching Student View by clicking. On the bottom right, the table display presents a list of the course's students, with identical data to that shown in the general view of all students and enabling drill-through to each student's individual view.

In the Course View (fig. 6), the top left graph shows the percentage of activities done in each week in the semester (for that specific course) and compares it to the percentage of activities done in each week of the semester, on average, on all other courses in the program. By mouse hovering the graph lines, one can see the percentage figures for participation in each week.

As in the Program View (fig. 5), the top right graph shows the distribution of students by percentage of participated activities in that specific course, only now in deciles. The bars are also "stacked" enabling mouse hovering to identify students and clicking to drill down to each specific student's view. It can also be switched into a pie chart by clicking the button.

The two graphs in the middle of the Course View page show the distribution of student participation per activity type, and the distribution of student grades in each activity subject to assessment. It is possible to check individual students in both graphs by hovering the dots, which produces a tooltip with the student's name and participation/grade figures for the activity. The bottom graph presents the course timeline, showing the scheduled activities for that semester, and their percentage of completion. By hovering the bars with the mouse, the chair can see the initial and final date of each activity as well as the figures on the percentage of students who completed the activity.

Finally, in the Student View (fig. 7), the top left corner has a timeline of all activities the student is enrolled in, in all courses, and the status of each individual activity: if it has been delivered on time, late or not delivered at all. By hovering each activity, the chair can see in a tooltip the duration of that activity in weeks, as well as its start and end dates.

The top right graph shows the percentage of activities done by the student throughout the whole semester and compares it to the average percentage of all other students in the program. The percentage figures can be seen by mouse hovering the lines of the graph.

The bottom left graph situates the student regarding the statistics of the courses the student is enrolled in, regarding the distribution of the students' participation in forums, attempted quizzes, submitted assignments, and submissions on time.

Finally, the bottom right table shows each activity done by this individual student, its grade, and the percentile of that grade in comparison with the grades of other students for that activity. The program chair can also to drill-through to the Course View where that activity is found, clicking on "Course" column in the table.

5.b. Evaluation

To evaluate the final prototype, we sent e-mail requests for videoconference interviews to the Master Program Chairs who evaluated the previous prototype, and to two more UAb professors with chairing experience. The protocol for these interviews consisted in the part about prototype evaluation prepared for the previous prototype. From the interviews' transcriptions, 32 pieces of evidence were extracted in 4 categories (table 2). After thematic analysis of these 32 pieces of evidence, 24 different problems were identified. The full lists of pieces of evidence and problems can be found in the dissertation supporting this work (Senra Viana, 2022).

The most mentioned problem was that graphs with individual students are likely unsuitable for courses with hundreds of students, as it would be hard to see each individual student dot or stacked bar among all the other students.

Other problems included requests for further information about activities and students; and the ability to drill-through or drill-down to Moodle (e.g., when clicking in an activity enabling navigation to that activity's page in Moodle). The latter problem is exemplar of several problems that represent extra features unspecified in the previous interviews. These require further study and provide pathways for further improvement.

Table 2 – Categories of the pieces of evidence from the evaluation of the final prototype

Category	Description
Missing information	Pieces of evidence about information that would be useful to take into consideration when analysing the prototype and is missing in the prototype.
Graph improvement	Pieces of evidence about improvements that need to be made to the graph so that data and its interaction can be more easily understood.
Non-scalable component	Graphs or components of graphs not suitable for classes or courses with hundreds of students.
Extra feature	Suggested extra features that were not mentioned in previous interviews.

6. Conclusions

Over the various design science research iterations of the prototype, which included interviews with experienced Master Program Chairs, the evolution of the prototype is clear in terms of interaction and visualisation techniques: the interviewers were overall pleased with the final version of the prototype, as demonstrated by most categories of pieces of evidence and problems referring to additional features, rather than to further corrections to previous features. The interviewees expressed having a very positive opinion of the way the changes enabled them to understand the data much better, support better-informed decisions, and ultimately contributing to better support the students enrolled in the program.

Regarding innovative features, not found in the similar systems that were analysed (or at least not described in their available documentation), the simples ones are the general view of all students and the navigation bar. More elaborated innovations are the course timeline listing all activities of all courses, and the completion level of each activity by students enrolled in the course in which that activity is included. This enables overall status of courses in a program to be screened directly, and finer information attained quickly by hovering, such as the starting and end dates of each activity and the participation percentage figures.

Functional changes include enabling the hiding and showing of lines in the line graph within the Program View, the ability to switch between graph types for the same indicator, and the provision of an ad hoc reference value to expedite status analysis regarding chair's objectives. Regarding new functionalities, the general student page can be mentioned, which was not a feature in the similar systems found, as well as the navbar, which helps a lot in the navigation of the system. Another new feature is the course timeline where activities are listed, and the completion of the activity by the students can be seen directly, with the initial and final date and the exact percentage of participation can be also seen in a tooltip when hovering the activity. When it comes to fundamental changes, a lot of them can be mentioned, such as the line graph in the Program View where it is now possible to activate and deactivate lines, the ability to switch between graphs and to input an exact number for the value of referent which both allow a better adjustment to the chair objectives.

As with all systems, there is always room for improvements and new features. Since there are so few learning dashboards directed to support program chairs, there is even less available information about visualisation and interaction techniques directed to this theme, making it harder to connect both matters and perceive the most efficient solutions. An approach for future work would be the implementation of the extra features that were identified, after conducting due further study of criteria for their proper design and implementation.

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