

A Preliminary Study on the Use of Generative Artificial Intelligence to Enrich Dashboards

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Abstract: The use of dashboards to show information to teachers in educational environments is a widespread technique. However, teachers often have problems to understand the charts and therefore to take decisions based on the information shown. This is, often dashboards just show information and do not help teachers to interpret which problems do students have with the course and, consequently, dashboards do not assist teachers to provide adequate interventions. In this context, the aim of this work is to analyse whether the use of Generative artificial intelligence (GenAI) can help teachers understanding dashboards and decide in turn when to provide interventions and what kind of interventions could be the most beneficial for the students.

1 INTRODUCTION

The field of learning analytics (LA) is oriented to collecting, analysing and reporting data so that the learning and the environment in which it occurs are understood and can be optimized. The Clow's learning analytics cycle (Clow, 2012) includes four phases: learners, data, metrics or analytics and interventions. In this work we have centered in the analytics step of the Learning Analytics cycle (Clow, 2012). The objective of this step is to process the acquired data and try to provide insights regarding the learning process. The results obtained from analysing data should be adequately reported and presented so that it really helps supporting the learning and teaching process (Yan et al., 2024). One of the main ways to provide those insights is the use of dashboards and visualizations.

There is a growing interest in learning analytics dashboards with the objective of supporting teachers in their teaching process (Matcha et al., 2020). However, it has been detected that understanding dashboards and making decisions taking into account that information is challenging for teachers (Pozdniakov et al., 2023). Therefore, teachers need tools that help them understand those dashboards. In


this aspect, according to (Pozdniakov et al., 2023), there are two main strategies to overcome the problems teachers face when using dashboards: improve teachers data and visual literacy and improve the explanatory capabilities of dashboards.


Recently, Generative artificial intelligence (GenAI) has appeared and several authors have indicated that using it could help overcoming the problems detected when teachers use dashboards. For example, (Yan et al., 2024) indicate that GenAI can be used in all the steps of the Clow's learning analytics cycle (Clow, 2012) and propose that the use of GenAI could provide rich explanations about the dashboards and facilitate their comprehension.


The work presented in this paper is related to whether GenAI can help enriching current dashboards in order to improve teachers' comprehension and analysis of the data shown. This in turn will drive teachers to provide adequate and informed interventions.

The main objective of the work was to carry out a first approximation to the possibility of using GenAI to give answer to the visual literacy and explainability problems teachers' face when they are in front of dashboards.

With that objective in mind, the enrichment of the dashboards with GenAI generated output has been

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analysed. The idea was to include a button next to each chart of the dashboard to show a GenAI generated explanation in order to improve the understanding of the dashboard and helping the interpretation of the visualization. In this first attempt, the objective was to answer the following two research questions:

- RQ1: Can the use of GenAI facilitate teachers understanding the charts used in dashboards? This is, can the use of GenAI help improving teachers visual literacy?
- RQ2: Can the use of GenAI help providing explanations to teachers in order to facilitate interpreting the shown data and taking decisions?

This paper presents the prompt engineering process carried out as a first approach to see how effectively can GenAI answer the research questions and help the Analytics step of the LA cycle. This paper is organized as follows. First, a related work section is presented. After, the followed prompt engineering process is depicted followed by a discussion section. Finally, some conclusions are drawn and future work lines outlined.

2 RELATED WORK

The use of technology-enhanced learning environments has seen a rise in the last years (Matcha et al., 2020). This, in turn, has generated the possibility of collecting student related data that can be used to improve learning experiences. In this context, Learning Analytics Dashboards are widely used as they help target users to visually comprehend

student performance (Pinargote et al., 2024). There exist many learning analytics dashboards oriented to support teachers. Dashboards introduce different charts to represent student data, being bar charts and radar charts the most used ones. The information displayed on these charts is typically limited to a single individual or to the comparison of one individual with its respective group (Matcha et al., 2020).

For the prompt engineering process presented in this paper, we have taken a set of real charts from the dashboard of the AdESMuS system (Villamane et al., 2020). This system was selected because the teachers participating in the study had already worked with this system and it provides the most habitual perspectives of data: information regarding a single student and information of a student contextualized in the group he or she belongs to. For individual students (see Figure 1), the system includes the visualization of data using both bar and radar plots. For the student data against her or his group (see Figure 2), AdESMuS includes visualizations using bar, radar and violin plots.

This type of charts are widely used, but teachers still find it “challenging to make sense of LA dashboards” (Pozdniakov et al., 2023). In that paper the authors propose two different strategies to address this problem: Improve teacher’s data literacy and improve explanatory features of current dashboards.

Data literacy is defined by (Gašević & Merceron, 2022) as “educators’ ability to use data effectively and responsibly”. However, usually teachers face dashboards and not data so what is required is visual literacy defined as “the skills required by teachers to interact with LA dashboards” (Pozdniakov et al.,

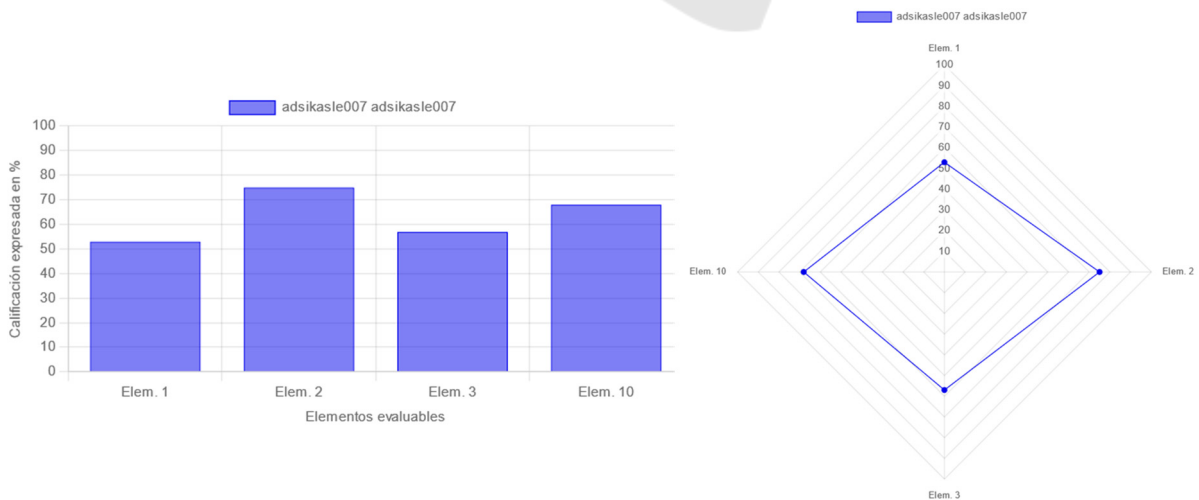


Figure 1: Visualizations for individual students.

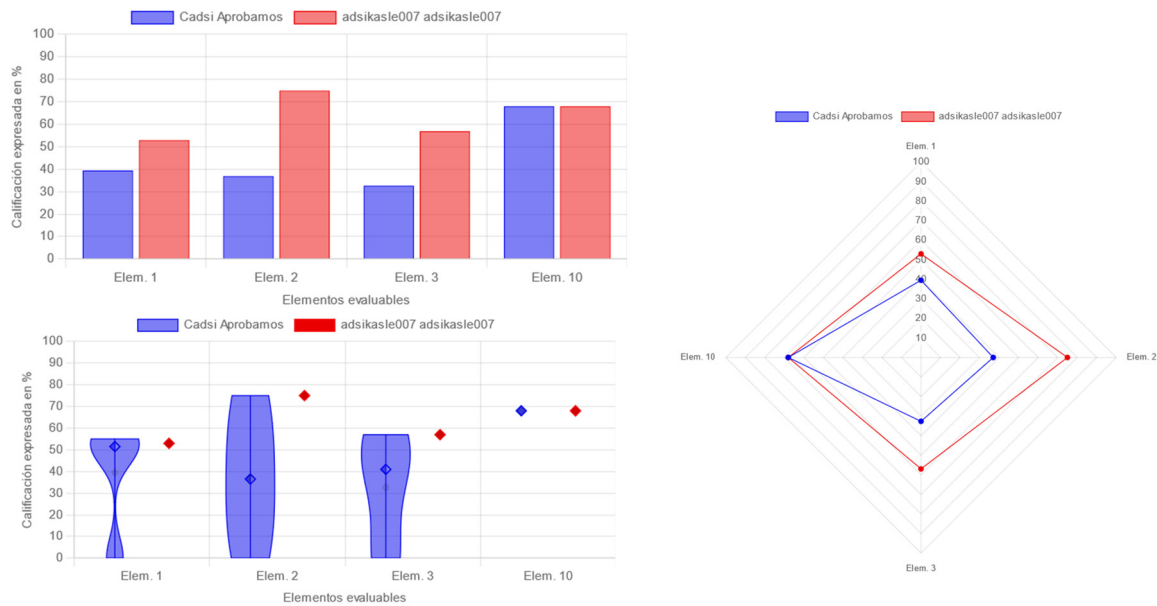


Figure 2: Visualizations of individual students against the group.

2023). Even if progress has been done in this area, teachers still have problems to understand information provided in dashboards (Pozdniakov et al., 2023). Therefore, tools to reduce the visual literacy lack of teachers are required.

Moreover, usually dashboards only show the information in charts where teachers have to search for insights. Some authors have introduced the idea of explanatory dashboards whose main goal is to present and communicate insights (Echeverria et al., 2018). Improving those explanatory features of dashboards has become a challenge to face up to, in order to give a more contextualized feedback.

In this area, (Pinargote et al., 2024) indicate that currently there is a gap in research related to the generation of feedback mechanisms and narrative elements in LA dashboards. Our research is centred in trying to answer some aspects related to this gap.

Next, the prompt engineering process followed to answer the research questions is described.

3 PROMPT ENGINEERING PROCESS

We have carried out an iterative prompt engineering process to determine how to best formulate the prompts in order to obtain outputs that could help to reduce the problems teachers have when using dashboards. As GenAI tool for our work, we have used ChatGPT and its ChatGPT-4o model. All the

prompts have included the related chart generated in the AdESMuS dashboard.

The prompt engineering process has been guided by the CLEAR framework (Lo, 2023) and the strategies and tactics guide for prompt engineering provided by the OpenAI platform (OpenAI, 2024).

According to the CLEAR framework, the prompts should be: concise, logical (structured and coherent), explicit, adaptive (experiment with various prompt formulations) and reflective. In the OpenAI guide among other aspects, it is indicated the relevance of:

- Identifying the errors or hallucinations in the output
- Output customization: tailor the output generated by the Large Language Model (LLM)
- Prompt improvement: Question refinement and alternative approaches

To carry out this process, two teachers have been involved in the prompt generation and improvement process.

The carried out prompt engineering process where prompt improvement has been developed, has included several rounds of the cycle outlined in Figure 3. Those rounds are described next.

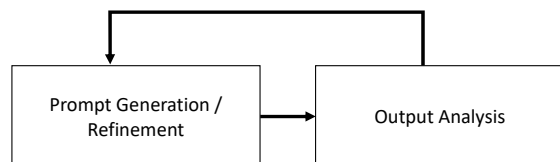


Figure 3: Prompt engineering process.

3.1 Round 1- General Prompts

In the first round, some general set of prompts (see Table 1) were generated in order to analyse what GenAI could provide when given different types of charts.

Table 1: Initial General Prompts.

Prompt1	Give me an interpretation of the following chart
Prompt2	I am a teacher and the following bar chart shows the grades (expressed as a percentage (%)) on the assessable items (on the horizontal axis) for student adikasle007 in one of my courses. Could you make an interpretation of the data?

The analysis of the output obtained in this first round was centred on whether the output contained errors or hallucinations.

Those prompts were tested different chart types obtained with the AdESMuS system, and two circumstances that generate hallucinations in the output were detected. When radar plots were provided, GenAI was not able to identify all the data in the chart, incorrectly identifying some of the values. For Figure 4 for example, the system identified Elem3 as having a value of 20 when it really is 80. Similarly, with bar charts including many assessable items and therefore many bars (10 for example), GenAI was not able to identify the correct values for the last elements.

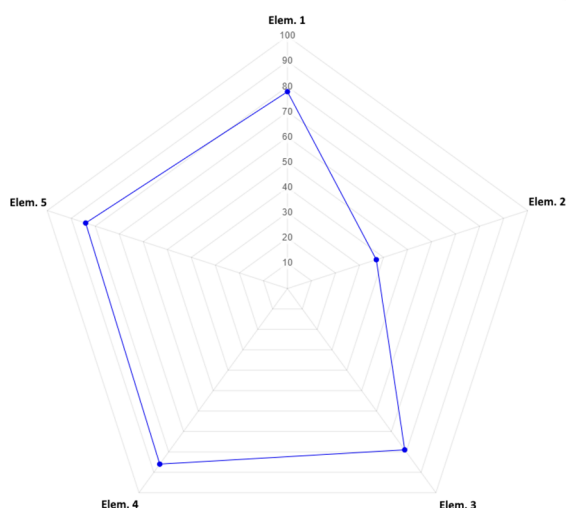


Figure 4: Radar chart.

3.2 Round 2- Eliminating Hallucinations

Taking into account the previous results, new prompts were generated. To solve the problems about the GenAI not being able to correctly read the data from the image, the prompts, in addition to the charts, included text data regarding the assessment of the different elements (see Table 2). Giving this information in the prompt solved the previous hallucinations.

Table 2: Prompt including text data.

<p>I am a teacher and the following bar chart shows the grades (expressed as a percentage (%)) on the assessable items (on the horizontal axis) for student adsikasle007 in the course ADSI. Could you make an interpretation of the data?</p> <p>Customize the explanations with the name of the student and replacing the names on the x-axis of the graph with the names in the following list:</p> <p>Elem.1 = Partial Exam 1, Elem.2 = Partial Exam 2, Elem.3 = Partial Exam 3, Elem.10 = Practical Part.</p> <p>Please note in your explanations that the percentage grades for each element are:</p> <p>Elem1 = 53 Elem2 = 75 Elem3 = 57 Elem10 = 68</p> <p>In addition, the minimum grades for each of the elements are: Elem.1=0 Elem.2=0 Elem.3=0 elem.10=0 And the maximum ratings for each element are: Elem.1 = 10 elem.2 = 10 Elem.3 = 10 Elem.10 = 2.5</p>

As giving the data as text in the prompt solved the problem of hallucinations in the output, we tested the produced output giving only the text data and eliminating the chart from the prompt. The conclusion from the analysis was that providing both text data and image, generated richer results.

3.3 Round 3- Analysing and Improving Output

In this round, we used prompt1 and prompt2 of Table 1 enriched with the text data and tested them with all the charts in Figure 1 and Figure 2.

When analysing the output, we detected that it contained a breakdown interpretation for each element in the chart and then a general interpretation. For the second prompt, the system provided a set of suggested actions at the end. The system also provided a general explanation of the chart type using the data in the image (see Table 3).

Table 3: General explanation for the bar chart generated by ChatGPT.

<p>The chart represents the performance or evaluation results of a student (named adsikastle007) across four categories or "elements," labelled Elem. 1, Elem. 2, Elem. 3, and Elem. 10.</p> <p>Here's a breakdown of the chart:</p>	
1. X-axis (Horizontal):	<ul style="list-style-type: none"> ○ Represents "Elementos evaluables" (Evaluable elements), which are the different categories or components that the student was assessed on. ○ The four elements shown are Elem. 1, Elem. 2, Elem. 3, and Elem. 10.
2. Y-axis (Vertical):	<ul style="list-style-type: none"> ○ Represents "Calificación expresada en %" (Scores expressed as percentages). ○ The percentage scale ranges from 0% to 100%, indicating the score achieved for each evaluable element.
3. Bars:	<ul style="list-style-type: none"> ○ Each bar is coloured blue and represents the percentage score the student obtained in each evaluable element. <ul style="list-style-type: none"> ▪ Elem. 1: Score of around 50%. ▪ Elem. 2: Score of around 75%. ▪ Elem. 3: Score of around 55%. ▪ Elem. 10: Score of around 60%.
4. Legend:	<ul style="list-style-type: none"> ○ The legend at the top shows the student's name, adsikastle007, which is associated with the blue colour of the bars.

The output shown in Table 3 can help with the problem of visual literacy. However, to avoid showing already known information to the users, this information should not be always shown, but only until the teacher is able to understand the chart.

Moreover, it has been detected that the given output is very long and includes information regarding different aspects that can give an answer to different problems teachers have when facing dashboards. Besides, some of the provided information is not always needed by teachers. Therefore, in the refinement the prompts were divided to provide output regarding three aspects that can give answer to different problems:

- General explanation of the chart
- Interpretation of the chart: element by element and in general
- Conclusions and recommendations

The first one will be used to facilitate reading the chart, the second one to interpret the data and the last one to help determining when to provide interventions and of which type.

Considering this, the prompt engineering process continued with the divided prompts. This way, having

three different prompts, each one can be used only when required according to the teacher's needs.

3.4 Round 4- Divided Prompt Analysis

In this round, different prompts for the three aspects detected in the analysis of round three were created. The prompts were refined, their output customized in order to obtain adequate answers by the GenAI and context (indicating that the receptor of the output will be a teacher) was also provided.

Next the prompt used for the interpretation aspect for the case of a violin plot that compares the results of a student with the results of the group the student belongs to is shown (see Table 4).

Table 4: Prompt for the interpretation aspect of the comparison violin chart.

I am a teacher and this image refers to the grades obtained by a student, whose name is adsikastle007, and the averages obtained in his group cadsiaprobamos, in different evaluable elements of a subject in different evaluable elements of the subject ADSI. Make me an interpretation of the graph by personalizing the explanations with the name of the person and replacing the names that appear on the x-axis of the graph with those in the following list: Elem.1 = Partial Exam 1, Elem.2 = Partial Exam 2, Elem.3 = Partial Exam 3, Elem.10 = Practical Part. Note in your explanations that the student's percentage grades for each element are: Elem1 = 53, Elem2 = 75, Elem3 = 57, Elem10 = 68. Group % grades are: Elem.1 -> mean 39.50 and median 51.50, Elem.2 -> mean 37 and median 36.50, Elem.3 -> mean 32.67 and median 41, Elem.10 -> mean 68 and median 68. In addition, The minimum scores for each of the items are: Elem.1=0 Elem.2=0 Elem.3=0 elem.10=0 And the maximum ratings for each item are: Elem.1 = 10 elem.2 = 10 Elem.3 = 10 Elem.10 = 2.5.

I want the output with these two sections:

*Detailed interpretation-> in this section I want a personalized and detailed interpretation for each evaluable element. Put for each element an interpretation section, don't put a qualification section and in the appropriate cases make a comparison with the other elements.

*General interpretation-> in this section I want an interpretation in general, without going element by element. In this section I do not want strategies for improvement to appear.

As the obtained results were satisfying according to the participating teachers, the prompt generation process stopped in this round and the obtained final results are discussed in the next section.

4 DISCUSSION

The explanations, interpretations and conclusions provided by ChatGPT to the prompts generated in the last round have been analysed. The results and discussion of the analysis are shown in this section.

For the explanation aspect, it can be seen in the output shown in Table 5 that the system explains what a violin chart is, but it also gives an example taking into account the data in the provided chart. The example description is not predefined or hard-coded and can therefore be adapted to the context. This contextualizes the explanation and facilitates the teacher not only understanding the chart but improving part of their visual literacy capability so that in the near future they would not need this kind of explanation. This is, this output allows giving a satisfactory answer to RQ1.

Table 5: Output related to explanation of the chart.

<p>A violin plot is used to visualise the distribution of a data set. In this case, the graph shows the grades obtained in different assessable items, both by a group of students (blue bars) and by an individual student (red diamonds).</p> <p>The width of the blue bars in the graph indicates the density of the grades, i.e. how many students obtained certain grades. The wider the bar at a specific point, the more students obtained that grade. The circle in the centre of each blue bar represents the group mean.</p> <p>How to interpret this graph is explained below with a concrete example.</p> <p>Let us imagine 'Elem. 1' (which corresponds to 'Midterm 1'):</p> <ul style="list-style-type: none">- The blue bar shows that most of the students in the group scored around 39.50 points.- The red diamond indicates the grade obtained by the particular student, which is above the group average. <p>This means that the student scored higher than most of his or her peers in 'Elem. 1'.</p> <p>Similarly, you can look at the other assessable elements:</p> <ul style="list-style-type: none">- 'Elem. 2' (Partial Exam 2) shows that the student scored well above the majority of his/her peers.- 'Elem. 3' (Midterm 3) also shows a mark above the majority.- 'Elem. 10' (Practical Part) indicates that the student's grade is in line with the majority of his or her peers. <p>In summary, this graph allows you to visually compare the performance of a particular student with the distribution of grades of the group in different assessments.</p>

Regarding the data interpretation, the GenAI has been asked to produce the output with two differentiated parts as shown in Table 6: element by

element detailed interpretation and overall interpretation of the chart.

Table 6: Output related to the interpretation aspect of the chart.

<p>## Detailed interpretation</p> <p>1. **Midterm 1 (Elem. 1)** ** ** **Interpretation**:</p> <p>adsikastle007 scored 53%, equivalent to **5.3 out of 10**.</p> <p>**Interpretation**:</p> <p>adsikastle007 scored 53%, equivalent to **5.3 points out of 10**. This result reflects a moderate performance in the first partial exam, being the lowest in comparison to the other assessable items, suggesting difficulties in this first assessment.</p> <p>2. Midterm Exam 2 (Element 2)** **</p> <p>**Interpretation**:</p> <p>**Interpretation**:</p> <p>In Partial Exam 2, adsikastle007 achieved 75%, i.e. **7.5 points out of 10**. This is adsikastle007's best performance among the midterm exams, showing significant progress from Midterm 1, with a stronger understanding of the content.</p> <p>3. **Midterm Exam 3 (Elem. 3)** ** **</p> <p>**Interpretation**:</p> <p>**Interpretation**:</p> <p>In Midterm 3, adsikastle007 scored 57%, which corresponds to **5.7 points out of 10**. Although slightly better than in the first midterm, this result is lower than in the second midterm, showing some inconsistency in theoretical performance.</p> <p>4. Practical Part (Elem. 10)** **Practical Part (Elem. 10)**</p> <p>**Interpretation**:</p> <p>In the Practical Part, adsikastle007 scored 68%, equivalent to **1.7 points out of 2.5**. This result shows a good practical ability, with a performance that is close to the result of Partial Exam 2. However, there is a small difference between theoretical and practical performance.</p> <p>### Overall interpretation</p> <p>Overall, adsikastle007 has shown variable performance in the different assessable elements of the ADSI subject. The **Midterm 2** stands out as his best result with 75%, while **Midterm 1** shows the lowest performance with 53%. Performance in the **Practical Part** is positive at 68%, suggesting that adsikastle007 can effectively apply theoretical knowledge. Although there are fluctuations in the midterm grades, overall, adsikastle007 has shown satisfactory performance.</p>
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This allows the system to provide first some general explanations and then going element by element creating richer explanations that are adapted to each type of chart and to the data displayed in the chart.

Regarding the conclusions, the output obtained is shown in Table 7. In the output in can be seen that it proposes some recommendations that can be taken into account by teachers. This is, this output can help teachers understand what is happening and also recommend teachers to take some decisions to improve the course taking into account the collected data.

Table 7: Output related to the conclusions of the chart.

The conclusions that can be drawn from the graphical data reflect adsikasle007's generally above-average performance in the "Cadi Aprobamos" group, especially in three of the four assessable items. This indicates a good overall performance of the student in comparison to his group peers, with one particular exception.

1. **Use Case Test (Elem. 1)**: The student adsikasle007 scores 53%, outperforming the group, which scores an average of 39%. This suggests a relatively solid knowledge in this topic, although he could benefit from reinforcement in certain aspects to achieve an even higher score.

2. **Domain Model Test (Element 2)**: This is one of the strengths of adsikasle007, who scores 75%, significantly above the 37% of the group. Here the student shows a deep understanding of the topic, clearly standing out above the average.

3. **Analysis and Design Test (Element 3)**: With 57%, adsikasle007 also outperforms the group (32%), but this score still reflects an opportunity for improvement. In this assessable element, both the student and the group could use more focus on the concepts of analysis and design.

4. **Final practical documentation (Elem. 10)**: In this case, adsikasle007 is exactly in line with the group average (68%). Despite being in line with his peers, there is room for improvement to reach the maximum score.

Recommendation: Although adsikasle007 performs quite well, particularly in the Domain Model Exam, it would be useful for him to strengthen his knowledge in analysis and design. In addition, perfecting the final Documentation could guarantee him an even higher score.

The output provided for both the interpretation and conclusion aspect facilitates interpreting the charts and deciding whether to provide some interventions or not. Moreover, the output proposes some interventions, so the output facilitate interpretation and decision taking, what gives answer to RQ2.

5 CONCLUSIONS

LA dashboards are widely used, but teachers need tools that facilitate their understanding and interpretation of the data to provide adequate contextualized interventions to students. The work presented in this paper aims to analyse whether enriching LA dashboards with the use of GenAI can give answer to the current problems that present LA dashboards.

We have carried out a prompt engineering process to see which type of output could be generated to facilitate understanding the charts (RQ1) and facilitate their interpretation and the decision taking process based on that interpretation (RQ2).

Taking into account the participating teachers' opinion, we have obtained quite good results regarding both research questions. In the near future we plan to carry out a study showing teachers the enriched dashboards to evaluate in a real context whether interpretations and conclusions regarding the charts shown in the enriched dashboard really makes easier for them to take decisions on their courses.

We also plan to include in the dashboard an option for the teacher to create their own prompts and directly ask GenAI different questions regarding the charts in the dashboard.

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