Learning analytics to support teachers in the challenge of overcoming the learning gaps in k-12 students

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Abstract

The emergency remote teaching caused by the covid-19 pandemic has potentiated the learning gaps of several students in Brazilian education, especially in the K-12 settings. Amidst the many challenges imposed by the pandemic, the adoption of digital tools in the school context has provided the generation of educational data, which can be collected and analyzed in order to provide evidence-based decision making, taking into account all the stakeholders in the teaching and learning process. Such decisions can provide for the personalization of learning, which aims to provide the student with educational resources that promote the building of weakened skills caused by learning gaps. The present thesis plan aims to present the work plan for the development of a Learning Analytics Dashboard tool for teachers in a basic education school in order to support data-driven pedagogical decision-making and to enable personalized monitoring of learning

Keywords

Learning analytics, learning gaps, k-12 students, personalized learning

1. Introduction

Schools have been facing new challenges due to the worldwide COVID-19 pandemic, which has been impacting, mainly, the teaching and learning process [1]. Many school institutions, even without the proper time and resources, had to migrate classes to the digital world, through educational apps and platforms [2]. The abrupt adoption of remote teaching evidenced the socio-educational precariousness of several countries, including Brazil. The strategy adopted to continue teaching did not reach some students and teachers, due to the context of social vulnerability [2] [3].

In the scenario of basic education, which comprises the levels of education from kindergarten to high school, such difficulties are potentiated, as it comprises one of the most important periods for students in this age group, the literacy process and the construction of mathematical skills, that serve as a base throughout their school career [4] [5]. These experiences and knowledge were completely affected due to adaptation to the new remote teaching scenario, increasing the learning gap that already existed in the context of Brazilian education [6] [7].

In this context, school management has the fundamental role of dealing not only with issues of improving educational indices, but also with concerns related to the physical and emotional health of its professionals, students and family members [2].This new reality, linked to the challenge of transposing face-to-face classes to the virtual environment, adds to the role of the school manager, who must take into account the current socio-educational reality, and improve his decision-making process to achieve the goals of the school. educational institution [3].

Amid so many challenges imposed by the pandemic, the adoption of digital tools in the school context has provided the generation of educational data, which can be collected and analyzed in order to provide evidence-based decision-making, taking into account all parties. interested in the teaching and learning process [8]. Decision making is a task that is part of the daily routine of a school manager, as well as the teacher who deals directly with the student and through his actions directly impacts student learning.

The data generated from student interactions with digital tools can be used to monitor, analyze, predict, intervene, recommend and, above all, improve the quality of the teaching and learning process [9].These are features recommended in teaching practice, which aims to maintain a personalized teaching and learning process, to meet the specific needs of each student.

Learning Analytics (LA) is an emerging field that addresses this context of educational data analysis, whose objective is the collection, analysis and reporting of data about students and the contexts in which they occur [10].Supporting the decision-making of managers, coordinators, teachers and other stakeholders in student learning. There have been applications of LA techniques in the context of basic education, among these applica-

Proceedings of the Doctoral Consortium of Seventeenth European Conference on Technology Enhanced Learning, September 12-16, 2022, Toulouse, France

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CEUR Workshop Proceedings (CEUR-WS.org)

CEUR-WS.org/Vol-3292/DCECTEL2022_paper01.pdf

tions are those that enable data-based decision making for teachers and other stakeholders, especially with regard to personalization of the teaching and learning process [11]. On the other hand, most efforts in the use of LA are focused on higher education [12] [13] [14], lacking more research and tools that meet the specific demands of basic education schools [15].

1.1. Main goal

Develop a Learning Analytics tool for teachers of k-12 education school in order to support pedagogical decision-making based on data and enable personalized monitoring of learning.

1.2. Specific objectives

- Collect studies that used Learning Analytics in the context of basic education;
- Identify the demands of an elementary school to adopt Learning Analytics at an institutional level;
- Investigate the main problems and challenges associated with the adoption of Learning Analytics in the context of elementary schools;
- Design of a Learning Analytics tool to monitor students' learning progress;
- Conduct an evaluation of the adoption of the proposed tool in a primary school and verify if it supports teachers in how to deal with student learning gaps through personalization of teaching.

1.3. Research questions

1.3.1. Main question

How to support a k-12 education school to deal with the challenges arising from learning gaps, through Learning Analytics techniques?

1.3.2. The main question is divided into four sub-questions

- How can educational data analysis help address learning gaps?
- How to deal with ethical issues in the adoption of Learning Analytics in k-12 education?
- How can learning analytics techniques support the personalized monitoring of student learning in k-12 education?
- What is the context of a k-12 education school to adopt Learning Analytics?

2. State of the art

Data-based decision-making is an essential action in the school context, taking into account the growing generation of educational data provided by student interactions with digital tools, as well as traditionally existing data, such as grades and attendance [9].Within this context, educational performance indicators also play an important role in decision-making with the aim of improving the teaching and learning process. All data and information from the various sectors that make up the school can and should be used in order to provide insights and support decision-making in a timely manner with the aim of promoting personalization and learning recovery.

2.1. Background and context

2.1.1. Personalized monitoring of learning in blended learning

Due to the global pandemic of covid-19, schools had to adapt the way they interact with students, starting to use more disruptive teaching-learning tools and strategies to guarantee remote classes, such as Google Meet and Zoom, which were used. to enable synchronous classes [16]. With regard to educational strategies, there was a massive adoption of hybrid teaching models, since, soon after the beginning of the vaccination period for health professionals, many schools began to partially return to the face-to-face model, adopting this approach [17].

Blended learning is "a model of formal education that is characterized by merging two modes of teaching: traditional and online, also valuing interaction and collective and collaborative learning" [18]. In the systematic review conducted by [19], where they investigated what types of hybrid learning models exist, having found six types. The following models were found: supplementary, inverted classroom, rotational laboratory, study rotation, synchronous collaborative hybrid and dual-collaborative group.

With a different approach to the traditional teaching model, blended learning has as its specific characteristic a more personalized learning, respecting the students' own pace and understanding that people learn in different ways [20]. Based on this understanding, it is possible to offer students learning that addresses their learning gaps and can enable students to learn more individually and effectively.

2.1.2. Application of Learning Analytics in k-12 Education

Learning Analytics (LA) is an emerging research field that aims to measure, collect, analyze and report data about students and their contexts, as well as understand

and optimize learning and the environment in which it takes place [21].

Despite substantial growth in the application of learning analytics to improve teaching and learning in the last decade, most of these works have focused on higher education issues and contexts [22] [23]. With a wider adoption of digital educational technologies in primary education, recently accelerated by remote emergency classes due to Covid-19, there has been a greater awareness of using LA to accompany and personalize the learning process [24].

In the systematic review of the literature conducted by [11] 42 studies were identified that applied LA techniques in the context of basic education, among the approaches are, data distillation for human judgment, prediction, educational data mining, discovery with models and clustering. Most of these approaches developed isolated works in some sector of the school, but did not address the context of adopting learning analytics in an institutional way. Some aspects must be considered with regard to the use of AL in basic education, an institutional diagnosis must be taken into account to understand the needs of the context of a particular school, the ethical issues that are generated must be taken into account. from the use of the data, it is necessary to use more diversified techniques that take into account, mainly, the personalized accompaniment of the learning and, finally, to use explainability techniques (Explainable artificial intelligence) in the algorithms used to support students, teachers and educational managers [11].

2.1.3. Use of Learning Analytics in formative assessment to support data-driven pedagogical decision making

Assessment has three general functions: diagnose, control and classify. These three functions are represented, respectively, by the types of existing assessments: diagnostic, formative and summative.The diagnostic evaluation, according to [25] , "the fundamental objective is to analyze the situation of each student before starting a certain teaching-learning process, to become aware of the starting points, and to adapt the process to the detected needs". The summative assessment, on the other hand, takes into account all the content taught, usually divided by two months, and at the end of this process, a test is carried out to verify the acquisition of knowledge [26].

Formative assessment aims to monitor students' learning during classes, in daily activities and is concerned with "determining the degree of mastery of a given learning task and indicating the part of the task not mastered" [27]. Unlike summative assessment, the focus of formative assessment is to collect data to reorient the teaching and learning process, pointing out its weaknesses, allowing necessary changes during the school period, in daily practice [28].

In view of the objective of formative assessment, which aims to accompany students, collecting evidence of their learning process, learning analytics techniques can be used to deal with the measurement, collection, analysis and reporting of these collected data, enabling teachers and other stakeholders valuable information about students during the construction of their knowledge, taking into account the individual learning pace. Through these data, it is impossible to make a pedagogical decision based on data, since with the increasing use of educational technologies, in the context of basic education, more data is generated during student interaction made possible through formative assessments made available by teachers daily.

Support for teachers' decision-making has gained a lot of notoriety in recent studies in the area of learning analytics for basic education [29]. And with regard to personalized monitoring of learning, through the increasing use of digital technologies in basic education, it is possible to empower teachers to deal with problems arising from lag and learning gaps, and help students to recover their learning [30].

2.2. Related works

In order to verify the importance of the challenges presented in this thesis plan, a systematic review of the literature was carried out, in order to obtain the state of the art of publications that addressed the application of learning analytics in the context of high school, and later it was A survey of studies was carried out, directly from the databases, to update these studies, as well as to identify studies that addressed the use of learning analytics in the context of basic education as a whole to support teachers and/or managers in pedagogical decision-making based on in data. Taking this context into account, some studies were identified that aimed to address issues similar to this thesis plan.

The work done by [9] uses the various data generated by educational information systems, such as: learning management systems or virtual learning environment, student diary, library system, digital repository, etc. The authors address that due to the use of these digital tools in the school context, there has been a significant increase in the volume and variety of data that can be captured, stored and analyzed in order to improve student learning and school effectiveness. In this study, they took a comprehensive approach to the use of learning analytics in Bulgarian education, and developed six machine learning models to support decision-making based on data from stakeholders in that context. The models were developed to support students, teacher monitors, classroom teachers, administrators, parents and educational

inspectors. Four models were evaluated, for students, monitor teachers, classroom teachers and parents, and showed promising results.

In the project developed by [31] learning analytics dashboards were developed to help teachers make quick and effective decisions regarding student learning activities in the classroom. The proposed dashboard was enhanced taking into account the needs of teachers, with a user experience and usability suitable for teaching practice, taking into account the dynamics presented in basic education. An important feature of this study is the provision of information through real-time dashboards to speed up teachers' decision making. The dashboard presented for the educational context was originally developed for the business context, however it was adapted to be used by teachers. The final prototype was evaluated by 9 teachers, and it was found to have a high potential to support pedagogical decision-making. As a point of improvement, the teachers participating in the dashboard evaluation pointed out the need to use data from external tools, which are already part of the school context.

The work led by [32] addressed an experiment carried out with five high school teachers, who were monitored during a school year. Teachers used information provided by learning analytics in their classrooms through data provided from computer-based assessments. Such information served as a basis for the planning of classes, which enabled a more individualized and personalized teaching-learning approach. Teachers reported that the insights extracted from the data collaborated in their teaching practice, highlighting the detailed information about each student, task and responses. In the classroom, teachers used such detailed insights to provide feedback to low-performing students and it was found that those students who had these learning gaps performed better after performing the data intervention.

Finally,[33] investigated the role of learning analytics to assess formative assessments, with the aim of using a data-driven approach to inform teachers about changes in their teaching practices and how they impact the development of student learning. The authors highlighted that one of the most challenging tasks for teachers is designing, managing and evaluating formative assessments, and this is one of the main reasons for not using formative assessments as a form of feedback for students and for teachers themselves to adjust their teaching strategies throughout the school year. One of the ways to overcome these challenges, according to the authors, was the use of learning analytics techniques that were employed in the study with the purpose of facing such difficulties and providing personalized feedback on a large scale. Briefly, the data collected from formative assessments were analyzed using learning analytics and provided recommendations that supported students in a self-regulated learning approach, and enabled teachers to reorient their planning and teaching practices.

Taking into account these approaches, how to use learning analytics techniques in formative assessments, in the context of blended learning, to collect, analyze and report educational data for teachers in a basic education school to monitor the learning process and support the decision-making process. data-driven pedagogical decision-making to help students address their learning gaps?

3. Work plan

The purpose of this work is to develop a descriptive and predictive Learning Analytics Dashboard - LAD, using data collected from Google Classroom and Khan Academy, to support teachers in pedagogical decision making in the classroom, in order to identify, monitor and propose interventions to deal with students' learning gaps.

3.1. Submission of the proposal

The proposal is to use data from computer-based assessments, with the support of two educational platforms, Google Classroom and Khan Academy, which are used to manage classes and activities in the context of online and face-to-face classes.

The APIs (Application Programming Interface) provided by both platforms will be used to access and form the data repository, which will serve as input for the construction of the LAD. The availability of descriptive and predictive data analysis through LADs is the most common way to fulfill the Learning Analytics cycle, which has as a crucial objective, in addition to measuring, collecting and analyzing educational data, to provide reports on this data. from student interactions on digital educational platforms, enabling teachers to make evidence-based pedagogical decision-making [34].

Through the use of LAD, teachers will be able to track student performance in real time on the Khan Academy and Google Classroom platform, as well as have access to predictive results based on student interactions. In the context of blended learning, using the rotational laboratory approach, students participate, in addition to the traditional classroom lesson, they also interact with digital devices, where they will have the purpose of continuing the class started in the classroom. Among the most common activities carried out by students are: research on the internet, answering online activities, developing individual or collaborative textual productions, etc.

Students will use Chromebook devices to carry out classes through the rotational laboratory approach, which are notebooks that use the Chrome OS operating system and are generally used in the school context. With

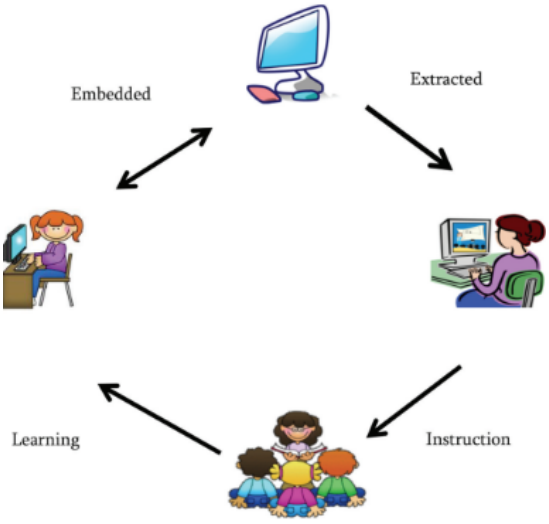

Figure 1: Embedded and extracted analytics in computer-based assessments.

the chromebooks, data regarding online activities will be collected through the Khan Academy API, and data regarding student interactions in the classroom will be obtained through the classroom API and Google Chrome's Sync function, which tracks logs from the browser.

LAD will support the teacher in decision making while students are working on an assignment, in the classroom, and will provide in real time which students will need support and what kind of support will be needed.

In order to support computer-based formative assessment, through Classroom and Khan Academy, for the construction of the LAD, the Learning Analytics - extracted analytics strategy will be used. There are two types of Learning Analytics strategies, the embedded analytics which refers to the data that is used to inform the student and/or adapt tasks to the students' skill levels without teacher intervention. And extracted analytics refers to the data that is presented for interpretation and provides teachers with information about the learning process and its results, where it is possible to personalize teaching and learning in the classroom [35]. Figure 1 illustrates the difference between the two approaches.

3.2. Method

The present work will use applied research as a type of study, which according to [36] are "research aimed at acquiring knowledge with a view to applying it in a specific situation", where the need to produce knowledge for the application of its results is the motivation to "contribute to practical ends, aiming at the immediate solution of the problem encountered in reality" [37].

For research purposes, it is characterized as descriptive, as it aims to describe the characteristics of certain populations or phenomena and "can also be elaborated with the purpose of identifying relationships between variables" [36]. Its approach will be qualitative for the analysis of research data, according to Gil (2002, p. 133) "qualitative analysis depends on many factors, such as the nature of the data collected, the size of the sample, the research instruments and the theoretical assumptions that guided the investigation" [38].

Regarding the technical procedure, the study is classified as action research, which is defined as a type of empirically based research and has a "close association with an action or with the resolution of a collective problem and in which researchers and representative participants of the situation or problem are involved in a cooperative or participatory way" [39].

In order to answer the research questions and achieve the objective of this study, the data collection tools will be the use of forms, observations and interviews with teachers of the Portuguese Language and Mathematics subjects, of elementary school 2, of the Escola Professor Olindina Roriz Dantas, as well as monitoring student performance through summative assessments made available every two months and through formative assessments made available by educational platforms, discussed in the previous topic.

As a methodology for the data mining process, the CRISP-EDM will be adopted, which is a version adapted for the educational context of the consolidated standard of data mining and knowledge discovery aimed at the CRISP-DM industry. CRISP-EDM fully follows the six steps of the original model, but with educational data mining particularities (RAMOS et al., 2020).

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