Alfadatizando 2.0 applied to data visualization at high school level and for digital humanities. Empowering digital citizens

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Abstract. Given the great evolution and transformation of digital technologies and their penetration in different aspects of daily life, there is a need to provide equal possibilities and equal rights to access them, which implies training digital citizens. On the other hand, digital technology and some methods of social sciences and computer science to visualize data, support what is known as digital humanities. These add computational thinking and create new kinds of jobs, skills and specific knowledge. Currently there are several efforts to add their teaching at the higher level, however, there is little evidence of their presence at the high school level. With the aim of promoting the formation of digital citizens by considering aspects of computational thinking through data visualization in digital humanities, this paper first analyzes articles that consider the teaching of digital humanities in order to know the visualization methods applied. A platform to make educational activities considering some of the surveyed methods is presented, a case study considering a curricular design is proposed and a proof of concepts from the above is performed.
The results of the survey analysis show, on the one hand, the use of certain data visualization methods in the teaching of digital humanities at high school level, on the other hand, the feasibility of using the proposed platform for the defined case study and the viability to develop digital skills and computational thinking in students. This is considered a contribution to the empowerment of digital citizens from the high school level.

Keywords: Digital Citizenship, Computational Thinking, Digital Humanities, High School, K-12, Secondary School, Teaching, Learning, Digital Literacy, Data Literacy, Platform, Distant Reading, Literature, Curriculum, Knowledge network -Techno-Pedagoy

1 Introduction

We live in a world of constant transformation and evolution of digital technology, which we use in many of our daily activities, for example, transportation, leisure, games, money transactions, communication, consulting information through generative artificial intelligence and education. One challenge is to ensure that all individuals have the possibility and the same rights of access to such technology and that they can also use them to take advantage of the opportunities it provides, so it is necessary to be digital citizens. According to Ribble, being a digital citizen implies more than being connected to the Internet or using digital tools; it is about having a responsible and critical attitude towards technologies, understanding their impact on society and using digital tools ethically and safely [1]. For UNESCO, it is necessary to address its teaching from the different forms of education [2], and as proposed by Bombardelli, to consider it as a continuous process [3] and in which one of the elements present is Digital Literacy, which allows developing digital skills and competences [4].

In addition to digital skills, it is important for citizens of the 21st century to develop computational thinking. This type of thinking was introduced by Papert [5] and taken up again in 2006 by Wing when the socio-materiality of the moment favored its development by adding it to the educational curriculum. According to Wing, computational thinking is transversal to different disciplines, and not exclusive to computer science, and can be carried out considering the aspects of abstraction, decomposition, patterns and algorithms [6], [7]. Reinforcing the idea of transversality, Denning and Tedre explicitly mention its application in the areas of humanities and social sciences [8], which complements the view of computational thinking applied more traditionally in STEAM. This type of thinking can be developed through different practices, such as programming and working with data through its visualization [8]. This type of work makes it possible to carry out what is known as data literacy, favoring the formation of active citizens [10] and being important to include it at the high school level [11].

On the other hand, and particularly both computational thinking and data literacy are important in what is known as digital humanities [12] [13]. These are presented in the 2.0 manifesto [14] as a set of methodologies that cut across the area of interest of the humanities and that incorporate digital tools and computational methods among other things to "*apply and pursue new ways of reading and interpreting texts offered by the digitization of texts*", "*suggest new methods concerning the preservation of and access to intellectually meaningful information*" and "*observe and understand discursive forms produced in new digital media*".

In the digital humanities, qualitative methods from the humanities are often used, but also quantitative methods from the social sciences and computer science, such as digital storytelling, distant reading [15], network analysis, data visualization, mapping, gamification, modeling and exploratory play [16]. When working with digital humanities, computational thinking is used to reflect on how to use computers, and on what is done through them, as well as being used to think about how to propose a solution. This type of thinking in the digital humanities transforms argumentation and the way knowledge is thought about [13]. In their work Berry and Fagerjord reflect on

the need to learn about digital humanities and how the future of their teaching should be considering the importance of considering information technology from the perspective of the discipline and understanding that, with this type of thinking, what happens computationally, is that the possibility arises that citizens can think not only in using, but also in modifying or creating things different from the existing ones. The authors also mention that developing disciplinary sensitivity not only allows developing new forms of knowledge and practices in the humanities, but also contributes to a more critical and reflective citizenship that can use these aspects to contribute to society, considering that digital humanities create new jobs, skills and specific knowledge for a new economy [13].

Taking into account the need to address transversally the teaching of digital citizenship in the education of high school students and putting in value the teaching in the area of digital humanities, working digital literacy and data literacy and considering computational thinking through data visualization, this paper is organized as follows, first, an analysis of an initial review of academic papers that use methods of digital humanities at high school level is presented, then improvements made on the Alfadatizando platform are reported to consider, among other aspects, one of the methods reviewed. Below, a case study is proposed and, from this, a proof of concepts to carry out distant reading considering knowledge networks and using Alfadatizando 2.0. The discussion of the case is presented and, finally, the conclusions and future work.

2 Analysis of reading works

As part of a first literature review in academic sources about the presence of digital humanities in the teaching-learning process at the high school level (which was carried out using a semi-structured method with the addition of the snowball method), different articles were found that apply, among others, some of the digital humanities methods described by Mills [16] using digital tools or platforms in their teaching-learning proposals. For use at the high school level.

From the analysis of the papers reviewed, we identified the use of graphs [17], [18], storytelling [19], storymaps [20], [21], sentiment analysis with natural language processing [20], programming [22], artificial intelligence [23], immersive exhibition [24], GIS [25] and distant reading [26], [27], [28]. A brief description of the analyzed works is given below.

Santa Marina presents a detailed proposal to work with graphs from the point of view of social networks, in this case formed between characters of literary works, available in the "Drama Corpora Project" (DraCor[1]) and in Shiny DraCor[2]. The aim of this proposal is to bring high school students (aged 15-17) in Spain closer to tools and applications of the Digital Humanities to work with dramatic texts from the Silver Age of Spanish Literature [17]. Alcantara et al., taking as a basis the recommendations of their country (Brazil) for physics to be socioculturally contextualized, pro-

[1] https://dracor.org/

[2] https://pozdniakov.shinyapps.io/Dracor/

pose, based on digitized historical charts from a repository (ePistolarium[3]), to create graphs by drawing them on paper (historical networks) to discuss the relationships between people and events that allowed the development of optical instruments in the Dutch Republic in the XVI and XVII centuries [18].

On the other hand, Kapaniaris and Dimitriou decide to use storytelling since, according to the authors, it is useful in the educational process in history subjects. The authors choose to work on the Greek civil war given its usual complexity in the understanding of students and as part of a proposal for students in the last year of high school in Greece. For this purpose, they carry out an exploration of tools for the creation of storytelling that are not included in the work [19].

Arteaga presents a pilot project focused on English teachers in rural high school level [29]. As a result of this project, recommendations and an activity guide [20] are generated to work on language teaching as part of the digital humanities field. The guide introduces the use of storymaps (using the tool from Northwestern University Knight Lab[4]) and sentiment analysis in a text using Natural Language Processing (NPL) provided by a prototype[5] from Stanford University. Regarding the use of story-maps, Hicks and Kenna present a case study based on a story of forced migration, to work in geography class on the topic of geographic movement in local history using the resource provided by ArcGis[6] for this purpose [21].

Chen et al. describe the realization of a Summer Code Camp with a focus on digital humanities. The camp is designed considering, among other aspects, a focus on literary studies and the language of markup in poetry. During the camp students carried forward the exploratory use of programming with phyton[7] [22].

Diaz Sanchez and Chapinal Heras propose a methodological approach consisting in the application of an open access artificial intelligence (Midjourney[8]) to "improve and reinforce the historical, archaeological and philological knowledge of classical antiquity", which would allow students in this field to "acquire and develop new skills to better understand and analyze literary sources" [23].

Casu et al. propose a configurable prototype to generate immersive exhibitions. The prototype developed by the authors is called RiftArt and allows to configure, in customizable rooms, art pieces, which can be augmented by the teacher through textual or auditory annotations associated with each of them [24].

Morrice works in ancient geography, on the theme of travel in the Roman Empire. In her study she points out that the way in which the Romans perceived geography in those days is very different from the way it is perceived today. From this the author proposes a didactic sequence that explores travel in the ancient world and how the Romans experienced travel in their times. For this she relies on two gis tools, Google Maps[9] and Orbis[10] from Stanford University [25].

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[3] https://ckcc.huygens.knaw.nl/epistolarium/
[4] https://knightlab.northwestern.edu/
[5] http://nlp.stanford.edu:8080/sentiment/rntnDemo.html
[6] https://storymaps.arcgis.com/
[7] https://www.python.org/
[8] https://www.midjourney.com
[9] https://www.google.com/maps

Finally, considering distant reading, Bekiari and Xesternou propose an activity for an Ancient Greek Language and Literature course, combining Greek tragedy with tools from the humanities. They perform an exploration of texts using a text mining tool (Voyant[11]) [26]. This same tool is used in Dabrowska's proposal where she presents a didactic sequence to innovate in literature in the high school level classroom with the objective of "*helping students to interpret texts and to think critically about traditional reading and reading mediated by computational procedures*" [27]. Finally, Voyant is also used by Perez Garcia in his work in which he proposes several activities for the area of literature, including the use of this tool to analyze texts [28].

After analyzing the academic papers found, it is possible to note that the area of Literature is the one in which most evidence was found. Of the most used methods, the distant reading method and the graph or knowledge network analysis method appear. Additionally, visualization in knowledge networks (graphs) constitutes a way of carrying out distant reading. On the other hand, in all the proposals analyzed, the activities are carried out on digital tools or platforms that do not allow for follow-up or interaction between students and teachers, and a record must be kept, for example, of the activities assigned to students, their doubts, deliveries, deadlines and returns using an additional platform or tool. Likewise, it is not possible to design activities, reuse them or share them if not through an additional tool.

3 AlfaDatizando 2.0

Alfadatizando [30] is a prototypical platform for data visualization in digital humanities that allows the creation of learning activities for this purpose. The version published in 2022 had the possibility of working with knowledge graphs generated from the Twitter API. After the commercialization of this API, the functionality was disabled. Additionally, the first version does not consider the graphs as a possible type of data source, does not allow messages between students and teachers when an activity is performed, nor does it consider aspects of awareness for the teacher to manage the activities in a simple way, among other things. Based on user tests performed and on the analysis of its architecture and implementation from the point of view of soft-ware engineering, also considering techno-pedagogical aspects, the need to improve the first version arose in 2023 [31]. Considering the above, this paper presents the new prototype of the Alfadatizando 2.0 platform to carry out activities in humanities and social sciences that allow the development of computational thinking and digital skills from data visualization, which would contribute to the empowerment of digital citizens [32].

The new prototype is configured to work with the different educational institutions of Argentina, which are automatically loaded from the updates of the official list of educational establishments of the Argentine Nation[12] (in the first version it was the

[10] https://orbis.stanford.edu/

[11] http://www.voyant-tools.org/

[12]https://www.argentina.gob.ar/educacion/evaluacion-e-informacion-educativa/padron-oficial-de-establecimientos-educativos

responsibility of an administrator to perform this type of updates). Note that this same prototypical platform can be used with institutions from different countries if the corresponding information is uploaded.
For each institution, it is possible to upload managers, teachers, courses and students. There are four user profiles: platform administrator in general, administrator by educational institution, teacher and student. Each profile contemplates actions that establish the activities that can be performed by each of them. Below is a brief description of each profile.

The *platform administrator* has all the creation, configuration and consultation privileges over the entire platform, and can perform the same activities as any other user profile (he/she is a superadmin) in addition to his/her own. The *administrator of each institution* registers the different actors of the educational system (managers, teachers, students and courses). For each course, the administrator of the institution assigns teachers and students. In addition, he/she can perform and visualize the actions of users with other profiles within his/her institution.

The *teacher* can upload new data sources to the platform or copy existing ones and modify them. These data sources have different levels of visibility (only for a teacher, for the institution or for the whole community) and categories, flat data, graphs and connections to social networks (currently only the connection to the Reddit[13] API was implemented [33], however, it is possible to add others later). It is responsible for creating, reusing or modifying activities and assigning them to students. When creating an activity, it selects the data source(s) and the type(s) of graphics that the student will be able to use to solve the activity (column, line, pie, bubble, map and graph graphics are available in the current version). In case of receiving a message from a student as a doubt to an activity, he/she can respond within the platform. The teacher visualizes through a board the different activities assigned to a course, the ones that have already expired and have not yet been submitted by all the students, as well as the activities that have been finished. The activities once submitted by a student can be viewed on the platform or downloaded in pdf format.

The *student* of a course receives activities from a teacher and can start an exploration to solve it. The platform allows testing until the student explicitly indicates that he/she wants to submit an activity to the teacher. Before submitting an activity, it is possible to ask the course teacher about the activity from the platform and receive his/her answers.

Users, independently of their profile, can register in the platform through a registration form including username and password, or replace this part using the unified login with Google [34].

As part of the technical and technological improvements incorporated, the following can be highlighted: the design of a new class model (it is an object-oriented model) that allows not only to extend functionalities, but also to handle a higher level of abstraction for future extensions through extension points. As for the specific implementation aspects, a new software develop was carried out to allow the modularization of functionalities, the automation of update aspects, as well as the incorporation

[13] https://www.reddit.com

of new techno-pedagogical features. Based on the above, a possible extension point is the implementation of an interface to use part of the Alfadatizando 2.0 functionality with an LMS, Moodle style, to take information related to teachers and students of an institution without involving rework for the institution. The technologies used during the development are Python, Javascript[14], for the databases MongoDB[15] and PostgreSQL[16] are used. The server is running Docker[17]. The frameworks used are Django[18], Django-Rest[19] and React[20].

4 Proof of concepts

Once the new prototypical version of the Alfadatizando 2.0 platform has been presented, we propose the design of a test case to then carry out a proof of concepts with one of its provided functionalities. The analysis of graphs in the framework of digital humanities.

4.1 Design of a case study

Considering the curricular designs of the province of Buenos Aires, Argentina[21], it was decided to focus on the design that the province has for the fourth year of high school in the subject Literature. In this curricular design, it is mentioned that "in this context, High School Education has at the center of its concerns the challenge of achieving inclusion and permanence for all young people in the province to complete mandatory education, ensuring the necessary knowledge and tools to fully comply with the three purposes of this level of education: the formation of citizens, preparation for the world of work and for the continuation of higher education". Considering the relevance of digital skills and computational thinking for the empowerment of digital citizens, this approach is considered appropriate as a methodological framework.

Among the readings proposed in the curricular design, for the chosen year and "whose teaching and learning is considered essential in the high school of Buenos Aires"[22] appears "La Casa de Bernarda Alba", by Federico García Lorca. Consequently, this work was chosen in this work (this same literary work, although for other reasons, was part of the work presented in [27]).

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[14] https://lenguajejs.com/javascript/
[15] https://www.mongodb.com/es
[16] https://www.postgresql.org/
[17] https://www.docker.com/
[18] https://www.djangoproject.com/
[19] https://www.django-rest-framework.org/
[20] https://es.react.dev/
[21] https://abc.gob.ar/secretarias/areas/subsecretaria-de-educacion/educacion-secundaria/educacion-secundaria/disenos-curriculares
[22] https://continuemosestudiando.abc.gob.ar/contenido/lecturas-escrituras-y-producciones-orales-irrenunciables-en-la-escuela-secundaria-bonaerense/

For the case study, a didactic sequence is considered to put in dialogue the teaching of traditional Literature with digital humanities, adding aspects of distant reading and computational thinking through data visualization. To achieve this, four steps are proposed: 1) classroom approach by the teacher where, among other traditional practices, the conventional reading of the work is carried out. 2) visualization of the knowledge graph between characters of a literary work 3) identification of the aspects of computational thinking present in the activity, 4) reflection activity about the visualized data in contrast with the individual imaginary generated from the traditional reading of the literary work.
From this design below, we show how to carry out steps 2 and 3 using Alfadatizando 2.0.

4.2 Alfadatizando 2.0 in action using knowledge networks

This section shows how to use Alfadatizando 2.0 to carry out the proof of concepts, considering steps 2 and 3 mentioned in the previous section.
First, the teacher must create the activity within the platform, for which he/she loads (in case it does not exist) a data source of graph type with the data of the characters and their relationships, with public visibility. For this work a graph is used, in .csv file format, obtained from the DraCord collection and made available in Alfadatizando 2.0. Then, the teacher creates an activity for which he/she defines the statement and general characteristics, selects in this case to associate the graph visualization, chooses the data source of the previous step and indicates for which students of the course the created activity will be available, in this case all the students. When the teacher creates an activity, he/she has the option to visualize it as if he/she were a student, which allows him/her to validate it before posting it.
Once the activity has been created, it is possible to perform steps 2 and 3 of the previous section. As for the *visualization of the knowledge network between characters of a literary work* (step 2), it is possible to preview it as a teacher, or by logging into the platform with a user with a student profile. When the student accesses the course, the activity created in the previous step will appear among his or her pending activities.
When the student selects the data source and enters the network option, he/she will be able to visualize the knowledge network between characters in the literary work (see Fig. 1).

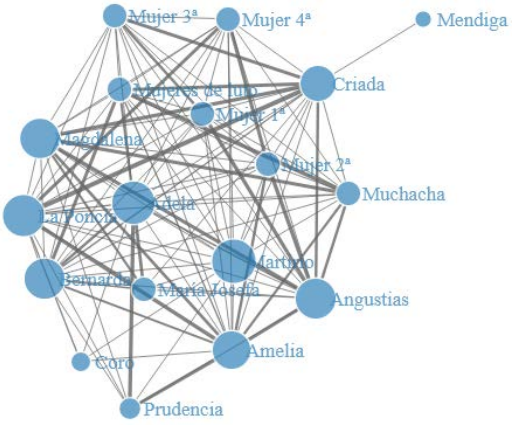

Fig. 1: Knowledge network between characters of "La casa de Bernarda Alba"

In the step of *identifying the aspects of computational thinking present in the activity* (step 3), based on the visualization of the knowledge graph between the characters of "La casa de Bernarda Alba", general aspects of computational thinking present in this form of distant reading approached for the case study are analyzed. One possible way to work on these issues with students is suggested below.

On the one hand, each circle in Fig. 1 represents a *node*. In this case, each node represents a different character. On the other hand, some nodes are connected to each other by lines, called *edges*. Each edge represents a connection between characters.

From the perspective of computational thinking, in this way, an *abstraction* is performed, it means that the literary work is abstracted using a *graph model* and *decomposed* by considering the characters (nodes) and how they are interrelated (edges). Then, the thickness of the lines (edges) indicates the number of times each character is related to each other, while the diameter of the circle (node) indicates the number of appearances in the text of each character. The largest node being the most named in the literary work and the smallest the least named. Another concept is that of *centroid*, that is, starting from a node, to know the relationships that exist with it. To find a centroid, clicking on a node visually highlights the edges and nodes to which it is specifically related. These highlighted relationships form a subgraph within the original. For example, if we consider the character "María Josefa", Fig 2. shows the way in which the characters with whom she dialogues in the literary work ("Bernarda", "Martirio", "Angustias", "La Poncia", "Adela", "Magdalena" and the "Criada") are highlighted, being possible to infer greater interaction between "María Josefa" and "Adela" since the line that connects them is of greater thickness with respect to other characters.

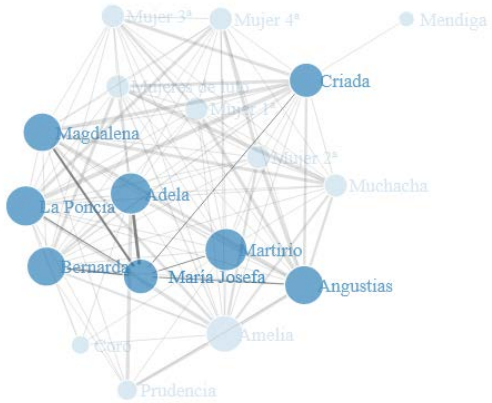

Fig. 2: Knowledge subnetwork with centroid in the character "María Josefa".

Analyzing it from the perspective of computational thinking, from the centroids, *patterns* are being detected.

Regarding the *algorithm*, we can mention the "behind the scenes" considering that, to achieve the visualization, there is a series of data coming from a table that, because of how they are manipulated, end up being visualized in the way shown in Fig.1. Furthermore, it is possible to work with the students to manually draw the graph from the original table data to understand how the underlying algorithm works.

In this way, the aspects of computational thinking present in a distant reading activity visualizing a knowledge graph between characters are identified for a proposal in the subject Literature in the fourth year of high school in the curriculum design of the province of Buenos Aires, Argentina.

5 Discussion

Firstly, from the use of the platform, we recognize the limited functionalities of Alfadatizando 2.0 in the face of the specific functionalities of the wide variety of options provided by the tools used by the authors of the works analyzed in Section 2, since in general these tools have stable versions and in some cases are for professional use, however, we consider that Alfadatizando 2. 0 brings to high school the first approaches for the use of data in humanities and social sciences in a simplified way, allowing centralized communication between teachers and students, the management of visualization activities and data sources according to this educational level.

It is important to note that the same didactic sequence proposed in this article could have been carried out, for example, using The Vistorian[23] tool, which allows graph visualization; however, the use of this tool requires greater expertise and may shift the focus of the proposed activity both because of the other visualizations available and

[23] https://vistorian.github.io/vistorian/

because it lacks an integrated environment to centralize the activity and questions between students and teachers.

The need for devices in the educational institutions to access the platform, as well as connectivity, in case of wanting to perform the steps that involve the tool in the classroom, becomes manifest. An alternative to this is to give the concepts for graph interpretation during the classroom and leave steps 2 and 3 for the student to solve at home (considering that the student has equipment and connectivity at home).

A very important aspect for the adoption of this type of proposal is that the institution should value the adoption of new teaching and learning proposals and that all the actors of the educational system should be part of this initiative. It is also important to provide and sustain a training space for teachers and managers. Even more fundamental is the adoption of these practices as part of the curriculum.

Regarding the proposed case study, it was possible to put it in the context of an existing curriculum design due to the generality with which the three axes of the high school level are specified in the considered curriculum design, being able to interpret "citizenship training" in particular as digital citizens training, and in terms of "preparing for the world of work and for the continuation of higher level studies", since computational thinking is considered transversal to the different disciplines as well as part of many of the work activities as well as digital skills.

Finally, as Gurukkal mentions, digital tools alone do not guarantee the expected performance of students; the success of techno-pedagogy depends on the creativity and innovation of the teacher who will promote the use of technology in a critical as well as creative way [35].

From the analysis of the proof of concepts conducted, the authors consider that it constitutes a first step to: a) validate the feasibility of, on the one hand, the use of the platform in one of the possible activities to carry out distant reading through analysis of knowledge graphs between characters and on the other hand, to work aspects of computational thinking in data visualization for digital humanities using graphs, b) put in dialogue the teaching of traditional literature with methods of digital humanities to develop computational thinking and digital skills c) contribute in the empowerment of digital citizens.

6 Conclusions and future works

This paper presented the analysis of a first review of academic papers that consider, in the teaching-learning process at the high school level, digital humanities methods based on data visualization. An update of the prototypical Alfadatizando platform was described to cover more functionalities and in a more effective way. A case study was proposed and using Alfadatizando 2.0 a proof of concepts was performed, considering distant reading from graph analysis, in this case a knowledge network between characters of a literary work. Aspects of computational thinking present in the proposed visualization were identified. The proof of concepts allowed validating the feasibility of using the platform in one of the possible activities to carry out distant reading through the analysis of knowledge graphs between characters, as well as the feasibility of working aspects of computational thinking in the visualization of data for digital humanities using graphs. It was possible to put in dialogue the teaching of traditional

literature with methods of digital humanities to develop computational thinking and digital skills, which allows to contribute to the empowerment of digital citizens.

As future work, it is expected, based on the results of the proof of concepts, to carry out new tests involving the different actors of the educational system within an institution (managers, teachers, students and support staff). Although the web version of the prototype was made with responsive technology, there are still extensive tests to be carried out to be used from mobile devices. These tests will be carried out in the short term.

Another aspect to incorporate in the future in the platform is the collaborative resolution of the activities as well as adding other visualization methods associated with digital humanities and aspects of natural language processing (NLP) and generative artificial intelligence in the context of digital humanities. It is also of interest to add a discussion forum per activity and another per course to work on the development of effective communication skills. In the long term, it is expected to incorporate knowledge graph queries using Wikidata[24] as a data source.

From the methodological point of view, it is expected to propose an approach that helps to generate this type of activities as well as a set of tools and data sources to promote their adoption by teachers for their implementation in the classroom as well as by the different actors of the educational system.

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