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AN AGNOSTIC MONITORING SYSTEM FOR ITALIAN AS SECOND LANGUAGE ONLINE LEARNING

Gerardo Fallani, Stefano Penge, Paola Tettamanti

Affiliation: University for Foreigners of Siena, Italy
{fallani; stefano.penge; p.tettamanti}@unistrasi.it

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This contribution follows the trend in educational research to collect data and create an information-based system to improve learning effectiveness. However, the value of quantitative data collected through online platforms is a subject of debate: when starting from data (inductively) meaningful interpretations are hard to discover; on the other hand, when starting from *a priori schema* (deductively), there is a risk of lack of flexibility and responsiveness to the changes. Hence, the need to hypothesize a different approach.

For this purpose, a monitoring system whose architecture we defined as agnostic has been built and tested. That system was connected to an online learning environment with free educational resources, whose operating learning fulcrum is the Digital Learning Unit (DLU), an original theoretical-practical device which allows interpretative assumptions to be made on the data obtainable from the system.

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Although minimal, the results achieved through the piloting are sufficient to enable the monitoring system as an information provider about learning experiences, resources, and the environment itself. The interpretative hypotheses made possible by the DLU legitimize the assumption of an abductive approach which, without incurring in the aporias mentioned above, allows us to transform mere quantitative data into useful information to support the learning process.

1 Introduction

In the last about ten years, since International Conference on Learning Analytics & Knowledge (LAK) (Siemens & Long, 2011), collection, analysis and visual representation of data concerning learners and learning contexts have become crucial in academic research, especially as far as e-learning is concerned.

However, researchers are aware of the issues arisen from the computational analysis of a high amount of data (Siemens, 2013). In order to interpret the collected data, either machine learning and data mining techniques (inductive approach) or filters based on *a priori* preset criteria (deductive approach) could be applied. Still, they both have limitations. The first approach might result in blurred phenomena mechanisms, producing only forecasts and effects rather than causes. With the second one, the referenced framework might become too rigid, and therefore not flexible and not responsive to the changes. This work should be considered under this theoretical issue and the more general debate on learning analytics (Ferguson, 2012; Chatti *et al.*, 2012; De Waal, 2017).

This paper is aimed to analyse and share the results of a piloting experience that has been conducted throughout the 2nd level Master in "E-Learning per L'Insegnamento dell'Italiano A Stranieri" (ELIIAS, "E-Learning for Teaching Italian to Foreigners"), by the University for Foreigners of Siena. The learning activities therein have been tracked by the agnostic monitoring system in the description of which the main part of this work consists of (§§ 4, 5 & 6).

The piloting was made possible by setting up a learning environment and a more specific place, the Digital Learning Unit (DLU), where the learning experiences and the monitoring system were tested[1]. In the next section features and functionalities of the learning environment will be described. The following is instead dedicated to the DLU, the aforementioned device capable of interpreting the data stored into the monitoring system[2].

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1 In addition to the monitoring system, the learning environment and the Digital Learning Unit (DLU) are also elements of original conception. The DLU is described here for the first time. Its original Italian name is *Unità Didattica Digitale* (UDD). We plan to issue a complete work about it soon.

2 Given the complexity of the experience described in this paper, and the different fields that were explored, we cannot provide a complete list of approaches and theoretical frameworks that were used to make the experience itself possible. However, we have tried to pinpoint some of the authors and contributions that are useful for the reader to understand the broader scenario of this research.

2 The Learning Environment

Throughout the design process of the learning environment in which the piloting here presented was carried out, some guiding principles were borrowed from a decade of experience with MOOCs (Cormier & Siemens, 2010; Yuan & Powell, 2013).

The learning environment has the following characteristics:

1. It is open and not reserved for the formal and institutional dimension of the learning processes;
2. It is participatory, not teacher-centred but primarily focused on social community interactions;
3. It is distributed, meaning it is not centralized: learners need to work without space and time constraints; they are free to work in their chosen places, and according to their times;
4. It is always connected, i.e., it supports a network approach to lifelong learning since the system remains open and connected indefinitely.

Moreover, from MOOCs' massive dimension derives the impracticality of any class group. Now, given that the audience is here indefinite and non-massive – it can be either massive or small – the lack of a teacher or a tutor implies the following distinctive feature:

5. It is here assumed a self-learning approach and, strictly connected, self-evaluation, possibly integrated by forms of peer assessment.

Finally, as has been argued, acquiring a second language is not about the transmission of declarative knowledge; rather, it implies developing procedural competences (Diadori, Palermo & Troncarelli, 2015). Hence, it is necessary to have the following:

- A considerable variety of learning activities, i.e., interactive contents (not just multiple choices, filling exercises, reordering, etc.);
- A flexible learning environment that could be integrated and modified according to the needs;
- A standard for monitoring learners' work and progress.

In order to meet these conditions, the learning environment has been provided with an adequate number of interactive contents (many of which were enriched media: interactive videos, augmented images, etc.)[3]; then, instead of a Learning Management System (LMS), a Content Management System (CMS) was chosen, suitably integrated with a number of plugins[4]; eventually,

[3] A major challenge for our work with enriched media is represented by the concept of media aggregator (Rossi, 2017).

[4] The inadequate use of LMSs had been criticized (Bonaiuti, 2006). A theoretical framework about using a CMS is contained

the whole system was used as an activity provider, i.e., to send xAPI statements to a Learning Record Store (LRS) (see § 5.2).

As of April 2018, learning resources have been created and tested. Around the middle of July, a two-week piloting was carried out within the Master ELIIAS.

Further characteristics of the learning environment were the following:

- It could be freely navigated, was networked and destructured (see § 4);
- Interactive contents were self-consistent and limited in duration. Learners could freely assemble them through the labels associated with each unit (CEFR[5] level, linguistic-communicative ability, semantic area);
- The monitoring system was designed to detect data from the learning environment, the resources, and the learners' behaviour. The agnostic architecture was set up for tracking interactions.

This experiment followed an ongoing trend to consider the learning experience as a whole, collecting information even from informal or non-formal learning activities.

3 Digital Learning Units

In this section, the Digital Learning Unit (DLU) will be described. DLU is indeed the learning experience's specific place where the monitoring system was to be tested. Above all, its digital structure makes it a suitable device for interacting with the monitoring system. As a matter of fact, the construct of DLU is an integral part of this study since it is necessary and consistent with the logical steps that lead to the final result, the development of an agnostic monitoring system capable of interpreting data through an abductive approach (Peirce, 1984; Bonfantini, 1987; Magnani, 2000).

Contributions about learning objects and OER (Wiley, 2000; Fini & Vanni, 2004; Giacomantonio, 2007; Fini 2012; Wiley, Bliss & McEwen 2014) and studies on Italian second language acquisition (SLA) (Freddi, 1994; Balboni, 2002; Vedovelli, 2002) converge into the DLU conception. Therefore, a definition of DLU is only possible combining the structural element with the educational purpose, i.e., the digital object with the theoretical and methodological framework.

Apart from being considered an operating model for Italian SLA, DLU is first and foremost a digital structure that allows formulating interpretative

in Collins & Ollendyke (2015). The post-LMS scenario is represented by the "Next Generation Digital Learning Environment" (NGDLE) (Brown, Dehoney & Millichap, 2015). Other ideas of "multiple integrated systems" can be found in xAPI.com website (https://xapi.com/do-i-still-need-lms/) and Fiumana, Cacciamani & Bertazzo (2016).

5 Common European Framework of Reference for Languages: Learning, teaching, assessment (CEFR) (Council of Europe, 2001 & 2018).

hypotheses about the data stored along with the tracking of learning experiences. Such digital structure provides both a mark-up system for linguistic, communicative and semantic data, as well as an architecture built to generate information (xAPI statements) to be sent to the monitoring external software (LRS).

The DLU has the following features:

1. It is a study session with a predetermined duration, although in a time frame of generally 15 to 60 minutes;
2. It includes an educational objective, a textual input, some learning activities, a theoretical purpose (declarative knowledge) and a final communicative activity (procedural competence);
3. It generates xAPI statements to be sent to an LRS for the monitoring process;
4. It contains linguistic, communicative and semantic descriptors expressed by categories and/or tags to formulate hypotheses about the stored data and to connect each DLU to others to build learning micro-paths.

The DLU structure can be described as follows: it generally starts with a brief presentation of the topic and the learning objective; it also includes the duration of the work session, the level of linguistic competence according to the CEFR, and the descriptors mentioned above. Typically, it goes on with the following steps:

1. Engagement or warm-up activities, i.e., activities carried out before the presentation of the core text. The Italian SLA literature refers to them with terms such as *motivazione* (motivation) (Freddi, 1994; Balboni, 2002) or *contestualizzazione* (contextualization) (Vedovelli, 2002);
2. Presentation of the core text (verbal, audio, visual) with testing activities to verify its comprehension. Italian SLA literature calls this *globalità* (globality) (Freddi, 1994; Balboni, 2002) or *input testuale* (textual input) (Vedovelli, 2002);
3. Focus on linguistic, communicative, lexical, or cultural aspects. This step involves what Italian SLA studies refer to as with *analisi, sintesi, riflessione* (analysis, synthesis, and reflection) (Freddi, 1994; Balboni, 2002), and consists on a single instance of work on one of the structural aspects before mentioned. From a different theoretical perspective, Vedovelli (2002) refers to this phase with *attività di comunicazione da/sul testo* (communicative activities from/upon the text), which involves metalinguistic activities on the core text[6];
4. Final communicative activities. The action-oriented approach

[6] It might be worth to point out that the DLU's structure is placed at a higher level of abstraction than the two aforementioned Italian SLA perspectives, with respect to which it is therefore theoretically neutral.

recommended by the CEFR is assumed here. Specifically, this phase is defined as *output comunicativo* (communicative output) as conceived in Vedovelli (2002).

The DLU structure might be interpreted otherwise, according to the teacher or the educational designer sensibility or theoretical perspective. It might be focused, for example, on engagement activities followed by the core text presentation, or again on a warm-up session on a known text to prepare learners to a different learning focus. In any case, every alternative interpretation of the structure should always end with a final step based on communicative activities.

4 Objectives

4.1 Approach

Our main objective was to design an open and flexible monitoring system shaped on the open and flexible learning environment. To build the learning environment, a new approach, flexible, informal, networked, and open, has been chosen – instead of a traditional, rigid, formal, linear, and closed setting. These are the main characteristics of a destructured environment mentioned in § 2. To such an environment nothing could be done other than adopting a monitoring system equally open and bottom-up.

Moreover, tools not solely designed for learning purposes, but also able to detect low-level activities data, were taken into account (e.g., which pages learners use the most, which paths they prefer to follow, the feedback they give on the learning activities, etc.).

The information collected from the website is useful to evaluate the system's usability while providing useful suggestions to improve the ease of use and facilitation of students all along the language acquisition process.

4.2 Architecture

The monitoring system was intended to collect and cross-reference data on learners' interactions. Then, it had to be capable of letting meaningful correlations surface from the crossing data. All these would have helped to understand if such a destructured system worked better than a more traditional and structured one.

The specific purpose of the work was building a so-called "agnostic architecture" for the data analysis, capable of interacting with destructured environments and of suggesting possible queries rather than answers to predetermined questions.

Therefore, this work is not based on a traditional approach to the evaluation, nor on sets of questions to be answered. Instead, a more experimental approach was preferred: the most considerable quantity of data on learners' behaviours (interaction with the environment, navigation data from the website, the resources, and the communication tools) was collected. Later on, the collected data were cross-referenced in order to look for meaningful correlations and better understand learners' approach towards their learning experience and the real effectiveness of such an open learning environment.

The next paragraph focuses on how the agnostic monitoring system was designed, which tools have been selected, and if it works, i.e., if it provides relevant information.

5 Tools and Methods

5.1 Issues

An open learning system has to deal with diversity. Different technologies and systems need to interoperate in a secure and standardised way. In other words, both machines and humans should be able to read the data.

In this case, it was not just a matter of finding a tool capable of managing a variety of systems. Another problem, at the monitoring level, came from the educational concept, or rather from the disintegration of the traditional course in a network of self-consistent micro-paths. Learners' interaction with the DLUs had to be thoroughly recorded to get as much information as possible about the overall learning experience.

Data collection required the following: to monitor in-depth the interactions between learners and learning resources; to track the navigation within the environment to identify the paths that learners set up; to receive feedback concerning either resources or the learning environment.

5.2 Standard Choice

First of all, it was necessary to find a standard specification to communicate with the selected software (mainly the CMS and the authoring tool)[7]; it had to be able to read multiple activity streams and express them with a standardised language.

Experience API (xAPI) was chosen. xAPI is a protocol specification developed for learning technologies to collect data from a wide range of online and offline experiences[8]. The APIs capture in a consistent format the data that

[7] In this case, as a CMS WordPress was chosen (https://wordpress.org/), even though other tools, like Drupal, Joomla, etc., could have been used. H5P (https://h5p.org/) was the authoring tool of choice. About the use of WordPress in Italian SLA see Giglio (2014).

[8] The xAPI specification was developed on behalf of Advanced Distributed Learning (ADL, https://www.adlnet.gov/). Its first version was called Tin Can API (2013), then renamed Experience API (https://xapi.com/).

are coming from different software technologies. In so doing, different systems can securely communicate, collect, and share the activity streams using the protocol's internal vocabulary.

xAPI is based on an inclusive logic approach: any learning experience, as long as connected to digital technology, can provide tracking data in a standardised language. Therefore, with xAPI[9] it is possible to bring out the tracking data about the learner's real experience, including where and when it takes place. A bottom-up logic approach perfectly suitable to the concept which considers the learning process a cross-experience, beyond the formal course dimension, ahead of the LMSs.

This protocol allows to record the learners' activities in detail, and this is very relevant from an SLA point of view because it provides valuable elements to assess whether and how a given linguistic input has turned into an intake (Krashen, 1985).

Once it was determined to collect the data with xAPI, it was necessary to decide where to store them. Therefore, the learning environment has been connected to an LRS. There, the learners' activity streams were stored.

As LRS, Learning Locker was chosen, an open source software that offers a free version suitable to our purposes[10]. Learning Locker stores the tracking data received with the xAPI protocol and aggregates them according to the criteria set by the user. The selected data can be later downloaded in.csv format and can then be elaborated in a different environment.

6 Piloting and Results

6.1 Context and Limitations

Setting up the learning environment and the assessment system, as well as the piloting, are activities that fall within the framework of the Master ELIIAS.

Such a project included a two-week piloting with about 50 learners. The limited number of participants and the reduced timeframe did not give enough data to evaluate the learners' learning and the environment itself.

Said so, the collected data allow to answer a simple and basic question, namely, if our agnostic monitoring system can say something about the learners' behaviour. In other words: if it works.

9 xAPI's syntax consists of RDF triples based statements: actor + verb + object. The statements can also include contextual data: context, result, timestamp, etc. More references are available on Github ADL section (https://github.com/adlnet/xAPI-Spec).

10 URL: https://www.ht2labs.com/learning-locker/.

6.2 Reading the Data

Thanks to the data collected by xAPI it is possible to analyse the behaviour of a single or a group of learners. Besides, data coming from different systems can be cross-referenced to find meaningful trends[11].

We carried on the analysis both for individual and groups but, due to the limitations mentioned above, only the results regarding homogeneous groups will be discussed[12].

The first group of results has been obtained through the application of filters and quantity features to the columns Result and Verb. It was possible to notice that:

- Learners' activity produced 7,614 statements (6,883 referred to interactions with 0 points, 482 related to passed activities, and 249 to not passed activities);
- The statements related to the field answered (there is a true/false for every item which requires an answer) are 886 (433 with a positive result, 241 with a negative one, 218 without any answer);
- The statements related to the field *completed* (related to the completion of an entire activity) are 184 (49 with a positive result, 8 with a negative one, 127 without any result).

It is essential to mention that a large part of learners involved in the piloting seemed to have quickly explored the resources without carrying out the testing activities. Therefore, the number referred to the passed activities is pretty low.

6.3 Correlations

The second group of results has been obtained by correlating activity level and success percentage with homogenous groups of learners by age group and by linguistic competence.

Fig. 1 shows the relations between the data about age, the average level of interactions, and success percentage.

The most active are the eldest learners, between 50 and 60 years, but the relationship between the activities and the success percentage shows a different trend: the best result comes from the age group between 30 and 40 years.

[11] Gathered data have been filtered and grouped with OpenRefine (http://openrefine.org/), to simplify and quickly read the original JSON code, and to order data according to a quantity criterion.

[12] It was also possible to analyse the interactions between a student and a DLU: the time taken, the scores obtained in a single activity, the level of competence acquired at the end. In this way, a detailed record of all interactions could be extracted for each DLU.

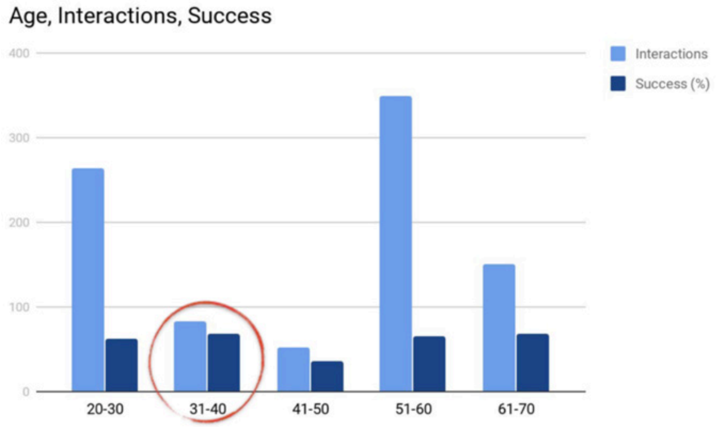

Fig. 1 - Interactions and success percentage compared to age.

Then, in fig. 2 the linguistic levels of competence have been compared to success percentage. In this case, learners with a B2 level of competence are the most active, with a double average number of interactions if compared to the others.

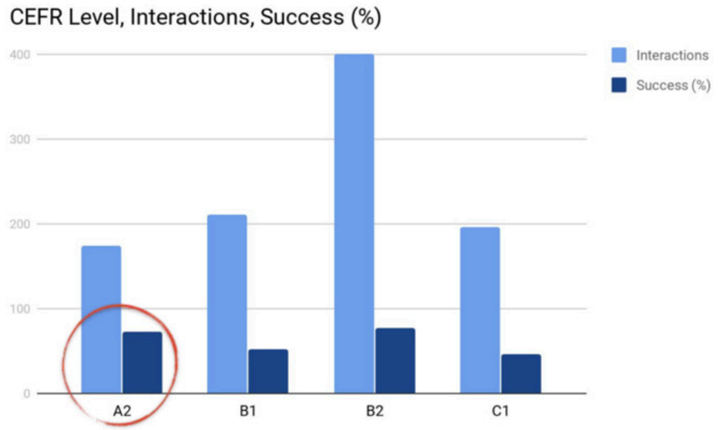

Fig. 2 - Interactions and success percentage compared to linguistic level (CEFR).

The correlation between the linguistic level and success percentage confirms that those with a B2 level of competence of Italian had better performances than the others.

Nevertheless, considering the correlation between the average number of interactions and the success percentage, the "best" are the A2, since they were able to take advantage of both interactions and resources.

Conclusions

Beyond the limitations mentioned above, the piloting produced some answers: the agnostic monitoring system appears to work. It suggests possible queries and shows valuable and meaningful trends to evaluate the learning experiences, the resources, and the environment itself.

The first result comes from the data analysis, that seems to confirm the learners' trend to significantly and extensively interact with the DLUs, even though not paying too much attention to proficiently completing the interactions. In other words, they showed a more inclined attitude towards exploring resources rather than completing them.

Hence the questions: Are the resources not attractive or usable enough to retain learners? Does the open and destructured environment lead to an overly serendipitous approach? Is it not functional enough to motivate learners to complete the activities?

The collected data are not sufficient to answer these questions: as said before, the experimental timeframe was too short, and the number of involved learners was too limited. An even crucial element could then be the learners' motivation since their purpose was not only learning Italian but also testing the resources.

This outcome encouraged us to deepen this experience creating additional resources, to obtain a whole set of new DLUs, starting from all CEFR levels of competence, and test both the monitoring system and the DLU reliability with a more significant number of learners. Indeed, this research has thrown up many questions in need of additional investigation. It is therefore required a further and broad study to establish the tendency of the learners to either quickly explore the resources or to make full use of them. In any case, it will be possible to reflect upon the resources themselves, the destructured environment, or the motivation. Still, a similar piloting could be conducted in similar context, e.g., with other foreign languages.

A second result concerns the approach to make sense of the data suggested at the beginning: an approach neither inductive, based on data mining or machine learning techniques, nor deductive, i.e., filtered by preset criteria, but abductive was chosen. This approach uses the data collected from the DLUs to guide the hypothesis-making process, and later verify them on the data collected from all the objects capable of issuing xAPI statements.

In so doing, it is possible to generate new hypotheses and test them, without forcing the adhesion to a single framework but maintaining a rebuildable relationship between raw data (xAPI events) and high-level strategies.

As a more general perspective, this research should focus on generating and sharing reports produced by this system with all the parties involved in the learning environment: authors, tutors, learners and, of course, researchers. This solution might translate in creating an endpoint capable of converting the data into a standard format like JSON, available for external parties. The authors of the learning contents might evaluate and maybe re-elaborate the DLUs. The tutors would notice in real-time the unexpected behaviours of the learners or groups of them. The interactions' data with the proposed contents might also help learners to notice their strategies and become more aware of their ability to learn – a crucial competence for SLA, as also CEFR clearly stated. And this is the contribution and the role of the researcher: conceive, implement and keep improving a monitoring system which, even with mere quantity data, might be able to support the learning process.

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