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► To cite this version:

Bertrand David, René Chalon, Xiaoheng Zhang. Virtual Assistants (Chatbots) as help to teachers in Collaborative Learning Environment. Michael E. Auer; Wolfgang Pachatz; Tiia Rüttnann. Learning in the Age of Digital and Green Transition (ICL2022), 633, Springer International Publishing, pp.135-146, 2023, Lecture Notes in Networks and Systems, 978-3-031-26876-2. <10.1007/978-3-031-26876-2_13>. <hal-03854073>

HAL Id: hal-03854073

<https://hal.science/hal-03854073v1>

Submitted on 15 Nov 2022

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Virtual Assistants (Chatbots) as help to teachers in Collaborative Learning Environment

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Abstract. Learning is an important activity from elementary school to university and more (long-life learning). Different learning models and approaches are used with more or less active and autonomous orientations. Technology supported learning objective is to assist and empower these approaches by proposing Learning environments. Collaboration is an important aspect of learning allowing to the learners to share and exchange learning contributions. In a group learning (class learning), the size is often a problem for the teacher to assist and supervise all learners. We are proposing a Collaborative Learning Environment using technology supported tools organized as a system considering different learning approaches and helping the teacher to manage his/her accompanying activity to learners in need by integration of virtual assistants. In this way the teacher can devote him/her to non-autonomous learners and virtual assistants to manage the work of autonomous learners. The distribution between autonomous learners or group of learners managed by virtual assistants and non-autonomous managed by the teacher is evaluated at defined period to reallocate learners to more appropriate groups. This process is called Orchestration. In this paper we describe main principles, system architecture and orchestration process. An integration process of external exercises as well as internal for which we give the design process and associated tools pour the teacher and construction of grouping exercises in session content and their short term and long-term use. Finally, we present the relation between our generic system and its use and adaptation to a specific field of study and education level.

Keywords: eLearning, Chatbot, CSCW.

1 Introduction

Learning is an important activity from elementary school to university and longer (long-life learning). A variety of learning models and approaches are used with more or less active and autonomous orientations [1]. During the COVID-19 pandemic, we observed

the need to replace collocated synchronous learning in class by a large diversity of configurations characterized by distant, synchronous or asynchronous working, individual and in-group learning. The role of teacher, very important in classical class learning, can be very time and effort consuming to obtain an appropriate level of mastering for all students mainly in heterogeneous classes. In other configurations teacher's time is also charged by new organizational constraints.

The role of technology, in technology-supported learning can provide appropriate support to the teacher, allowing him to increase the time dedicated to the students. Our objective is to introduce, in the Learning Collaborative Environment, Virtual Assistants that will be in charge to manage more autonomous students and in this way decrease the number of students (less autonomous) who need to be accompanied all the time by the teacher. In order to be sure that the initial distribution between autonomous (in charge of Virtual assistants) and non-autonomous students (supervised by the teacher) was appropriate, this distribution can be changed dynamically at identified steps in the learning process (at the end of each lesson, half day or full day) either by the teacher observing behavior defects (too good or too bad results) or by the students themselves at their demand. After each student action (exercise), not only his/her result is collected, but the system demands him/her to give his/her learning emotion, i.e. appreciation of his/her behavior (on 3 or 5 level scale: well-done, intermediately-done, mitigate, lost, truly lost). The results and learning emotions are used in the evaluation conducting to the proposal of new appointment (in teacher's group, or a Virtual Assistant group). This process is called Orchestration. After each orchestration a new distribution in teacher's group and autonomous groups (or individuals) is elaborated. Working of these groups is dependent of working conditions presented earlier (collocated, distributed, synchronous or asynchronous).

2 State of the art

2.1 eLearning

eLearning is an important research field on which researchers work for more than 20 years. Its objective is to put together the progress in learning and teaching and in information technologies [2]. Important contributions emerged not only in academic teaching but also in industrial, mobile, just-in-time situations, based on technological progress in computers and their devices (PC, tablet, Smartphone, ...). More and more precise relations between learning methods and computer capacities [3] in data management, calculation capacities and human-computer interactions, allows new learning approaches and their model efficiency for different categories of learners [4]. MOOC, synchronous and asynchronous collaboration, and just-in-time contextual learning are recent inventions of this type. During COVID-19 period, eLearning received a very interesting context to show to large public the results of research developed in the last years [5, 6]. This occurrence led to generalize its use and appreciate its contributions and impacts. We also worked on these problematics for more than 15 years [7, 8, 9].

2.2 Virtual assistants - Chatbots

Virtual assistants are available on the market for several years. Siri from Apple, Home from Google and Alexa from Amazon are the most well-known types. We decided to use Alexa devices, which are voice and image-based (picture and video) assistant: Alexa Echo is voice oriented; Alexa Echo Show is voice and picture oriented. They are largely used in the family for one-shot commands either for simple questions and answers or for controlling TV channels or domestic appliances such as lights, blinds, etc. But the use of these assistants in what is called ‘multi-turn applications’, i.e. in a loop oriented sequences of commands-actions, is much less frequent [10, 11]. Alexa can work either on specific devices provided by Amazon (Echo or Echo Show), or on a PC [12, 13]. As Alexa is cheap and currently available at family level, it can be used at school too. At school Alexa devices can be purchased or a PC version of Alexa application can be used [14, 15].

3 Our approach

3.1 Orchestration oriented approach

Our starting point was the observation of an in-class situation. In an important number of classes, the number of students is more than 30. In this situation the teacher is not able to supervise all students as necessary. It is also possible to observe that not all students have the same level of autonomy. This is an important point determining the level of supervision or guidance needed. Non-autonomous students need more step-by-step supervision, which is not needed by autonomous ones.

Taking into account this observation we decided to split the class into one non-autonomous group to work with the teacher, several individuals and a small groups of autonomous students to work with the virtual assistants Alexa.

Alexa as a vocal chatbot can either be used as individual device or it can be shared by several users. A more collaborative configuration is to have one Alexa per student to create a group of students in which their Alexa devices work in coordination. The coordination process between the devices can occur in synchronous working mode for all students co-located in class or at distance, as in COVID-19 period, with students at home.

First step in design and development of our system [16] was to create an Alexa Learning Collaborative Environment (ALCE) to manage the autonomous students and the autonomous group. During the period of Alexa supervision, the students were asked to do pre-planned exercises and answer the questions related to the course. These exercises, which were external to the system, came from the students’ work book or the documents provided by the teacher. Our objective was to ORCHESTRATE the operation process and the sequence of activities to proceed to the evaluation of the results and to declare what to do next. [17, 18].

Then, we designed a set of SKILLS (Alexa official term describing a User Interaction with corresponding behavior). We created a set of generic skills for the target users (students, teachers, and the system manager): Open, close, identification, asking for

help, how to launch actions, to determine the sequence of the execution of the actions based on the teacher demand and to obtain the results on the correctness of the student's responses and the results on the appreciation of the student's learning emotions [19, 20].

At the end of each period, orchestration process aims to appreciate the student's results and his/her behavior (called learning emotions) [16]. The formulae, elaborated by the teacher, calculates the student's score on the Alexa activities which determine the new orientation of each student in class to do further practices (to stay in the autonomous Alexa supervised context – group, or to move to the non-autonomous group managed by the teacher). In this formulae, the results of the appreciation of the student on his/her learning emotions are combined to the result report given by Alexa on how many correct answers were given can intrigue auto-evaluation on the part of the student. More sophisticated appreciation analysis could be introduced later in the project, namely the face analysis or capture EEG or other physiological data. This orchestration process is schematized in [Fig. 1](#).

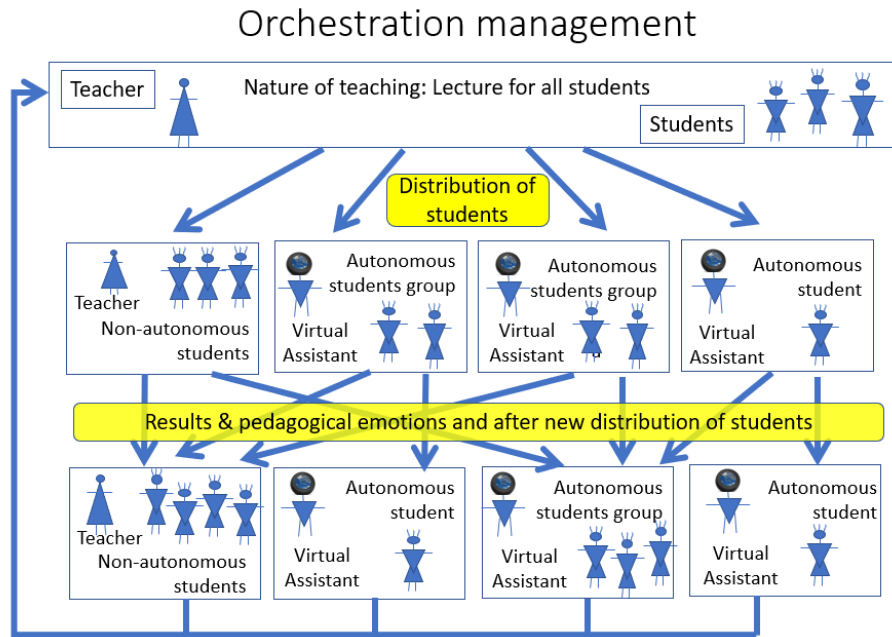


Fig. 1. Learning process with distribution of students in different groups and the orchestration process conduction to new distribution for next learning period.

Structure of the orchestration skill is composed by:

A Skill identifier (for possible reuse) –an application as a student (identifier) A Number of exercises to be examined – The Orchestration model to apply – Results to deliver to the student (and his/her teacher).

Orchestration models proposes

1. Simple solution (50% results) + (50% pedagogical feelings) = if > 0.5 thus the student continues with virtual assistant, otherwise he/she returns to the non-autonomous group led by the teacher.
2. Solution more constructed with the setting (0-1) for each exercise result and for each local feeling through choice of orientation according to the weighted averages obtained.

As we will see later, the orchestration can be applied to one or more exercises, or on an “official” group of exercises called a session of learning. Therefore, the orchestration model is composed of:

A Session orchestration identifier (for possible reuse) – a number of exercises to obtain results on the session and results on the student’s pedagogical emotions and an orchestration calculation formula

3.2 Integration of the notion of exercise

Next step in our project was progressive integration of exercises in the system, i.e. to integrate first external computerized exercises into the system using appropriate API (Application Programming Interface) to execute the exercises on the computer (PC), or on Alexa (Dot or Show), or Smartphone. In this case the relation between these exercises and our system is limited to activate them (via API) and to collect students’ results needed for orchestration process.

However, a significant improvement was realized to propose the integration in the system of native exercises (becoming internal) elaborated by the teacher.

To introduce these exercises into the system, they were transformed into Alexa Skills (commands) in Alexa Development Environment using Alexa programming language. Naturally it is not possible to ask to the teachers to master this language and the programming environment. For this reason, we created a set of higher-level skills allowing the teacher to formulate new exercises more naturally in the same environment as other Alexa users do, i.e. allowing the teacher create his/her session plans and use Alexa for any educational subject

To do thus, we created different models of exercises and asked to the teacher to express the contents using a specific Alexa skill whose role is to collect the parameters of evaluation of an exercise and store them into a database.

It means that the teacher can specify new exercises by an Alexa application at hand. The objective of this application is to collect and store all elements describing each exercise in a database (see later).

These models of exercises can be activated in two different ways: either they are used in a generating process to automatically create the finalized exercises and store them for a further use in a database (Fig. 2, Solution 1), or to provide a generic exercise execution skill which is able to consult dynamically the values associated to the formal

parameters stored in the database (Fig. 2, Solution 2). These two approaches can be used according to the complexity of the exercise model.

If existing exercise models are not sufficient, i.e. they are not able to handle the teacher exercise objectives, thus it is possible to create a new model of specification for the new exercise based on formal parameters type to cover larger set of exercises.

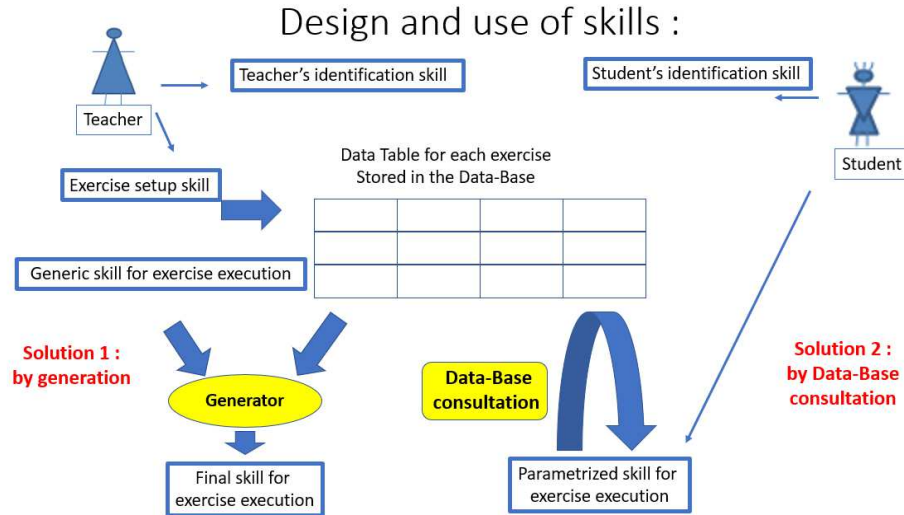


Fig. 2. Design and implementation exercise skills.

As we indicated, several working situations can be supported with Alexa, along with the basic voice limited interactions. The working context can be upgraded by image presentation with voice or tactile interaction or by a video presentation for the same type of interaction objectives.

We list basic templates of exercises from fully structural at first place, to more semantic at the last:

- Find 1 item (vocal or visual) between 4 (or more) items with basic semantic: Biggest, smallest, heavy, light; look for intruder ... with the semantics attached to presented items.
- Order 4 (or more) items, as: four seasons, university diplomas, university staff degrees, military ranks...
- Listen and give the correct answer: simple questions, translations
- Listen, watch (a video) and give the correct answer, order integrated items...

In Fig. 3 we formalize basic templates of exercises composed by items indicated by different colors.

Model for specifying an educational action (Exercise)

Three variants are possible: 1/ fully vocal, 2/ vocal and images, 3/ vocal and video

1/ Identifier (for possible reuse) – Field to be collected – Level to be collected – Text describing the question and its (textual) arguments to be provided – Possible external processing (via an API) – Result to be collected (text) – Pedagogical feeling to be collected (text) – Correct answer – Message giving the result

2/ Identifier (for possible reuse) – Field to be collected – Level to be collected – Text describing the question to be provided and the list of images (references) to be displayed – Possible external processing (via an API) – Result to be collected (text or click) – educational feeling to collect (text or click) – Correct answer – Message giving the result

3/ Identifier (for possible reuse) – Field to be collected – Level to be collected – Text describing the question to be provided and the video (reference) to be displayed – Possible external processing (via an API) – Result to be collected (text or click) – pedagogical feeling to collect (text or click) – Correct answer – Message giving the result

Explanation of use of colors:

In blue: information necessary for data management in the Database

In green: Question from Alexa and answer from the teacher

In red: Question and arguments provided by the teacher that will be addressed to the student

In black: possible external processing via API

In green: educational results and feelings to be collected from the student

In blue: Correct answer (provided by the teacher)

In red: Message from Alexa given the information provided by the student

Fig. 3. Basic templates for exercise skills

3.3 Integration of the notion of session

When templates of the exercises are created, they are accessible by the teacher to use in learning sessions. The notion of session is an important concept. A session can be either short-lived, created specifically for a unique use, or it can be created, named, and stored to reuse by the same or by several teachers. It is also possible to create, validate and certify these sessions as an official program for a discipline, level or a learning period. These sessions can be the collections of different exercises either homogenous (a set of identical ones with complexity evolving progressively) or more composite (containing different actions to progress the learning). All created exercises and sessions are stored in a catalog to be used by his/her owner or by whom they are shared.

4 Targets of our system

4.1 Generic orientation

As you understood, our ACLE is by construction generic. This orchestration approach of construction allows us to produce appropriate supports for different learning levels from elementary school to university.

The adaptation process has as objective to support the variations from structural models to semantic ones through the orientations of the teachers on different disciplines and levels. In addition such models derived from the orchestration approach can fulfill the needs on collaboration among teachers and (discipline as physics, field as electronics, and level as second year of BS degree) pedagogical specialists. That is because the objective of this approach is to adapt a generic system to a new context. To do so we could present it to the experts in different fields to see if the templates are still supported by the system and to ask the users to give them more semantic adaptations. If certain exercises are impossible to be formulated with existing exercise templates, the second step is to propose a new format of exercises and to develop new templates covering these new behaviors under our approach presented earlier.

We summarized the orchestration approach by fig. 4 & 5. The schematic view in Fig.4 indicates a generic basic part of the system (in blue in Fig. 4), proposing a structural model functioning with no semantic notions at the external part (several slices in yellow and green) bringing semantic adaptations to different contexts related to a discipline, a field and an education level.

ACLE (Alexa Collaborative Learning Environment):
Generic and field oriented specialization

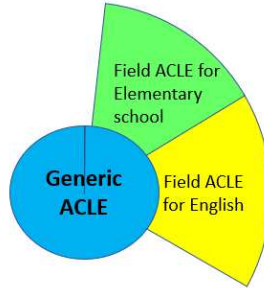


Fig. 4. Generic heart of the system and its connection with a field adaptation.

More precisely, we can see on the left side of Fig. 5, generic structural view of the ACLE system and on the right-side an explanation for the content of the semantic view. The objective of the figure is to establish a clear relation between semantic and structural models. The figure also indicates who is concerned by each part, i.e. system designers, working on the generic system and teachers proposing the adaptations of the generic system to field oriented part. The collaborations between system designers and

teachers occurs in order to adapt pedagogic-didactic exercise models to structural models. Obviously, the creation of new templates to extend the possibilities of generic system is possible in case it seems necessary.

It is also important to conduct ergonomic studies, which can be shared between system designers and teachers.

Synthesis of actors' contributions

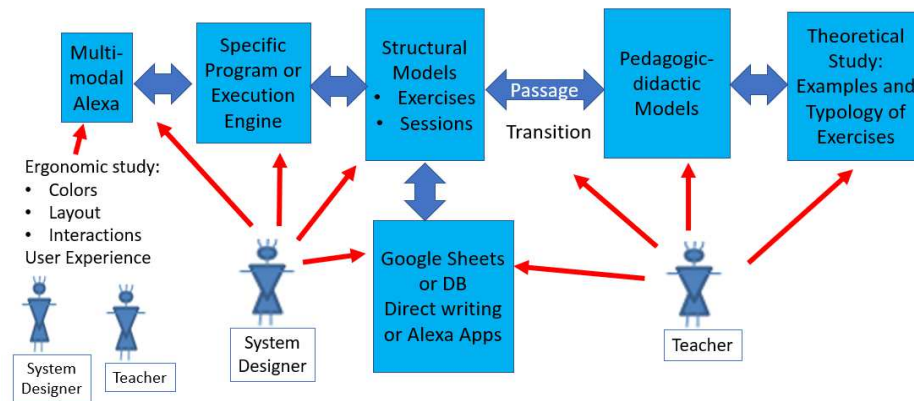


Fig. 5. Generic part of the system (left part) and field-oriented part (right part).

4.2 Field orientation: a case study of English language learning ACLE

After toy examples of adaptation to elementary school, we are working at the moment on the adaptation of our generic system to a context of learning of English language at a higher level devoted to learning language specificities for business schools in vocabulary, special sentences and meaning.

We can give only a short example of the problematics, which is related to spoken English understanding. To practice understanding in a new context two approaches are proposed: listen and chose the right answer and listen and do. In the second case to deliver the exercise, a list of explanations and actions are demanded to realize at each step. Such an activity provokes the student to ask Alexa to repeat the instructions or indicate appropriate progression. This template is not naturally proposed by the generic system. We decided to add it to enrich our system to support this new kind of exercises, which can receive appropriate semantical declinations in numerous disciplines and levels.

Another adaptation performed is a semantic variation of exercises based on the same template, in same teaching context, i.e. to be able to change values for identified parameters and provide automatically a set of exercises [21, 22].

5 Conclusions

In this paper we presented an approach and a system capable to increase efficiency and efficacy of teacher implication in his/her class by several Virtual Assistants in charge to supervise autonomous students. In this way the teacher can devote his/her effort to less autonomous or non-autonomous students based on his teaching requirements. This distribution is dynamic and can be evaluated at each identified step (end of session, half-day or full-day). This evaluation is based not only on student results but also on their pedagogical emotions collected in different manners (auto-declaration, image analysis or collect of physiological data as explained earlier).

In the first version, the system was only orchestration oriented, i.e. learning actions (lectures, exercises and assessment) where external to the system. The system indicated only what is to do and it collected the results needed for its evaluation and orchestration.

Meanwhile in second version we added to the system digitalized actions, called exercises. We elaborated several templates of exercises and created two ways to use them by the teachers, who are naturally not able to be programed in Alexa programming language. The first solution is based on an Alexa skill to specify the exercises using Alexa application. There, Alexa guides the teacher during his manipulation to provide him the exercise specifications and store them in DynamoDB database. The second solution is based on Google Sheets to provide a readable table-based structure of the database which can be easily edited by the teacher.

We also proposed to group these exercises in sessions, in order to create more macroscopic elements corresponding to teacher managed working period which can be considered as appropriate moments for orchestration and increase meaningful learning chance on the part of the students.

This work was totally generic and independent of a discipline and level. We considered that all proposed could be used in any context.

The third version of design and development was devoted to the specialization, studying the manner to adapt our generic system to a particular discipline and level. Globally that is a shift from the structural model to a more semantic model to let the teachers to propose more communicative and meaningful teaching templates. This work needs to align the structural model to semantic model (of discipline and level). This alignment is the transformation of freely expressed semantic exercise to one of available structured exercise template. If the teacher is not able to find an appropriate template he/she can ask to the system designer to help him/her propose a new template appropriate to the specification of his/her exercise. We described shortly a case of this approach concerning English language learning in a Business School context.

Of course, this last step is only started, we will continue to work on, not only in present context, but in several different contexts (primary, secondary, high school, even university) on various subjects and fields (general culture, language, physics, geography, history, politics, etc.), both in terms of what we offer and beyond, what is missing in proposed system. Validation of utility and usability opens the need for further research.

From collaboration point of view, the collaboration of students using different Alexa will be deepened. At the moment, the system is able to manager several users working

each with his/her Alexa. It is also possible to share one Alexa by several users in a local interaction management and collaboration by the Alexa managed participation. We would take into account, more collaborative situations, as such the collaboration among the students in which everyone uses his/her own Alexa, within synchronous or asynchronous scenarios, in problem resolution situations, and in serious game situations if possible.

It is worth mentioning again that the data on emotions collection are at the moment based on auto-declaration, with well known gaps and shortcoming like overestimated positive and negative appreciations. Thus, more precise face image analysis and/or physiological parameter-based approaches will be considered with respect of code of ethics.

Finally, we welcome and appreciate the interested teachers' and students' to let us know their criticisms and their ideas on the gaps of our proposal.

Acknowledgments

The authors are grateful to the ASLAN project (ANR-10-LABX-0081) of the Université de Lyon, for its financial support within the French program "Investments for the Future" operated by the National Research Agency (ANR).

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