Predicting collaborative learning spaces based on traces

imane Lmati[1], Okacha Diyer[2], Naceur Achtaich[3]
[1]Faculty of Sciences and Techniques, University Hassan I, Settat, Morocco
[2]Training Center for Education Inspectors, Rabat, Morocco
[3]Faculty of Sciences Ben M'Sik, University Hassan II, Casablanca, Morocco

E-mail: lmati2010@gmail.com, odiyer@yahoo.fr , nachtaich@gmail.com

Abstract— Trace analysis is regularly used by researchers in several fields. The traces have solved several problems in the field of learning either for the teacher or for the learner. In this work, We are interested in methods which facilitate the creation of collaborative spaces employing traces in learning situations for the benefit of learners in difficulty. The approach aims to update the learner profile model to specify their learning weaknesses using several indicators such as success rate, rate of attempts to fail and the rate of consultation of didactic concepts.
For the creation of working groups, we also used the classification of the exercises of the students in difficulty which makes it possible to classify their problems and to create clusters of the exercises. From this grouping, we can create workspaces allowing students to share their experiences for a given problem.

Index Terms—Trace model, Ontology, EIAH, Automatic classification, Evaluation, Group, adaptative learning.

1 Introduction

THE computer assisted learning process is a delicate task for a peer, tutor or teacher. It requires permanent adaptation during activity [1]. In an attempt to understand the dynamics of learning, trace analysis is regularly used by researchers. In the same way, an appropriate modeling of traces should help teachers and learners to understand. during the activity, learners also benefit from the trace as a tool for steering and summarizing their work ([2],[3],[4]).
The teachers, for their part, rely on the indicators resulting from the experiments to evaluate more quickly the learning situations which they follow, and exploit the traces of the learning in progress as à real-time representation of the learning dynamics to exchange with learners on their way of carrying out their learning activity ([5],[6],[7]).
All these works show the importance of traces in the learning activity either for the teacher or for the learner. In this work, we are interested in methods to facilitate the analysis of traces in learning situations for the benefit of learners in order to complete their profile model. And also, for the benefit of teachers to help them create useful collaborative spaces for the success of assessment.
To resume, our approach provides new research work that aims to design an adaptive EIAH able:
1. to update the learner's profile using the the traces, and
2. to propose recommendations for learners in difficulty in the form of collaborative groups to succeed in their assessment.
In the next chapter, we will first present the general architecture of our system. Thereafter, we give the strategy we adopted to update the knowledge of the learner profile from the analysis of the traces and at the end we propose the collaboration model.

2 Architecture

In order to provide flexibility in supporting, the proposed system must allow the monitoring of the progress of each learner by offering spaces for collaboration to avoid blocking during the evaluation. To this end, the architecture that we propose brings together several modules, we quote the trace module which makes it possible to analyze the traces of the learner during his self-assessment from the base of the exercises, and to make updates in the learner model concerning its level in relation to the pedagogical concepts. There is also the module for extracting the clusters of exercises about a pedagogical concept Ci. These exercise clusters will be determined by exercises done by Bad/Medium-Profile (Ci) and also the rest of the population. And finally, there is a module for predicting and generating clusters of individuals to collaborate with Bad/Medium-Profile (Ci).

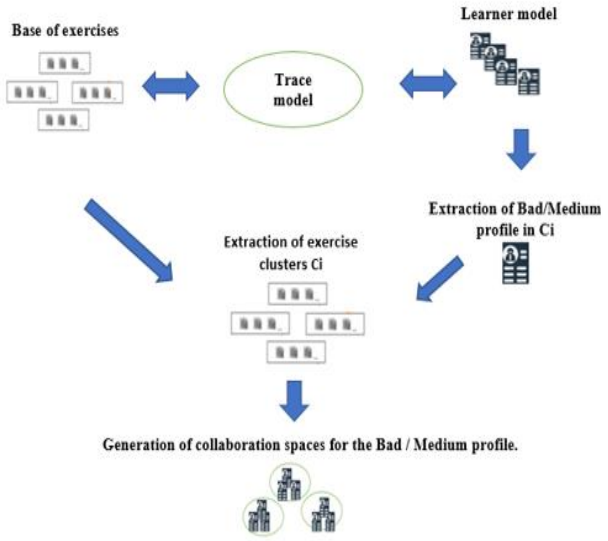

Fig. 1. Process for generating collaboration spaces using of the trace analysis

Subsequently, each module and model of the present architecture will be developed.

3 PROFILE MODEL

For the creation of the collaboration model, you have to go through the learner profile model, the latter is created from the alignment of two ontologies (Onto-Math [8,9], E-orientation [10]), This model makes it possible to define the didactic concept DC which has not been well mastered by the learner during his school career. such that, for each DC, we can add as an attribute « score » obtained by the learner to give remediation if necessary.
The model makes it possible to guide the student during the realization of his activities by redirecting him towards spaces of collaboration to overcome these difficulties.

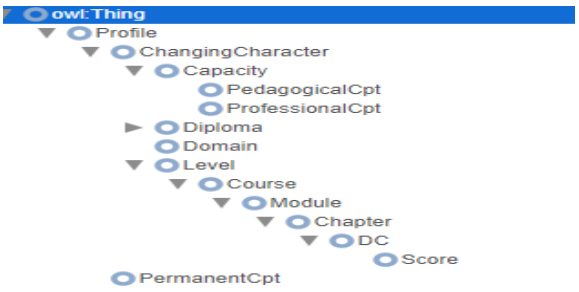

Fig. 2. Profile model created from E-Orientation and Onto-Math ontology

The model can be fed from the trace model presented in the following paragraph.

4 MODELING OF TRACES AND UPDATE OF THE PROFILE MODEL

The collection of traces consists of observing the learner in a learning situation and to memorize its traces of activities to infer the learner's model (i.e. Onto-Math [8,9], E-orientation [10]). So for the development of our trace model, we were inspired by the model [11] which uses exercises as observables to calculate the degree of mastery of mathematical operations like subtraction and addition. For our case, we have chosen observables as exercises in relation to pedagogical concepts (theorem, definition, etc.) C1, C2…Ci…Cn, generated from the Onto-Math ontology [9,10].

A trace is a sequence of observations representing the actions of the learner on the exercises and/or problems of the scenario. So to formally represent a trace T for a concept Ci we write:
T(Ci) ={O1(Ci), O2(Ci)…On(Ci)}
Each observed Oj is characterized by the following 5-tuple:

Oj(Ci) = <Q, R, Ca, E,C>
Q: Exercise/Problem in relation to Ci
R: Learner Response
Ca : Correct answer to the question
E: Discrepancy between the learner's answer and the correct answer.
C: Consultation of the Ci concept in the course.

From Observables O1(Ci), O2(Ci)…On(Ci), we can calculate:
-**S:** represents the percentage of successful exercises compared to all the exercises proposed.
-**NS**: represents the percentage of failed attempts in relation to all exercises, such that for each observable (exercise) only one failed attempt is counted even if there are several.
-**C:** On unsuccessful attempts, the percentage of the number of course views is counted.

TABLE 1

AN EXAMPLE OF SIMULATION OF LEARNER TRACES IN RELATION TO PEDAGOGICAL CONCEPTS

Person	C1	C2	C3	C4
A	(50%S,50 %NS, 10%C)	(80%S, 20%NS, 5%C)	(60%S, 40%NS, 15%C)	(90%S, 10%NS, 20%C)
B	(20%S, 80%NS,16 %C)	(70%S, 30%NS ,10%C)	(90%S, 10%NS, 20%C)	(75%S, 25%NS, 25%C)
C	(50%S, 50%NS, 10%C)	(80%S, 20%NS, 40%C)	(60%S, 40%NS, 60%C)	(80%S, 20%NS, 30%C)
D	(75%S, 25%NS,12 %C)	(60%S, 40%NS, 50%C)	(50%S, 50%NS, 10%C)	(10%S, 90%NS, 55%C)
E	(95%S, 5%NS,30 %C)	(80%S, 20%NS, 10%C)	(30%S, 70%NS, 85%C)	(30%S, 70%NS, 10%C)

In order to populate the profile model, we have chosen three indicators to calculate the degree of mastery of a given concept: S the percentage of successful exercises in relation to the observables
O1(Ci), O2(Ci)…On (Ci), NS the number of failed attempts versus observables (exercises) and C the number of consultations of the course compared to the attempts of failures.

T : <S, NS, C> → L
The function T defines the level L of the learner from the correlation between three extracted variables from the model of the trace: S, NS, C. In order to simplify, we use the following classification:

→ If 80%<S & NS <20% & C=0% then L= Very Good
→ If 50%<S & NS <50% & C=0% then L=Good
→ If S=50% & NS =50% & 0% ≤ C < 50% then L= Average
→ If S<50% & 50%<NS & C=0% then L= Bad
→ If S<50% & 50%<NS & C=50% then L= Very Bad

5 CLASSIFICATION OF EXERCISES

The purpose of creating collaborative spaces is to improve the levels of learners from the low or medium level to the high level.
We suppose for example that the individual A is medium level Ci(M) then the question which arises this is how to evolve individual A into Ci: Medium/weak to strong?
The idea is to create clusters using exercises failed (For a problem type P) by individual A and similar exercises by other individuals in relation to concept Ci.

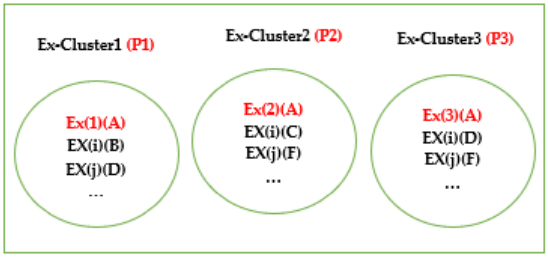

Fig. 3. Creation of exercise clusters for Bad/Medium Profile (Ci)

Knowing that Ex(1)(A), Ex(2)(A) and Ex(3)(A) represent respectively exercise 1, exercise 2 and exercise 3 performed by individual "A", and EX(i)(B) represents exercise(i) of individual B and EX(j)(D) represents exercise(j) of individual D…
Then Ex-Cluster1 (P1), Ex-Cluster2 (P2) and Ex-Cluster3 (P3) represent the groups of exercises related respectively to the problem P1, P2 and P3 recognized by individual "A" in exercises Ex(1)(A), Ex(2)(A) and Ex(3)(A).
According to figure 3, Ex(1)(A), EX(i)(B), EX(j)(D) … are similar with respect to problem P1 and can be grouped in an Ex-Cluster1 (P1) cluster.
The same applies to the exercises of the other clusters Ex-Cluster2 (P2) and Ex-Cluster3 (P3).
We can deduce that the number of clusters represents the number of exercises performed by individual A.

6 COLLABORATIVE MODEL

It is then assumed that the (-) relate to the exercises not done. It is also assumed that the exercise clusters are generated from the exercises performed by individual A with a low level of Ci and the other individuals B, C, etc.
From the analyzes of the traces, we obtain the following table :

TABLE 2

SIMULATION OF THE TRACES OF A WITH THE REST OF THE POPULATION COMPARED TO THE CLUSTERS OF THE EXERCISES

Cluster/Person	A	B	C	D	E	F	G
Cluster1-Ex	Low	Medium	-	Medium	Strong	-	Strong
Cluster2-Ex	Medium	-	Low	-	-	Strong	-
Cluster3-Ex	Low	Strong	-	Strong		Medium	-
Cluster4-Ex	Medium	Low	Medium		-	-	Strong

Grouping similar exercises in a cluster makes it possible to assess the level of the whole population concerning an exercise category, so if a student is strong in one of the exercises of the cluster, then automatically, he is strong in all the exercises of the cluster. Similarly, if it is weak in one of the cluster exercises then it can be categorized in the low level. From these

categorisations, we can create working groups of individuals to remedy the weaknesses of the Bad/medium profile.

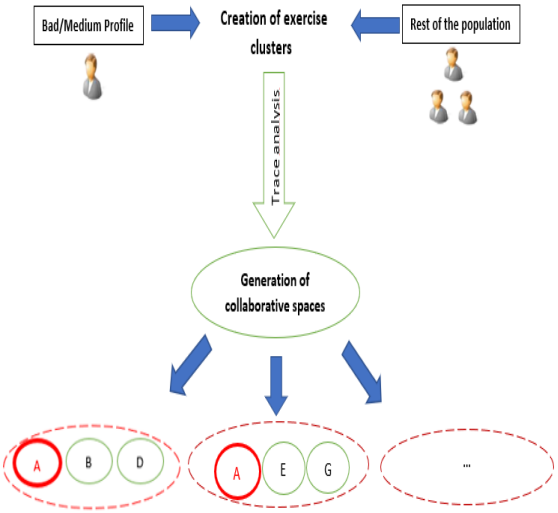

Fig. 4. Model for generating collaboration spaces

The idea of our approach is to create collaborative spaces based on exercise clusters achieved by bad or medium profile (Individual A) and the rest of the population.
According to the diagram above, profile "A" can work with group 3 made up of high level individuals : B and D and that for the problem P3. And for problem P1, individual "A" can also work with group 1 composed of high-level individuals: E and G.
As a result, one can predict population groups who can work with individual A for each type of problem (P1, P2…).

7 Conclusion

Traces are very important elements in collaborative environments. They make it possible to solve several problems in the field of learning either for the teacher or for the learner. Their analysis aims to understand and monitor the learning of a learner or a group. In this work, we are interested in methods and mechanisms that facilitate the creation of collaborative spaces based on the analysis of traces for the benefit of learners.
For the creation of working groups, we also used the classification of exercises for students in difficulty which makes it possible to classify their problems and create exercise clusters. From this classification, we can create workspaces for students to share their experiences for a given problem.

We hope in the next works to implement our work in the GAEMS platform [10] to be able to test it with students. We also hope to develop the process of classifying exercises by the method (K-means), without forgetting to work on the learner failover module at two levels at once : from low/very low to medium and also from medium to high/very high.

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