A new approach based on modelled traces to compute collaborative and individual indicators' human interaction

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***Abstract*—We propose in this paper a new method to compute indicators based on models transformations. We use the concept of modeled trace and trace-based system to design an indicator. We use traces transformations to build indicators model and to actually compute them. Effective implementation of the indicator is demonstrated through the transformations effected on a particular learning platform based on real traces, constituting so called primary modeled traces. A «path» of transformations is explicitly designed and applied both for documenting and building the indicator. We illustrate our approach on the Moodle learning platform through a concrete example describing a practical use of our contribution.**

Keywords: Modeled trace, indicators calculus, Transformations sequences, collaborative learning.

I. Introduction

One of the most important and delicate tasks in computer human learning environments is to evaluate collaborative learning situations for one or more learners. This evaluation requires a permanent adaptation during the learning activity. In order to understand the dynamic of learning and evaluate effectively these collaborative learning situations, researchers analyze interaction's traces in many learning systems. Many of them are presented in a state of art in [1]. In this paper, we are specifically interested by different methods used to facilitate the analysis of traces in collaborative learning situations.

According to [2], an indicator is a mathematical variable which has a list of characteristics. It is a **variable** that takes values represented by digital, alphanumerical or graphical **forms**. The indicator value is used to build a feedback to different users. According to the categories proposed by [1], this feedback can be a direct visualization of the indicator value (*mirroring*), or the value can be compared to a desired state (*monitoring*) or it can feed a more elaborated process providing guiding information to learners (*guiding*).

A lot of works have been published about indicators, generally respecting the definition proposed by [2]. For example, we compute in [3] the cohesion and the centrality in social networks from discussion forums. Reference [4] offers a tool that computes from the interactions, the degree of involvement of each learner during the learning unit. It identifies: participative learner, useful learner, non-collaborative learner, learner which takes initiatives, and communicative learner. Other indicators are qualitatively interpreted as in [5] where the density of the social network is interpreted using histograms.

All these works use *data processing* integrated to learning platform, and for a specific indicator calculus. This approach does not allow to reuse indicator calculus in other learning platforms, or to compute other indicators in the same learning platform. In the next section we propose a generic method to compute and to reuse indicators in different learning platforms.

II. A Method to Compute Indicators from Interaction Traces

In the method proposed here, we compute collaboration indicators from trace model transformations. This method includes three steps: Collecting data, trace transformation used to prepare the indicator's calculus, and finally the computation step. Figure 1 shows the order of these steps:

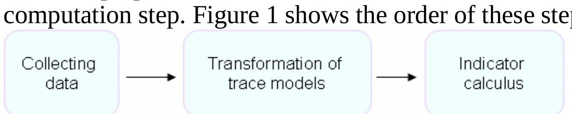

Figure 1. The trace model based approach in three steps

- Collecting data: Collecting data consists in selecting pertinent data within the learning environment. This process depends on learning platforms, and leads to the collected primary trace model. The primary trace model defines what information is needed which can be collected in the learning environment (collecting sources). In this paper, the collecting phase uses collaborative activity models, and, according to them we collect all observable elements that can inform us about the collaborators behavior;
- The model's transformations sequences: Starting from the primary trace, we propose transformation sequences using model's transformation operators. Once the indicator is built, if the model needs any change, it becomes easy to modify the sequence of transformation. We propose a library of indicators with their associated (transformed) trace models, where each trace model is associated with the sequence of transformation leading to it. We can then reuse the transformations to generate new models of M-Traces and therefore, new indicators;
- The indicator calculus: Our proposition is to associate to each indicator "I" its calculus based on

the trace model. This model helps to compute the indicator directly.

An indicator is computed by the way of a transformation sequence of trace models leading to the “indicator” level trace “I”. The indicator is defined by its trace "I" and its calculus rule $Ri(Xi)$ where Xi are all the variables needed for the calculus. The transformation sequence for the indicator “I” build the path from the primary trace model to the indicator level model. When collecting data, various observed elements of the primary traces model are built. The result of this step is the primary M-Trace. The transformations sequence leads to the indicator level trace from the primary trace by propagation of transformed data across the transformation paths.

III. IMPLEMENTATION

We propose here a specialized collecting phase for various collaborative learning activities from Moodle [6]. We are interested in synchronous and asynchronous activities, where actors work together on the same resources. In a previous work [7] describing such a collaborative learning activity, we proposed a model for the primary trace Moodle. More details about traces and models are in [8]. We extended the model to support additional actions that manage learners’ exchanges. This additional information helps to explain the collaborative behavior of learners using the generated indicators values. Figure2 shows the calculus rule implementation for the indicator *Proportion* (defined in [2]) between two types of actions *A* and *B* for *ActorX* using different transformed M-traces

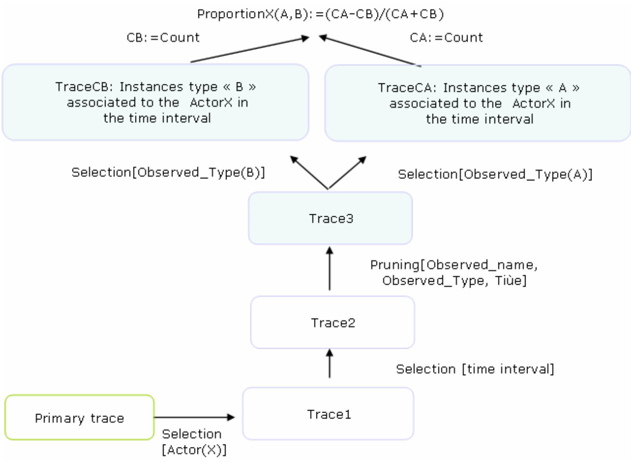

Figure 2. Generic transformation Sequence to compute the indicator "Proportion between two observed types A and B”

Our tool provides interfaces for selecting the data the user wants to collect. This choice is based on trace models the user needs in order to compute the target indicator. Using Moodle, the tool connects to Moodle database, imports necessary data, and instantiates the trace model in OWL format. This format respects the syntax of Jena parser [9]. The plugin collects data from collecting sources and instantiates the primary trace model. The result of this collecting phase is a primary trace in OWL format.

IV. CONCLUSION

We presented in this paper, a method and a tool to describe and compute collaborative indicators when using a Trace-Based System. The method we propose is based on an MDE approach (trace models), and helps to build transformation sequences of models in order to compute collaboration indicators. This method uses Trace-Based System to manage the traces we need to compute indicators, and especially to manage models for reusing purpose at the design and computation steps. We propose an architecture and a tool to build and manage interaction’s traces which are used to compute indicators. It is essential and crucial for the proposed engineering to support the modelling process by facilitating the reuse of models for observables’ collecting as well as for the indicators’ calculus themselves.

The user can then reuse transformations’ sequences to compute the same indicators for other learning platforms, to ensure independence between the learning platform and the calculus rule of a collaborative activity indicator. The use and reuse of transformations’ sequences applied on the M-Trace is the originality of our proposed method.

In future works, our implemented TBS and the models transformations library, will be tested by independent researchers with other learning platforms. We also expect to add more transformation operators to give more richness to the transformation mechanism proposed by our method, particularly the rewriting operator.

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