Analysis of tracks from student's use of a system to teach a problem solving method

Françoise LE CALVEZ[1], Hélène GIROIRE[2], Gérard TISSEAU[2], Jacques DUMA[3]

[1]CRIP5, Université René Descartes, 45 rue des Saints Pères, 75270 Paris cedex 6

[2]Equipe SysDeF - LIP6, Université Paris6, 8 rue du Capitaine Scott, 75015 Paris

[3]Lycée technique Jacquard, 2 rue Bouret, 75019 Paris

Francoise.Le-Calvez@math-info.univ-paris5.fr, Helene.Giroire@lip6.fr,

Gerard.Tisseau@lip6.fr, dumajd@club-internet.fr,

Abstract. In this paper, we present the results of the analysis we made about the tracks collected when students use a specific computer supported educational system. This system aims to teach a method to solve combinatorics exercises. The analysis of the tracks enables to make visible some students' abilities or difficulties in order to individualize the teaching.

We present an ongoing study about data collected from the usage of Combien? (How Many?) Software [2] [7]. Pedagogical interfaces are proposed to students to help them to learn combinatorics using mathematical language. These interfaces are based on our solving method: the "Constructive Method": to obtain the numeric solution of the exercise, the constructive method consists in building one element of the set of configuration-solutions; this element is defined by a set of exclusive constraints; for each constraint the number of various possibilities can be calculated; then, the solution is the product of all these possibilities (cf multiplicative principle). Each interface corresponds to a class of problems according to their solving schemata. It trains the student to build a solution using the constructive method and detects the errors incrementally. The first aim of the software is not so much to turn students into counting experts, able to determine the number of elements of a set, as to train them for a modelling task and to make them able to represent a situation by a complex structure. These interfaces, which we call "machines", have been used in different contexts in classrooms for senior high school students and first-year university students.

1. What kind of tracks?

It is possible, when using the software, to record all the events and inputs from the student so that the session can be re-played. The tracks are the result of this recording. The tracks are structured according to the model of the solution. And when the input is a validation-click the machine tests the validity of the sub-solution, and records the action and possible errors. These data are organized using the "descript" language [4] and are transformed to XML-files. Tracks analysis are performed from the XML files.

2. The aims and use of data analysis

When a student uses the machine for the first time, the exercises proposed have been chosen for their capacity to highlight possible students' difficulties. Then the tracks contain relevant information about the solving method comprehension and the underlying mathematical concepts (constructive method, sets, properties, constraints, functions...).Then, tracks are analyzed according to two directions. On the one hand, general information (here called generalLevel) can be extracted about the session: the name of the used "machine", the number of attempted exercices, the number of ended exercises, the total duration of the session, the order in which exercises have been processed and for each exercise, its name and the duration of the solving process. On the other hand, specific information (here called domainLevel) can be extracted from the inputs from the learner and the reactions from the system about these inputs: errors and hesitations. First use of track analysis is to give to the students a summary of their work so that they become aware of their abilities or difficulties, second is to improve teaching and enhance learning by means we present below .

2.1. Personalized courses and exercises

During the solving of the exercise, when the student makes an error, the system displays a message. This message is neither an explanation, nor a correct part of the ongoing solution. It is composed of hints about the missed concept, to help the student to overcome cognitive conflit and continue the process. In the track, the name of the error and the error message are recorded. According to their work, students need different explanations and even a more personalized help (course, exercises...). At present, we study how we can build some explanations taking into account the errors possibly grouping them in more general concepts. For example, in the "SetConstruction Machine", thirteen types of errors are possible, and underlying concepts are "Universe", constructive method and multiplicative principle.

According to the errors done and to the categorisation of exercises, we can propose some new series exercises which make the student to work about his/her difficulties.

We have begun such a work in collaboration with LeActiveMath group [1].

2.2. Automatic progression in various machines

Progression from a machine to another is linked to the results of the analysis. Each machine corresponds to a class of problems and the complexity of the concepts increases. For example the Universe in ListConstruction is a set of functions and the Universe in the SetConstruction is a set of basic elements. The upper machine contains exercises from all classes and the challenge is to choose the right machine to solve the problem.

2.3. *Categorization of exercises*

For a group of students and one exercise, statistics are made about number and types of errors made, the duration of solving it etc, allow to define values of attributes as, difficulty, underlying basic concepts which induce errors, duration if used in limited session... This study on numerous exercises gives the categorization used to personalize the exercises.

3. Conclusion

The special feature of "Combien?" is to teach an explicit problem solving method. During its use, it records all the students' inputs, events and error diagnosis in a track structured according to the model of a solution. These tracks used to define a student's profile or exercise features are very complete. Calculations are made to give to the various actors (students, teachers, tutors and designers) an overview of the students' activities and abilities so that the teaching can be modified to become more appropriate. According to the result of the track analysis, some personalized courses and exercises can be proposed, an automatic progression in the use of the various machines can be defined, and exercises can be typed.

References

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