# Work Units in Tutorials Software for Learning Mathematics

**Laurent Souchard**
Ministère de l'alimentation, de l'agriculture et de la pêche, France
LDAR, University of Paris Diderot, France
CREAS, University of Sherbrooke, Quebec, Canada
laurent.souchard@dbmail.com

**ABSTRACT**
In this paper, we describe one of the tools we use to construct the comparison of four tutorials software dedicated to the learning of mathematics in early secondary. One of the biggest differences between the traditional school and the use of computer for learning is the number of interaction that the student obtains with software. After this report, it is necessary to measure these interactions. The tool we have built and we present here, is the Work Unit, which is the interval of time in the course of which the learner receives no answer of the software. It helps us reach even more precisely in the description of CTS of our study as an institution of teaching and learning.

**Author Keywords**
Moments of working, Work Unit, Work Unit Factor, learning time, tutorial software.

**INTRODUCTION**
The offer of tutorial software [1] for learning mathematics and many other disciplines is becoming increasingly important.

The impact of a technological environment on the organization of education and classroom has been known for many years [2]. The research we conduct is to describe the characteristics of an environment using Closed Tutorial Software for learning mathematics at the beginning of secondary education in France [3]. These characteristics fall within the description of CTS as an institution of teaching and learning.

Before a didactic analysis we have constructed in our research, we chose to describe one of the specificities of the CTS: the temporary management of the moments of the study [4] which proposes every software. For it we set up, from the software *The Observer 5* [5], the following protocol:

- moments of study and research (AER);
- moments of institutionalization;
- moments of the technical work (M5);
- moments of evaluation (M6);
- moments of manipulation software (Manip).

The moments most often encountered in the four software by pupils and by the expert, are the moments of the technical work (M5, continuous moment) and evaluation moments (M6, instantaneous moment).

Among the different areas of comparison of four software, math education, algebra or calculus, educational organization of the software, student assessment, we decided to take into account the pace of each software through the repetition of evaluation moments.

Encoding scheme that we chose, we can see significant differences between software and the chapters of each software. It's possible to see these differences in the beginning of the *Visualize Data* [4] of the expertise of the four CTS.

So, we need to create a new tool to describe these differences, the Work Units [3].

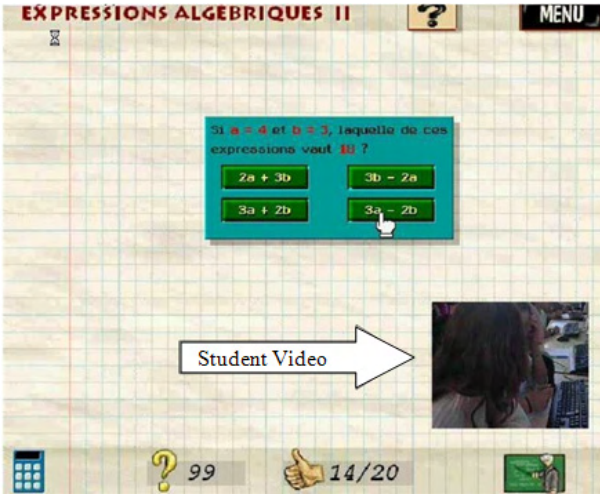


**Figure 1. Pupils working with Closed Tutorial Software.**




*Proceedings of Measuring Behavior 2010 (Eindhoven, The Netherlands, August 24-27, 2010)*
Eds. A.J. Spink, F. Grieco, O.E. Krips, L.W.S. Loijens, L.P.J.J. Noldus, and P.H. Zimmerman

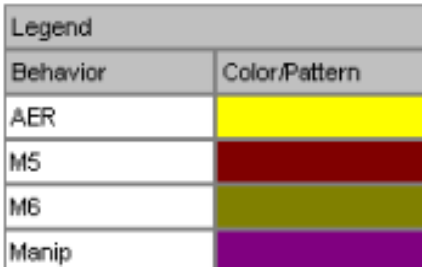


**Figure 2. Colors for the moments.**

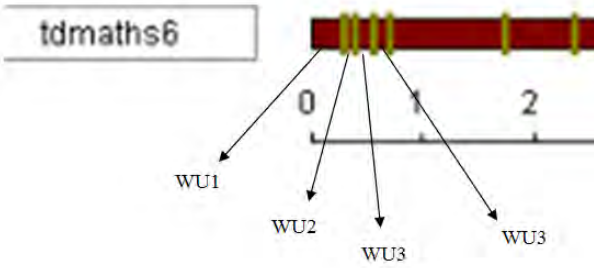


**Figure 4. The first Works Unit.**

## WORK UNIT

A work unit is the interval of time between two consecutive time assessment of student work or expert. For example, if $t_0$, $t_1$ and $t_2$ are the first three moments of assessment in a series of exercises, W1 and W2 are the first two Work Units:

$$WU1 = [t_0, t_1]; WU2 = [t_1, t_2].$$

## COMPARISON OF WORK UNITS IN FOUR SOFTWARE

The first remark concerns all Work Units (WU) of the expert. We have listed about 1800 that the expert must make all four Tutorial Software. Of the results, the average duration of WU is approximately 24.7 seconds. The average of tutorial software not very different and is 23.75 seconds (3%). This shows that the deviations of the averages by the average total Tutorial Software are not unimportant. We noted in our analysis that the serious game in the software *Smao* is singular from the rest of the software.

By the calculations of average years by WU and we find the average values of 20.5 and 20.8 seconds. We keep in mind that the average value of Work Units of the expert for all four Tutorial Software is around 20 seconds off the serious game in *Smao* part, that is to say for 1700 UT expert. The serious games in *Smao* are not thus comparable to the other types of exercises in four CTS and would require a more specific analysis.

The Figure 5 shows the average duration of the WU expert and provides us a ranking of the four Tutorial Software. *Tdmaths* and *Les Maths, c'est facile* are fast enough with an average of 17.3 and 19 seconds by WU on all software. *LiliMath* is slower with an average of 22.7 and *Smao* is much slower if all the software is taken into account with an average of 36 seconds by WU. If the serious games are excluded from the calculations, *Smao* is quite comparable in speed to *LiliMath* with an average of 24.4 seconds. The first calculation of average says that:

- *Tdmaths* and *Les Maths, c'est facile* are fast;
- *LiliMath* is moderately slow;
- *Smao* is rather slow.

The second set of remarks on the division of Work Units of the expert into three categories: very short WU under 10

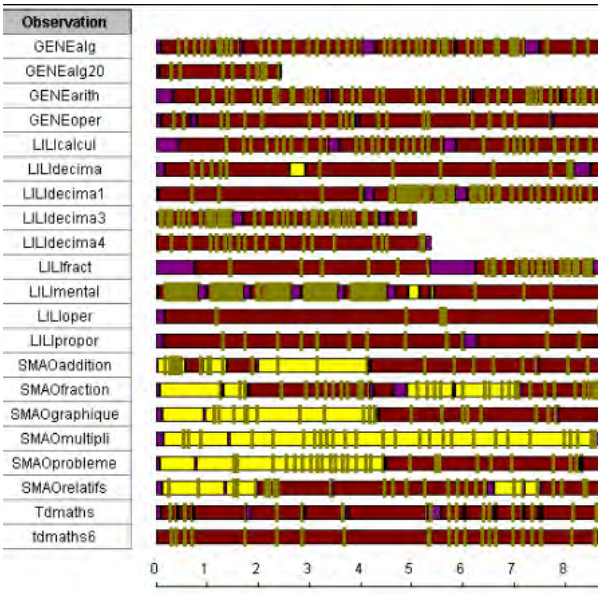


**Figure 3. *Visualize Data* of the expertise of the four CTS in The Observer 5.**

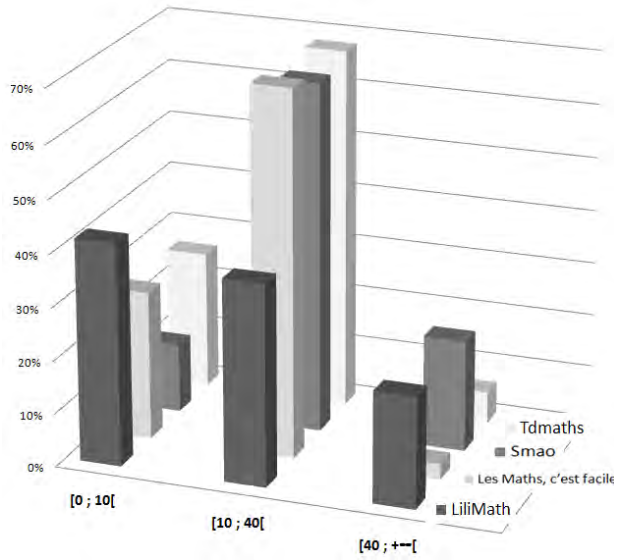


**Figure 5. The duration of Work Units by software in seconds.**

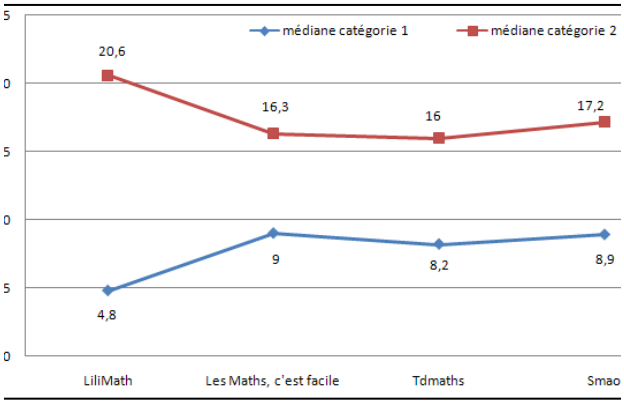


**Figure 6. Median duration of WU of the expert by exercises.**

seconds, those who are average and whose duration is between 10 and 40 seconds, and finally, WU's rather long that lasts more than 40 seconds.

Going further in the statistical analysis, we can notice in the Figure 6, some differences with three additional software and *LiliMath*.

## WORK UNIT FACTOR

Work Units allow us a first description of the software on their use by learners. A second possible use of this concept is one that compares the student work with that of the expert. For this, we define the Work Unit Factor as the ratio: duration of the Work Unit of student on the duration of the Work Unit of the expert.

$$\text{Work Unit Factor} = \text{WUF} = \frac{\text{Duration WU}_{\text{student}}}{\text{Duration WU}_{\text{expert}}}$$

**Figure 7. Work Unit Factor.**

For example, here are the WUF four students using the software *Smao*. Two of the students seem to work faster than the expert. Going to check the actual work of these two students, we find that they have actually met many difficulties to solve their exercises. This timeliness can translate a shoddy job.

| Camille | Jules | François | William |
|---|---|---|---|
| **2,10** | **1,47** | **0,75** | **0,74** |

**Table 1. Work Unit Factor in *Smao*.**

The time management is the heart of the successful education of all students: a good student is one who often knows how to manage his time during the homework, quizzes and other competitions or examinations in a limited time, as we remember Christine Pierrisnard-Robert:

> ***Note that the best performing pupils academically, who have specific knowledge and meta command of their "role as students, tend to perform the tasks required quickly, which joined the assumptions of teachers who generally believe that" good student "works quickly and well. [6]***

Nothing escapes the clock and the first sentence which hears a professor on behalf of his pupils in failure is: «I did not have time to finish ". But the tools available to enable students to learn to manage their time are not numerous. Time management is actually one of key to success, particularly in mathematics.

The research has made Christine Pierrisnard Robert confirmed.

> ***It is particularly difficult and rare to explain what we know and what we make of "time" of the school activity. [7]***

The concept of Work Unit, or WU, in Tutorial Software provides us a tool to measure and a different approach to this "time" of the school activity. The time when, to be exact, the different types of times are not the same as in conventional institution: teaching time, decided and managed by the teacher and the learning time, experienced by the student are not exactly transferable to the new institutional environment where the student works alone with a Tutorial Software. The teaching time is integrated and programmed into the Tutorial Software by the creators of the software but the student is also an actor in the management of this didactic time. He may decide to recover control, for instance, by repeating as many times as desired exercise. This suggests that the learning time, instructional time, time of activity, all these times and their acceptance by students and teacher need multiple institutions to express themselves more effectively.

Work Unit Factor is ultimately for us a tool that allows us to focus on parts of the student work through this indicator on working time. Based on a repository of expertise achieved by the Tutorial Software, we can define an optimal duration of the work unit by year and Tutorial Software. Once the factor of a WU student deviates too far from the average value, an analysis is necessary. This does not mean of course an average value close to the standard value is sufficient proof. From these averages, we could imagine a system that assigns each student a series of WUF type exercise gradually as the student advances in the Tutorial Software.

## CONCLUSION

The concept of Work Unit has allowed us to enter a new dimension of analysis of student work. The method of behavior analysis and computer tools allowed us to use this approach. The time of activity can be approached in the second and the student has to have access there to manage the evolution of his learning. As well as a sportsman who trains for a competition, a pupil must be able to measure his progress and have access to tools which allow such an approach.

## REFERENCES


1. Bitter G., Pierson M., *Using technology in the classroom*, Allyn and Bacon, 2007.
2. Haymore J., Sandholtz C., Owyer D. C., *La classe branchée*, collection de l'Ingénierie éducative, CNDP, 1998; titre original : *Teaching with Technology: Creating Student-Centered Classrooms*, Teachers College Press, 1997.
3. Souchard, L., Les Logiciels Tuteurs Fermés: institutions d'apprentissage et d'enseignement des mathématiques? le cas du début du secondaire. Université de Paris Diderot, France, 2009. http://tel.archives-ouvertes.fr/tel-00421836/fr/
4. Chevallard, Yves, *Organiser l'étude :1. Étude et fonctions*, Actes de la 11e École d'Été de Didactique des Mathématiques, Grenoble, La Pensée Sauvage, 2002.
5. The Observer from Noldus Information Technology: http://www.noldus.com/office/fr/observer-xt-2 /.
6. Pierrisnard-Robert, C., Conceptualisation des aspects temporels en situation d'apprentissage scolaire. *Temporalistes*, *40* (1999), 9.
7. Ibid, p. 8.