FROM A CUSTOMIZABLE ITS TO AN ADAPTIVE ITS

AIED 2013

Nathalie Guin and Marie Lefevre

Issue

- Personalization of learning
- How to assist a designer who wants to turn a TEL system into an adaptive one

Outline

- What we had
  - AMBRE-add : a customizable ITS
- What we wanted to do
  - make AMBRE-add an adaptive ITS
- What we used
  - Adapte : a tool to define personalization strategies
- What we did
  - Description of the case study

AMBRE-add

- AMBRE : a project designing ITS to teach problem solving methods based on problem classes
- AMBRE-add : an ITS teaching a method to solve additive word problems
  - Brad went to school with marbles.
    He gave thirteen of his marbles to Luke during the day.
    In the evening, he had fifty-six left.
    How many marbles did he have when he went to school ?
- Two phases
  - Presentation of a few typical solved problems
    - one for each class
  - Solving new problems using
    - reformulation of the problem using schemas
    - case-based reasoning

AMBRE-teacher

- Allows teachers to adapt AMBRE-add to their needs and their pedagogical strategies
- The teacher can
  - configure the software intended for her students
  - create the sequence of problems she wants them to solve
- Possible to personalize the sequence for each student
  - type of problems to solve
  - number and order of these problems
  - functionalities of the software

GenAMBRE

- GenAMBRE : a problem generator driven by the teacher
- The teacher can define constraints about :
  - Structural features (class)
  - Surface features (objects, characters)
  - Values (interval, carry over, …)
  - Complication (language, order of the sentences, distractor sentences, non pertinent data, …)

Analyzing traces to build profiles

- Goal: automated process for personalizing AMBRE-add
- Need to have student profiles
- A module that computes profiles by analyzing the traces of the students interaction
- Traces
  - All the learner's actions: answers, requests for assistance or diagnostic, uses of specific calculation tools
  - All of the ITS feedbacks: hints and diagnostics

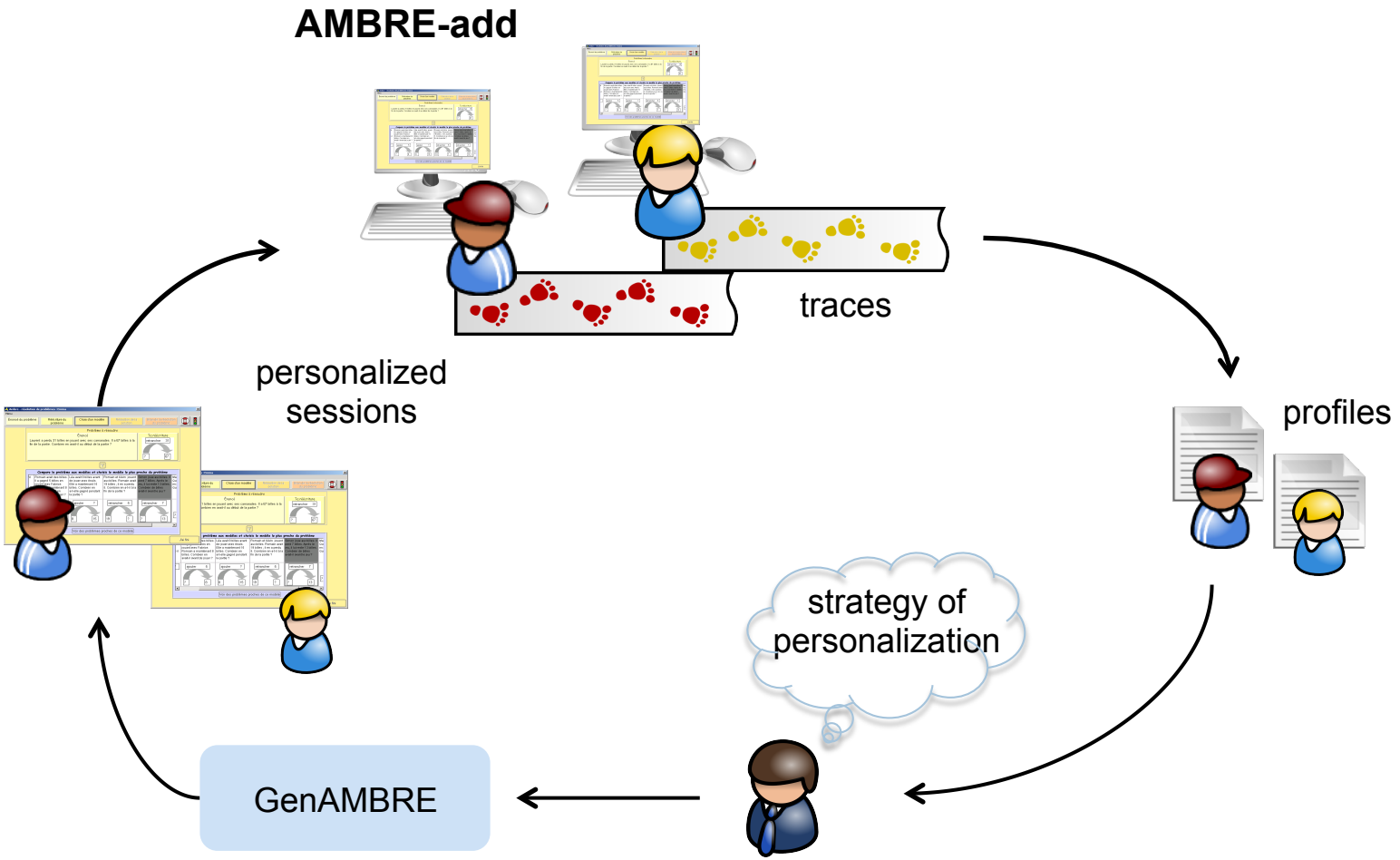
AMBRE-add profiles

- Personal data about the student that may be given by the teacher (e.g. reading level)
- Skills and behavior computed by the software
  - The learner can solve an arithmetic problems
    - in general
    - according to the class of the problem
    - depending of some parameters: using large numbers, using carry over, writing numbers in words, adding unnecessary values or unnecessary sentences
  - Learner's success in specific steps of the resolution
    - for example reformulation, calculation

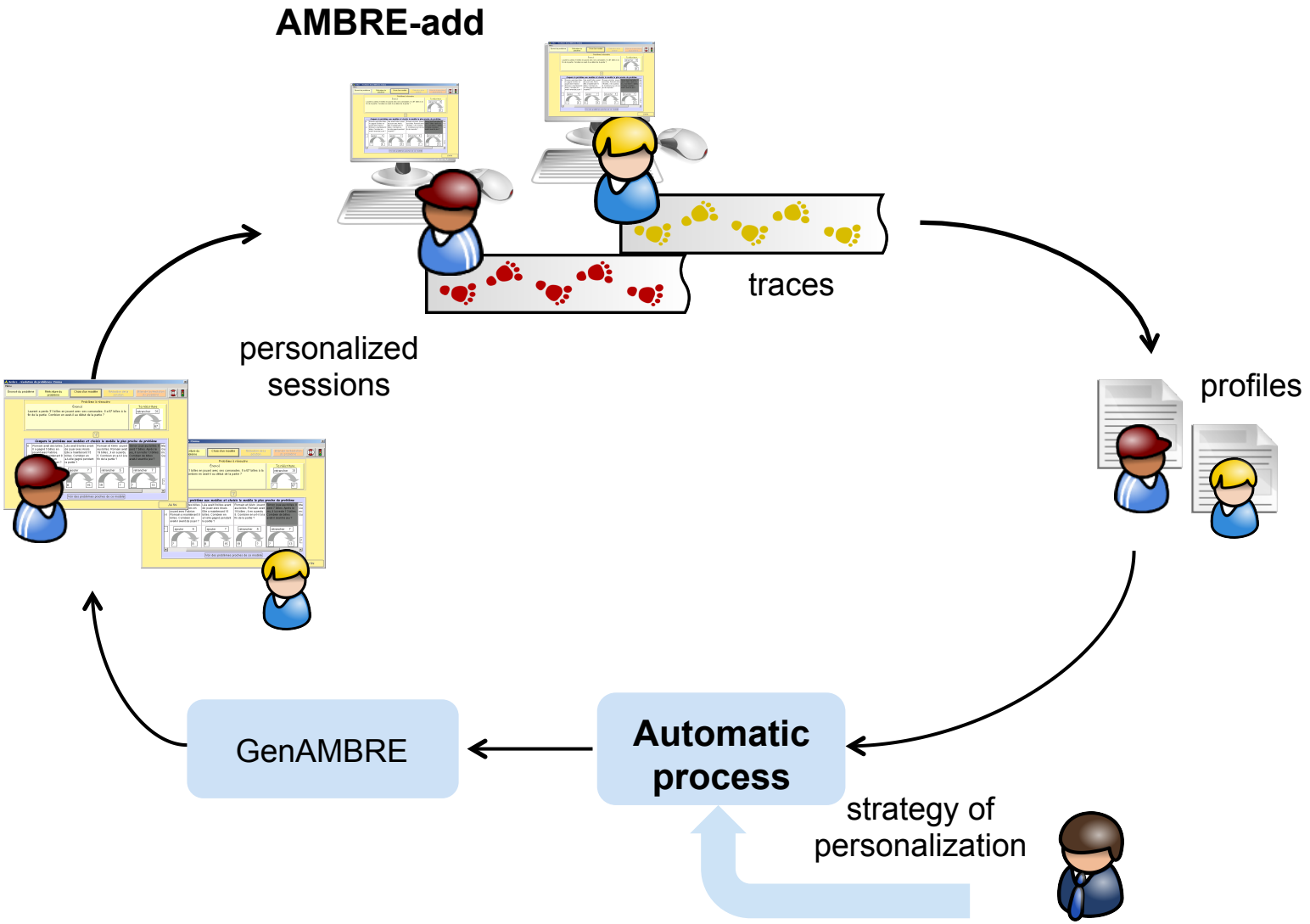
Outline

- What we had
  - AMBRE-add : a customizable ITS
- What we wanted to do
  - make AMBRE-add an adaptive ITS
- What we used
  - Adapte : a tool to define personalization strategies
- What we did
  - Description of the case study

Personalizing AMBRE-add: a very heavy task for the teacher



Towards adaptivity



Outline

- What we had
  - AMBRE-add : a customizable ITS
- What we wanted to do
  - make AMBRE-add an adaptive ITS
- What we used
  - Adapte : a tool to define personalization strategies
- What we did
  - Description of the case study

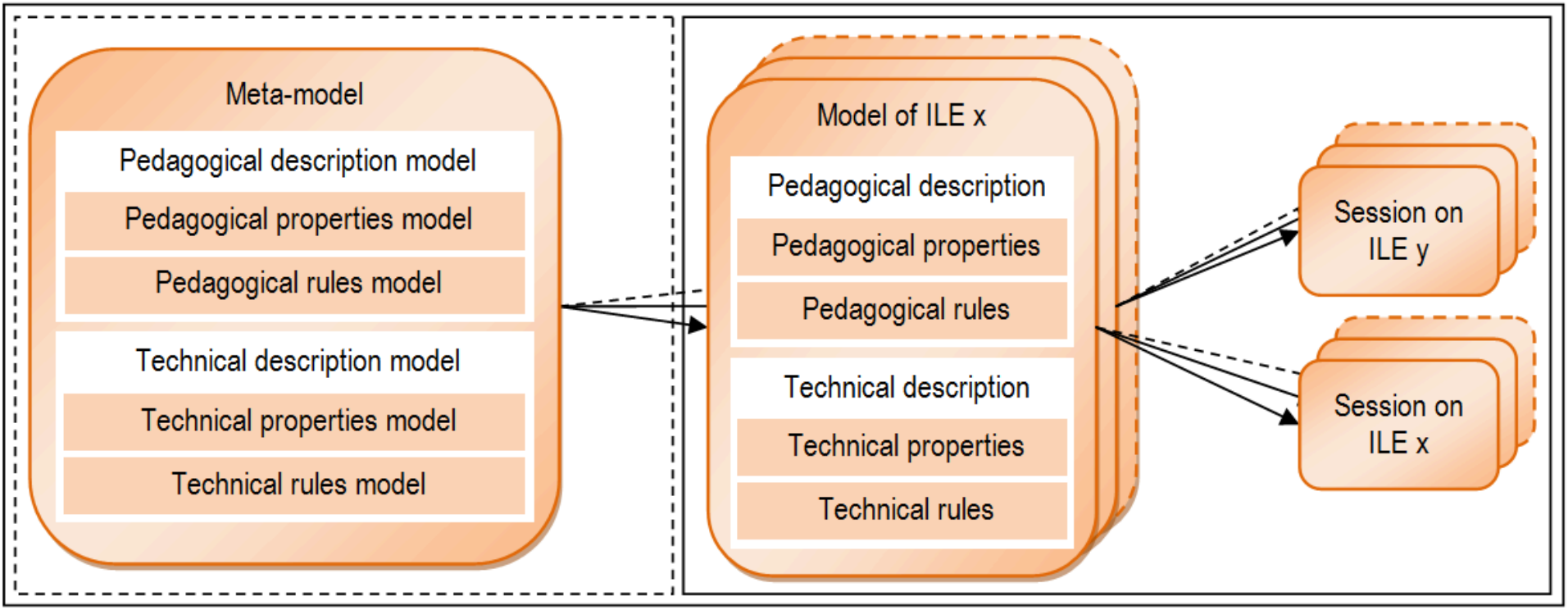
Adapte

- Tool intended for the teacher
- The user can define personalization strategies
- Can be used to customize external ITS

- Adapte needs
  - knowledge about the ITS to be personalized
  - personalization strategies
  - learner profiles

Acquisition of knowledge about the ITS

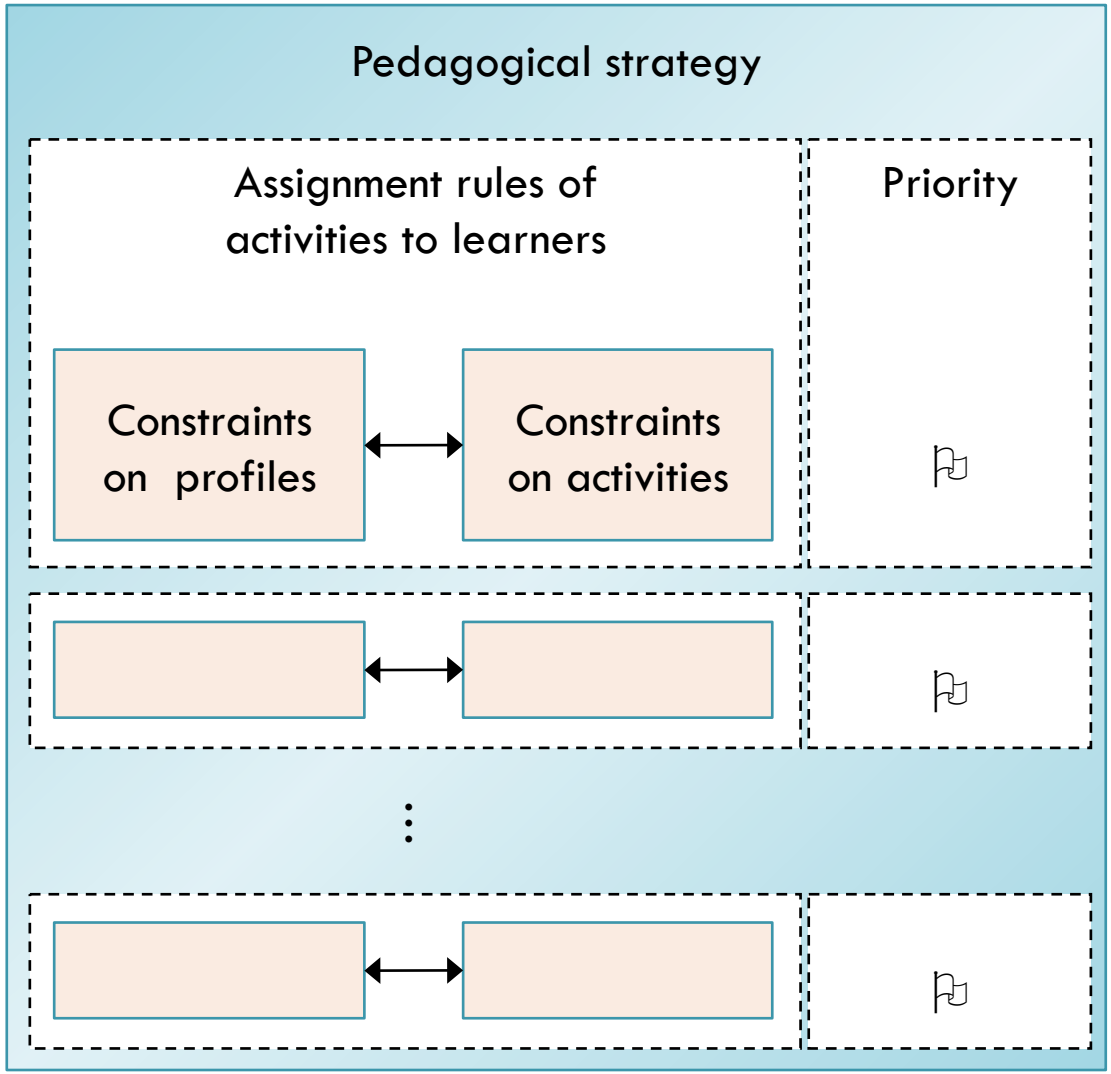
- In order to personalize an ITS X, Adapte needs to have a model of this ITS
- An expert of the ITS X must define this model



Once Adapte has a model of the ITS

- Using the model of the ITS X defined by the expert
- Adapte generates a specific interface
- The teacher uses this interface to define a strategy of personalization

Acquisition of personalization strategies



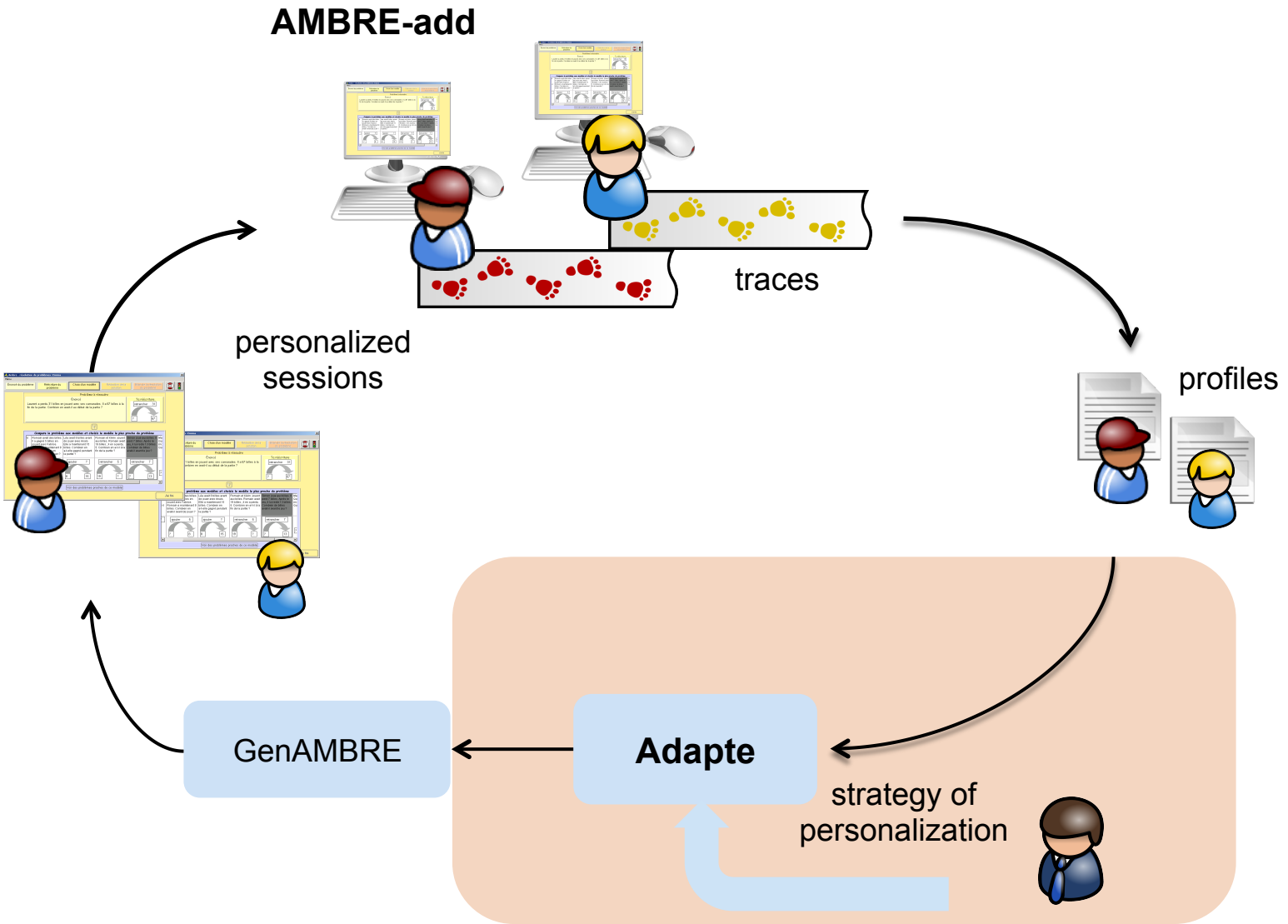
What has already been proved

- Teachers manage to define personalization strategies using Adapte *(PALE 2012)*
- Adapte can be used to customize any customizable ITS if (*Adaptive 2009*) :
  - this ITS proposes individual learning
  - its configuration files are open
- Adapte creates personalized sequences that comply the teacher's strategy *(PALE 2012)*

Outline

- What we had
  - AMBRE-add : a customizable ITS
- What we wanted to do
  - make AMBRE-add an adaptive ITS
- What we used
  - Adapte : a tool to define personalization strategies
- What we did
  - Description of the case study

Personalizing AMBRE-add with Adapte



A new context for using Adapte

- Usually: 2 users
  - The expert defines the model of the ITS
  - Each teacher defines a strategy of personalization
- Here: 1 user, the designer of the adaptivity
- The user
  - Has a good knowledge of AMBRE-add
  - Never used Adapte but has a good knowledge of concepts and process
- 3 steps:
    - Role of the expert to define how to import profiles
    - Role of the expert to define the ITS model
    - Role of the teacher to define a personalization strategy

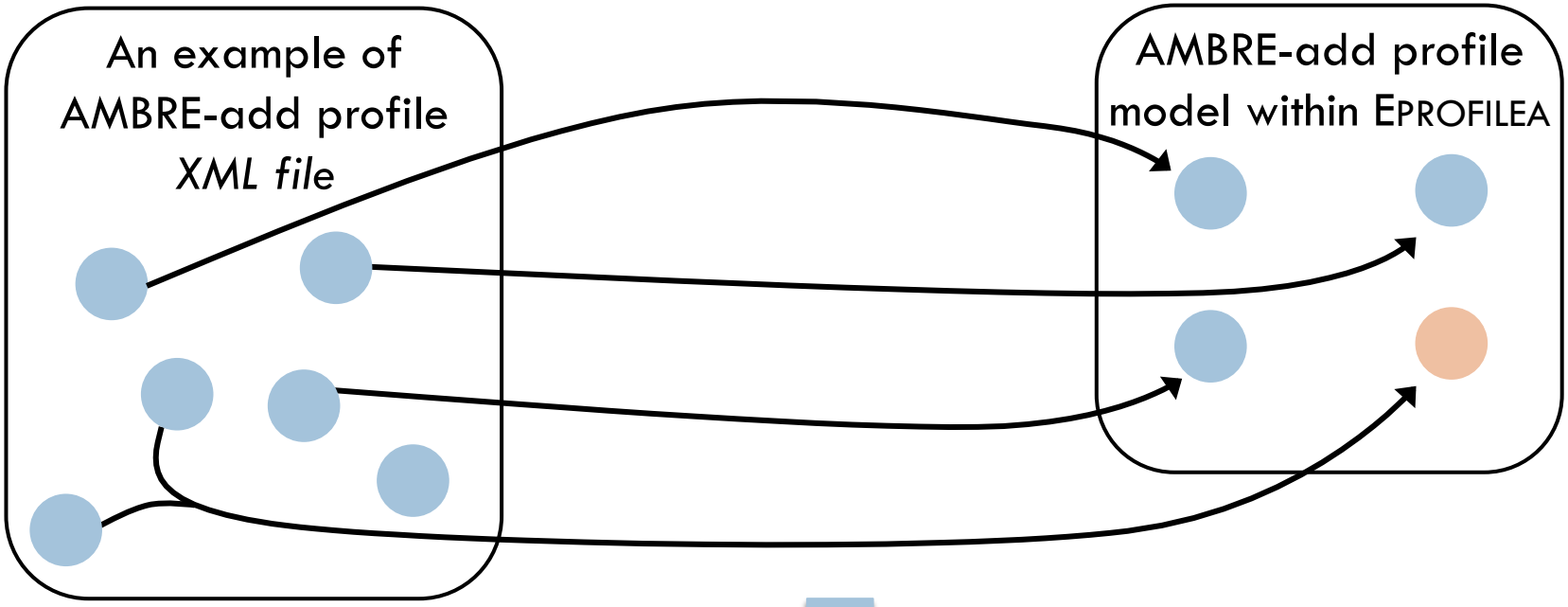
Step 1: defining how to import profiles

- Adapte is a module of EPROFILEA
- EPROFILEA is designed to:
  - manage learners' profiles produced by various sources
  - use these profiles, especially using Adapte
- To import AMBRE-add profiles
  - Define a profile model within EPROFILEA
  - Define a process for converting AMBRE-add profiles into profiles in accordance with this model

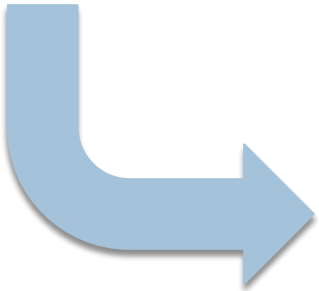
Definition of the profile model

- Not all the elements of the original profile have been reported
  - only those the user thought useful to adapt the ITS
- Information given by the teacher
  - learner's level in reading
- Ability to solve problems
  - for each class
  - grouped into four categories of difficulty ***(new)***
- Mastering the step of problem reformulation
  - in general
  - according to the complication elements introduced in the wording
- The level of calculation
  - in general
  - in difficult cases (carry over, large numbers)
- The frequency of use of calculating tools

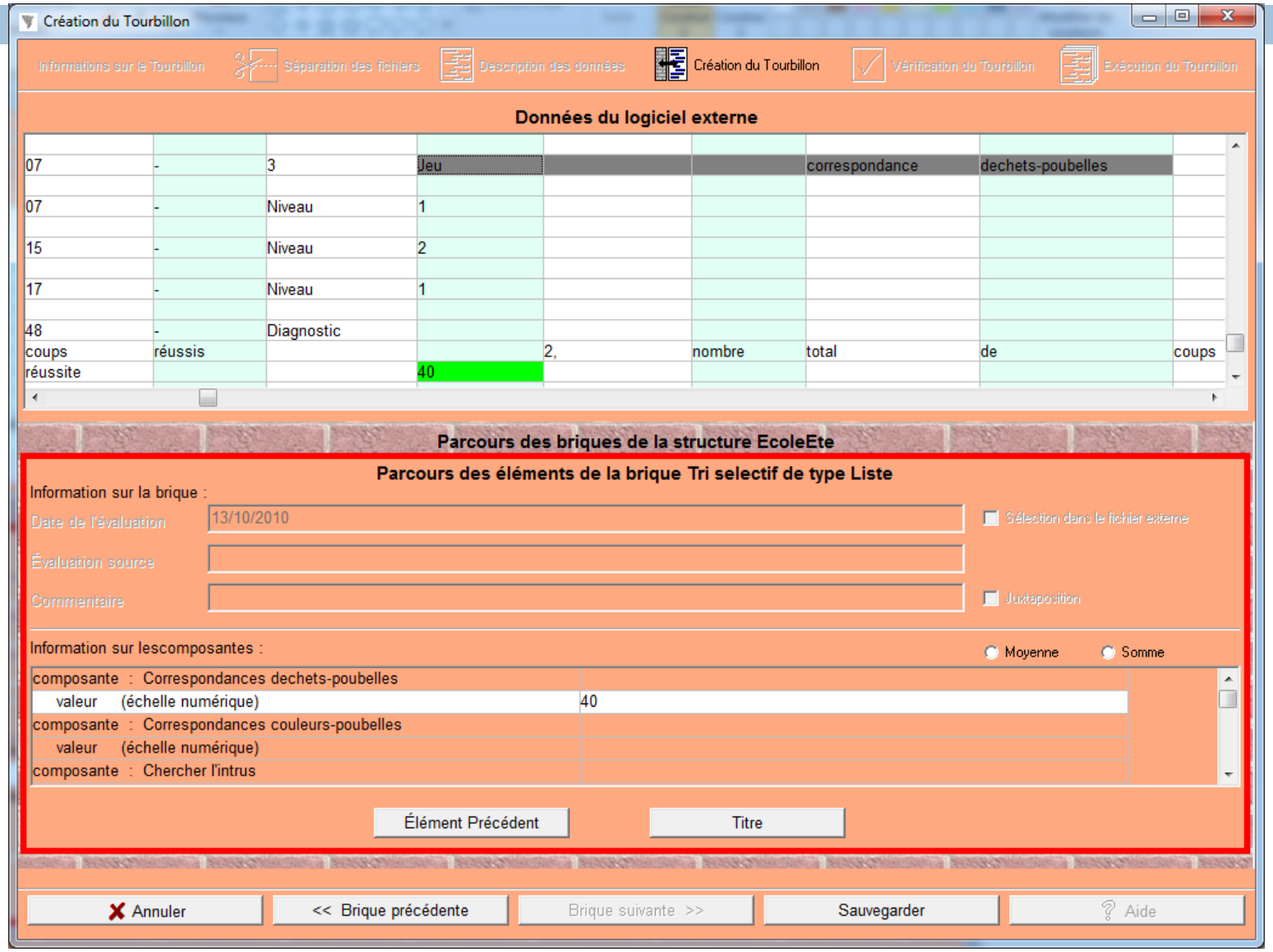
Definition of the import process



+ how to convert values



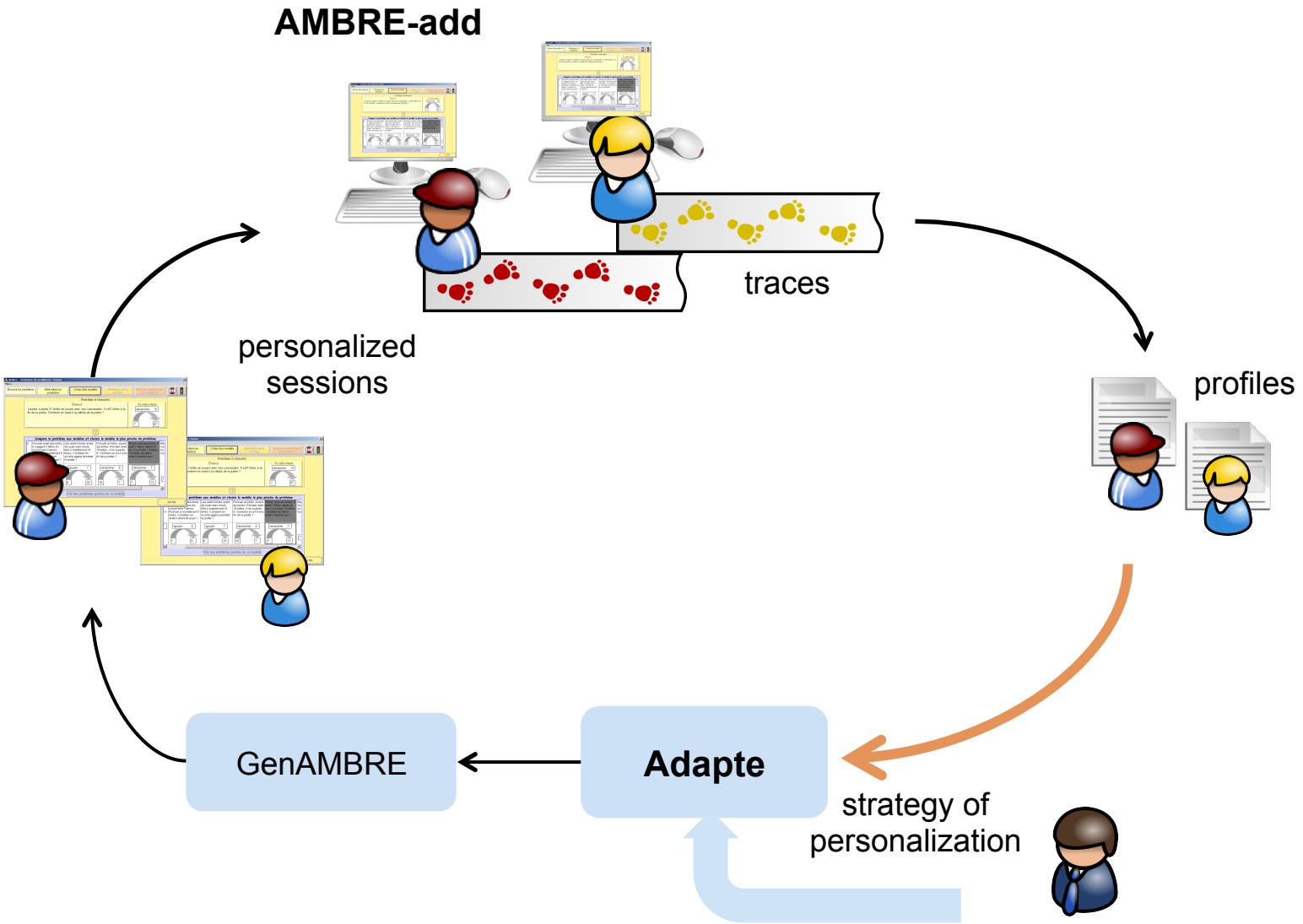
Definition of the import process



Synthesis on step 1

- 50mn to create a profile model for AMBRE-add within EPROFILEA
- 1h10 to create a converter to import existing AMBRE-add profiles into EPROFILEA
- Automated process for importing AMBRE-add profiles in EPROFILEA, as they are updated
- Step done only once
- Profile import is now possible in a few seconds

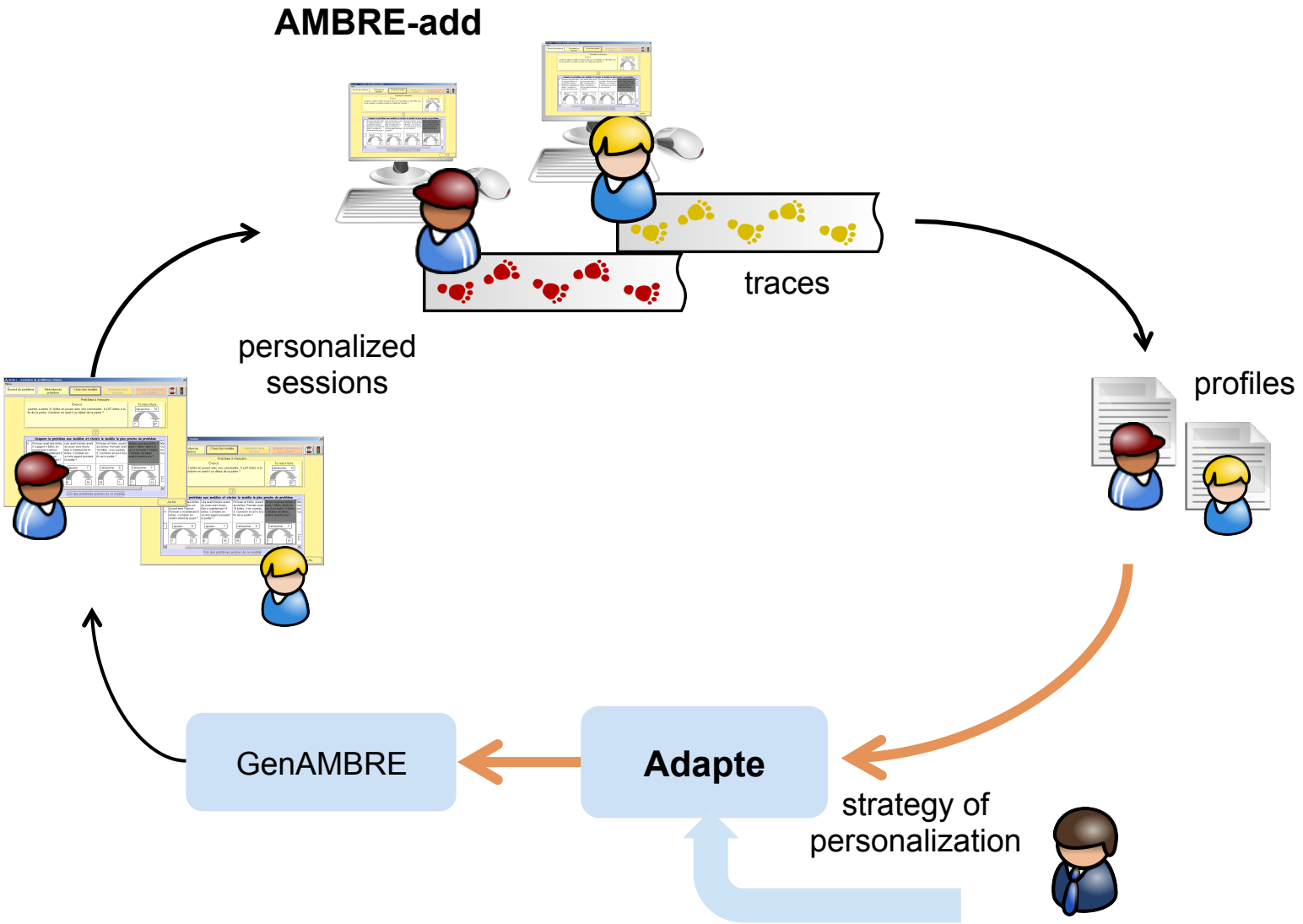
After step 1


AMBRE-add
traces
profiles
personalized
sessions
GenAMBRE
Adapte
strategy of
personalization

Step 2: defining a model of AMBRE-add

- Pedagogical properties: features of the problems
  - Parameters of GenAMBRE : class, carry over, values, complexity, unnecessary sentences…
  - New: combination of properties
    - difficulty of a class of problems
    - difficulty of the calculation
    - level of complication of the wording
- Pedagogical rules: relations between values of pedagogical properties
- Technical properties: path of files for GenAMBRE
- Technical rules:
  pedagogical properties ➔ modification of files describing the generation constraints
- Time for step 2: 2h

After step 2


AMBRE-add
traces
profiles
personalized
sessions
GenAMBRE
Adapte
strategy of
personalization

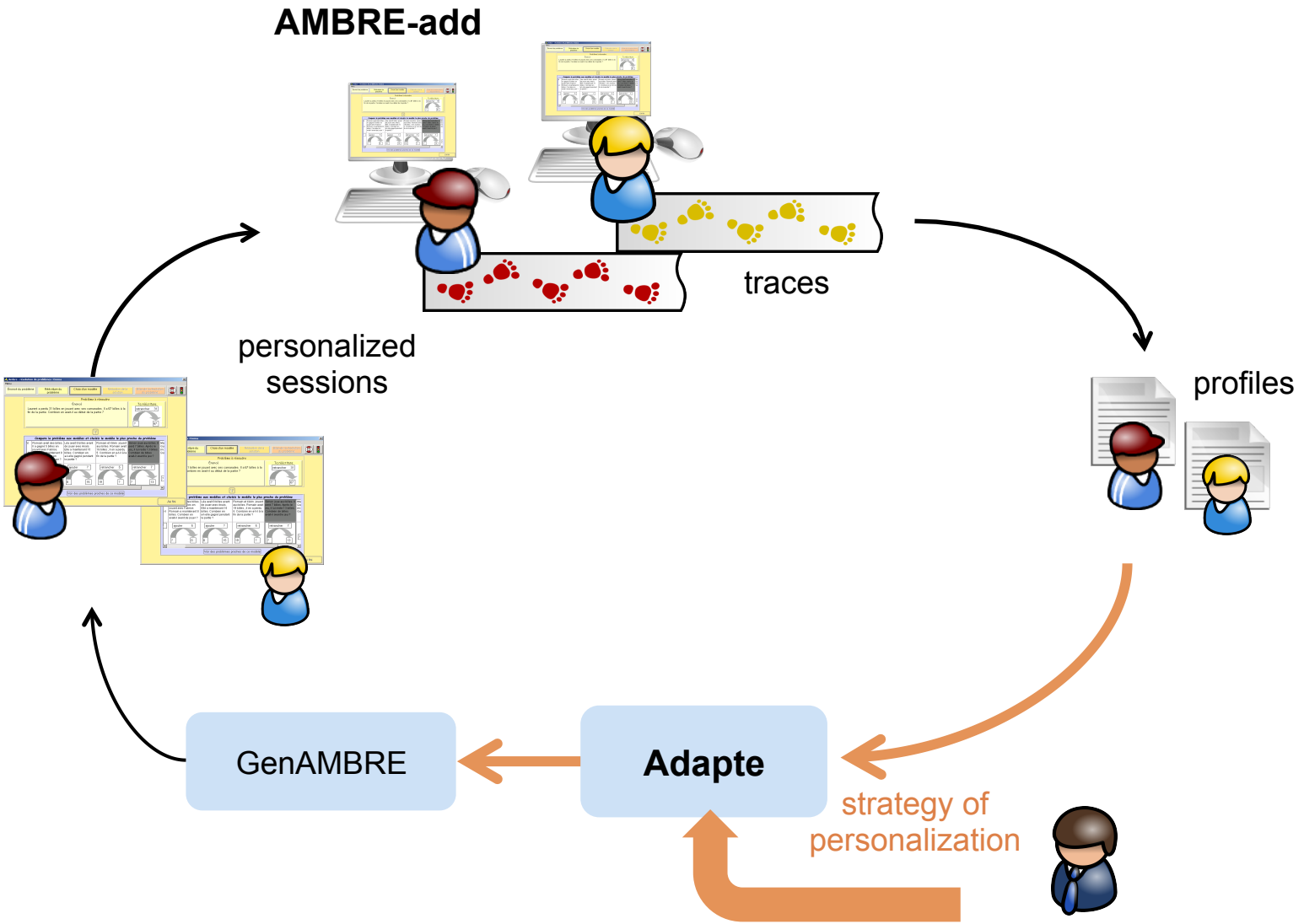
Step 3: defining a personalization strategy

- IF <constraints on profile>
  THEN <structure(s) of activity(ies)>
  ELSE <structure(s) of activity(ies)>
- First the user defined a strategy on a paper (40mn) ➔10 rules
- 2 about the learner's reading level
  IF reading level = very low
  THEN never offer a complication level of the wording greater than 1
- 3 about the learner's level in calculation
  IF calculating in general is partially mastered or mastered
  THEN propose a calculation with difficulty greater than 2
- 5 rules about the difficulty of the class of problems
  IF very easy classes = mastered and easy classes = partially mastered
  THEN provide very easy classes with complication = 2 and / or easy or difficult classes with complication = 1

Difficulties when defining the strategy with Adapte

- Not possible to use an OR in the THEN part of a rule
  ➔ create 2 rules
- Not possible to reason about the whole sequence (problems assigned one after the other)
  ➔ create 2 rules and use priority rules
- Not possible to use IF - THEN - ELSEIF rules (progress into levels of difficulty)
  ➔ create more rules with more complex conditions
- Not possible to consider independently the choice of the class of the problem, and the choices related to the level of reading and the level of calculation, with rules able to change the outcome of other rules
  ➔ create more rules with more complex conditions

After step 3


AMBRE-add
traces
profiles
personalized
sessions
GenAMBRE
Adapte
strategy of
personalization

Synthesis of the study

- 6h to make AMBRE-add adaptive using Adapte
- No programming skills required

- The personalization strategy can be modified by the teacher

- Feedback on the use of Adapte: usability problems
  - definition of the process to import of profiles
  - definition of the pedagogical strategy
    - propose improvements to the tool

Research perspectives

- Conduct experiments using this adaptive version of AMBRE-add
- Does an adaptive version arouses greater satisfaction or interest from students and teachers?
- Does it brings a gain on learning?
- Do the teachers adapt the ITS adaptivity?

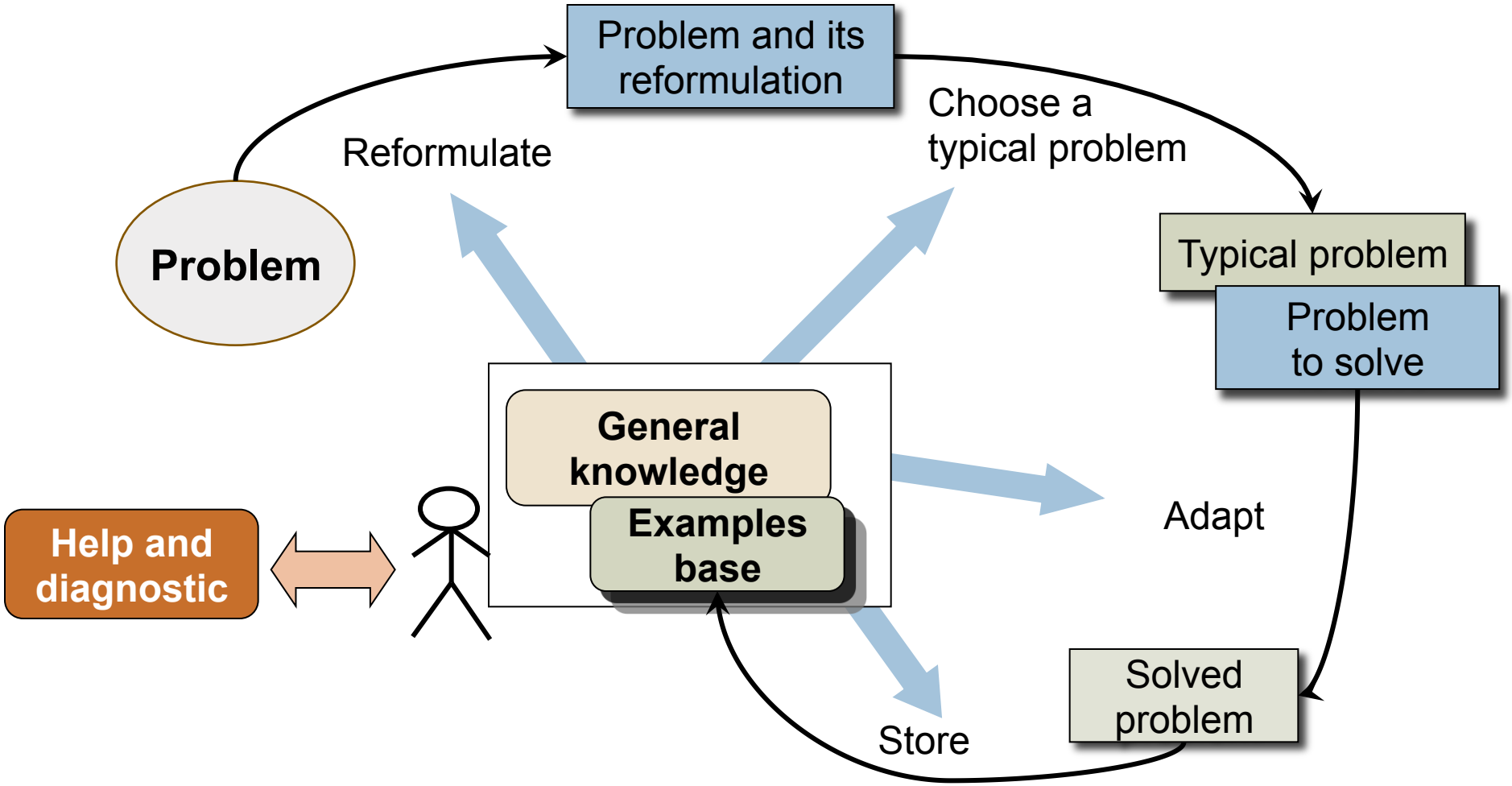
?

FROM A CUSTOMIZABLE ITS TO AN ADAPTIVE ITS

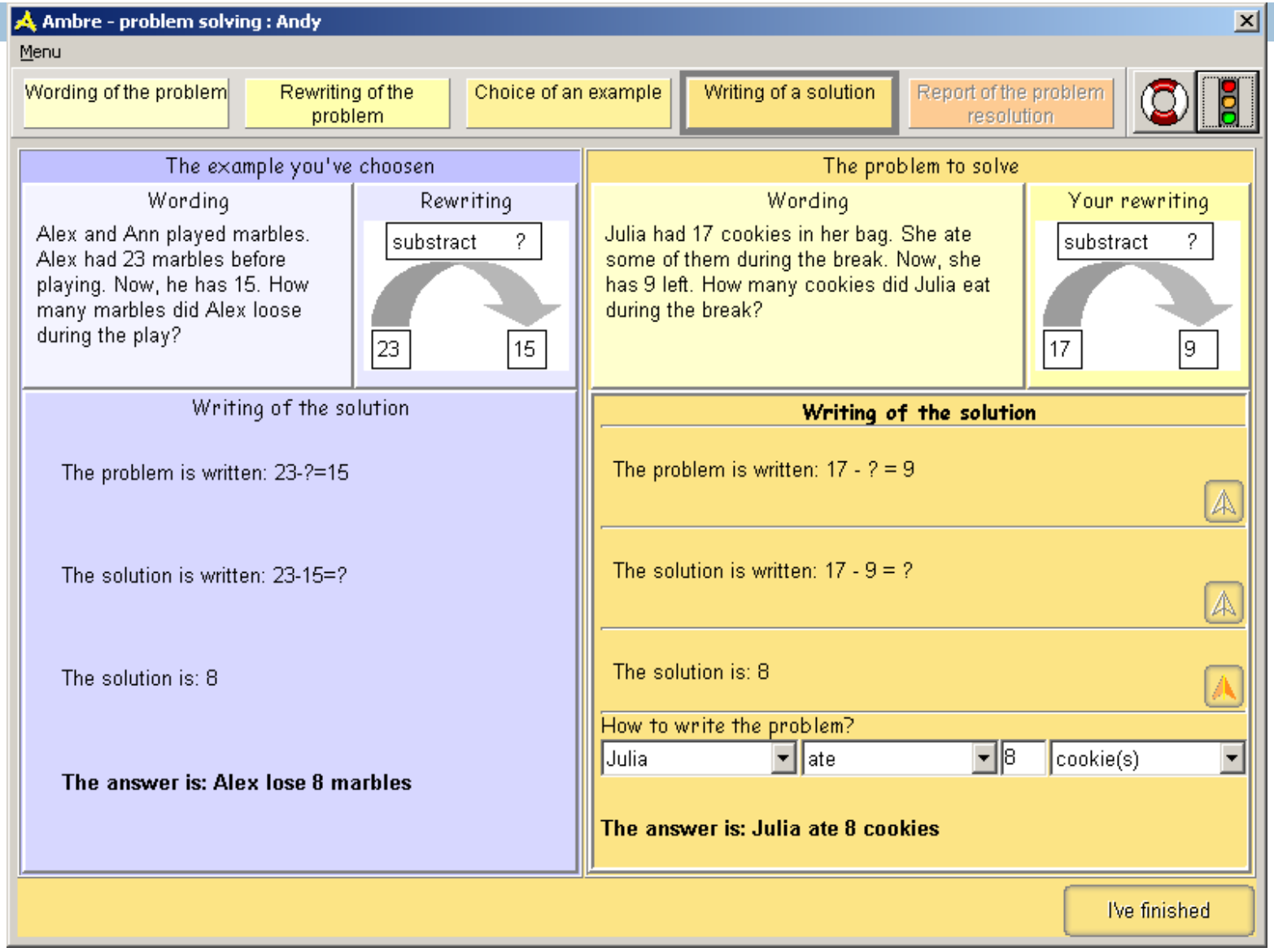
AIED 2013

Nathalie Guin and Marie Lefevre

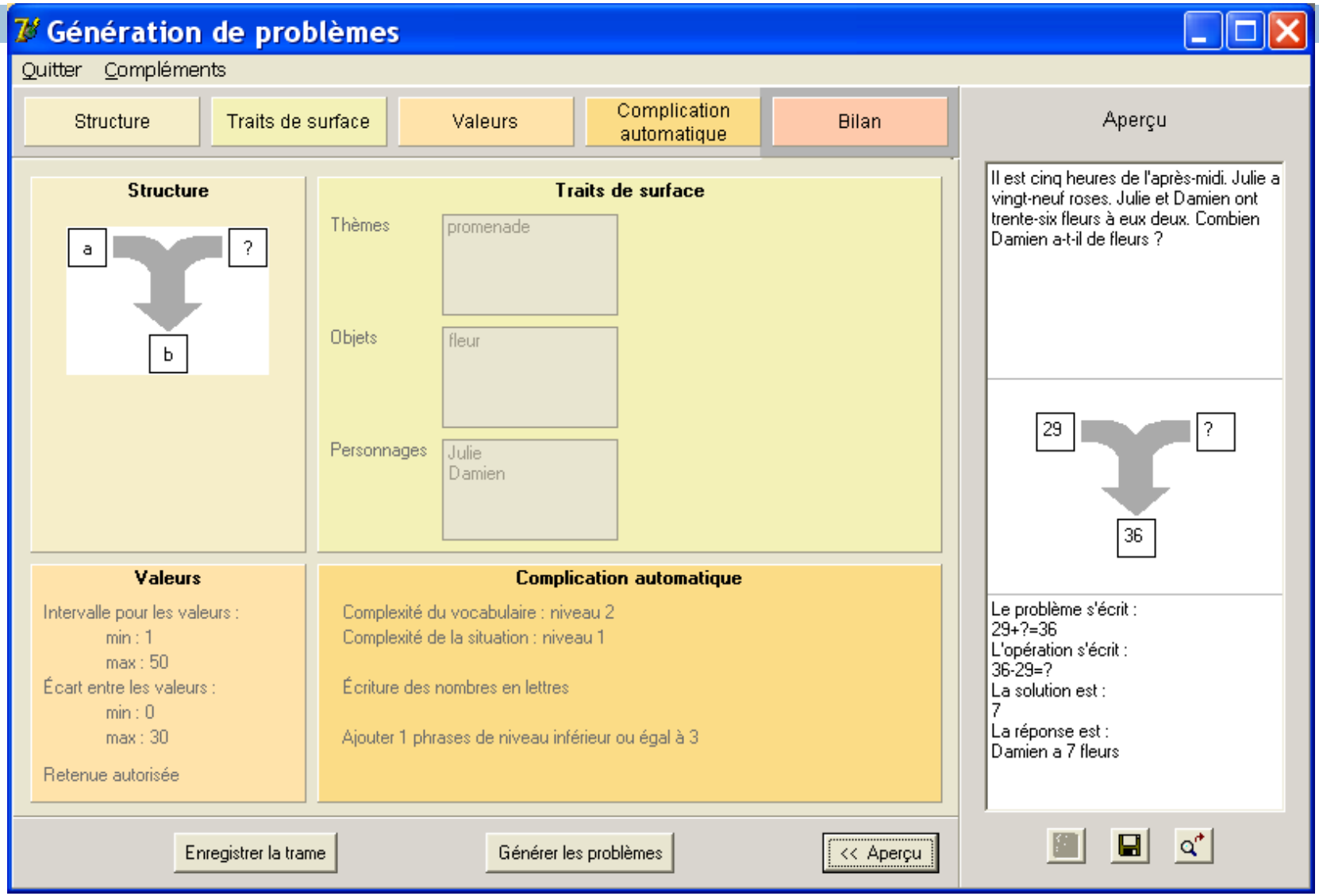
AMBRE cycle


Problem and its reformulation
Reformulate
Choose a typical problem
Problem
Typical problem
Problem to solve
General knowledge
Examples base
Help and diagnostic
Adapt
Store
Solved problem

Adaptation step



AMBRE-teacher



AMBRE-add profiles

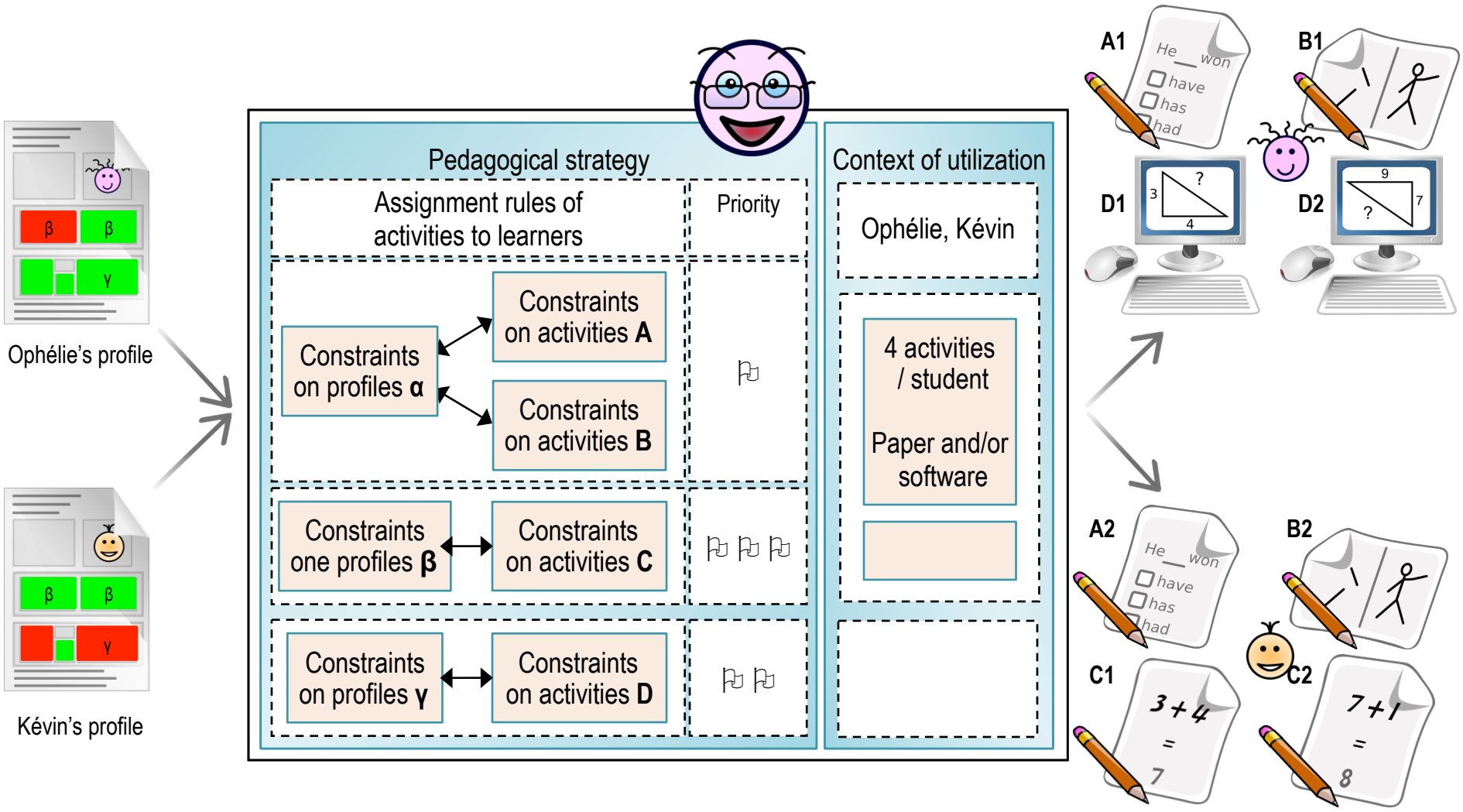

```
▼<ProfilAmbre xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" NiveauClassification="AMBRE" Creation="2011-12-08+01:00"
 xsi:schemaLocation="data/ProfilAmbre.xsd">
  ▼<Informations_personnelles NiveauClassification="AMBRE">
     <Nom_apprenant NiveauClassification="AMBRE">D.</Nom_apprenant>
     <Prenom_apprenant NiveauClassification="AMBRE">Emilie</Prenom_apprenant>
     <Date_naissance NiveauClassification="AMBRE">2011-02-01+01:00</Date_naissance>
     <Sexe NiveauClassification="AMBRE">F</Sexe>
     <Langue_maternelle NiveauClassification="AMBRE">Français</Langue_maternelle>
     <Classe NiveauClassification="AMBRE" Enseignant="Mr DEMO LIRIS 2010" Redoublant="false">CE1</Classe>
    ▼<Aptitude NiveauClassification="AMBRE">
       <Lecture NiveauClassification="AMBRE">Normal</Lecture>
       <Calcul NiveauClassification="AMBRE">Normal</Calcul>
       <Probleme_audition NiveauClassification="AMBRE">false</Probleme_audition>
       <Probleme_attention NiveauClassification="AMBRE">false</Probleme_attention>
     </Aptitude>
     <Theme_prefere>Jeu</Theme_prefere>
   </Informations_personnelles>
  ▼<Connaissances_et_comportements NiveauClassification="AMBRE">
    ▼<Sait_resoudre_un_probleme_additif NiveauClassification="AMBRE-add">
      ▼<Details_selon_la_granularite_des_classes_pour_les_problemes_additifs>
        ▼<Pour_toutes_les_classes NiveauClassification="Maths" Nombre_moyen_de_reponses_soumises="2" Nombre_observations="9"
         Nombre_de_fois_detectes="0">
           <Taux_de_reussite>0.0</Taux_de_reussite>
         </Pour_toutes_les_classes>
        ▼<c_reunion>
          ▼<Valeurs Id="1" NiveauClassification="Math" Nombre_moyen_de_reponses_soumises="2" Nombre_observations="1"
           Nombre_de_fois_detectes="0">
             <Taux_de_reussite>0.0</Taux_de_reussite>
           </Valeurs>
          ▼<c_reunion_res Id="1.1" NiveauClassification="Math" Nombre_observations="0" Nombre_de_fois_detectes="0">
             <Taux_de_reussite>0.0</Taux_de_reussite>
           </c_reunion_res>
          ▶<c_reunion_operande Id="1.2" NiveauClassification="Math" Nombre_moyen_de_reponses_soumises="2" Nombre_observations="1"
           Nombre_de_fois_detectes="0">...</c_reunion_operande>
         </c_reunion>
        ▶<c_changement>...</c_changement>
        ▶<c_comparaison>...</c_comparaison>
       </Details_selon_la_granularite_des_classes_pour_les_problemes_additifs>
      ▶<Sait_resoudre_un_probleme_avec_chiffre_ecrit_en_lettres NiveauClassification="Math" Nombre_moyen_de_reponses_soumises="2"
       Nombre_observations="5" Nombre_de_fois_detectes="0">...</Sait_resoudre_un_probleme_avec_chiffre_ecrit_en_lettres>
```

Model of pedagocical rules

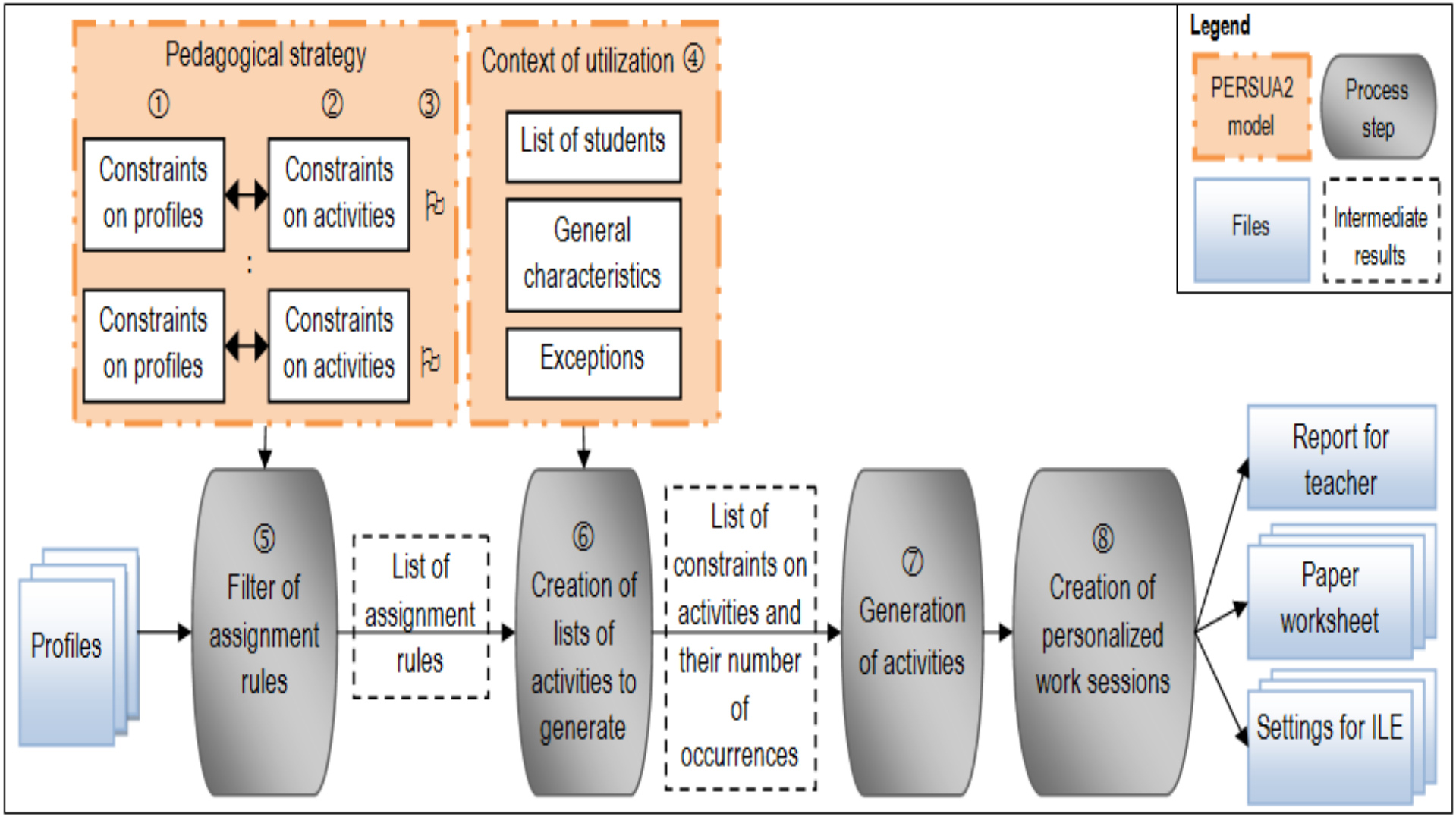
IF
Value(parameter i_1) **=** X_1
Value(parameter i_1) **ϵ** {X_1 .. X_n}
Value(parameter i_1) is **undefined**
C_1 **and** C_2 where C_i is a constraint on the value of a parameter

THEN
Value(parameter j_1) = Y_1
The parameter j_1 will be **inaccessible**
ValueDomain(parameter j_1) = {Y_a .. Y_b} with a≥m et b≤n, where m and n are initial bound
C_1 **and** C_2 where C_i is a constraint on the value or on the value domain of a parameter

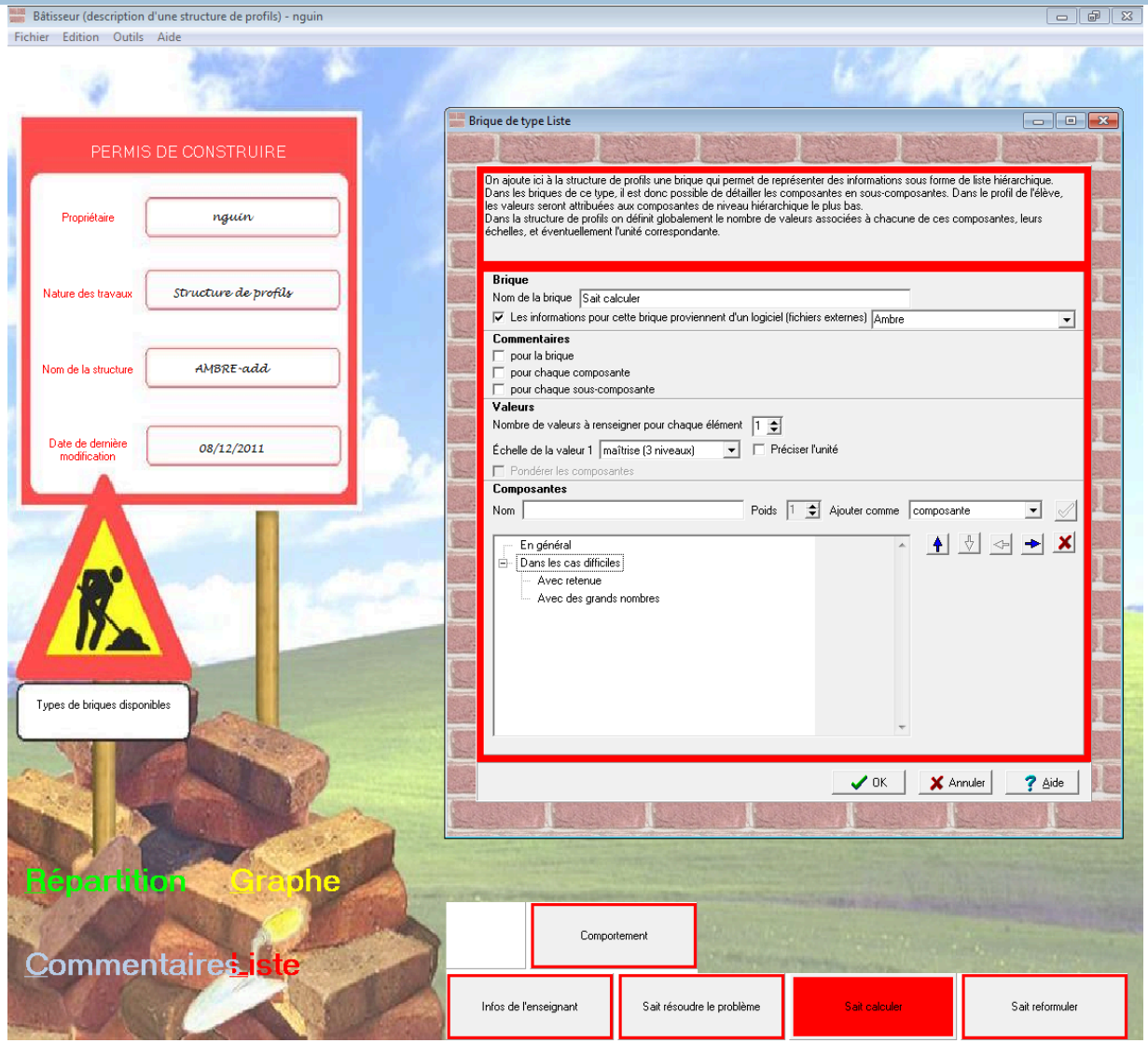
Illustration of the personalization



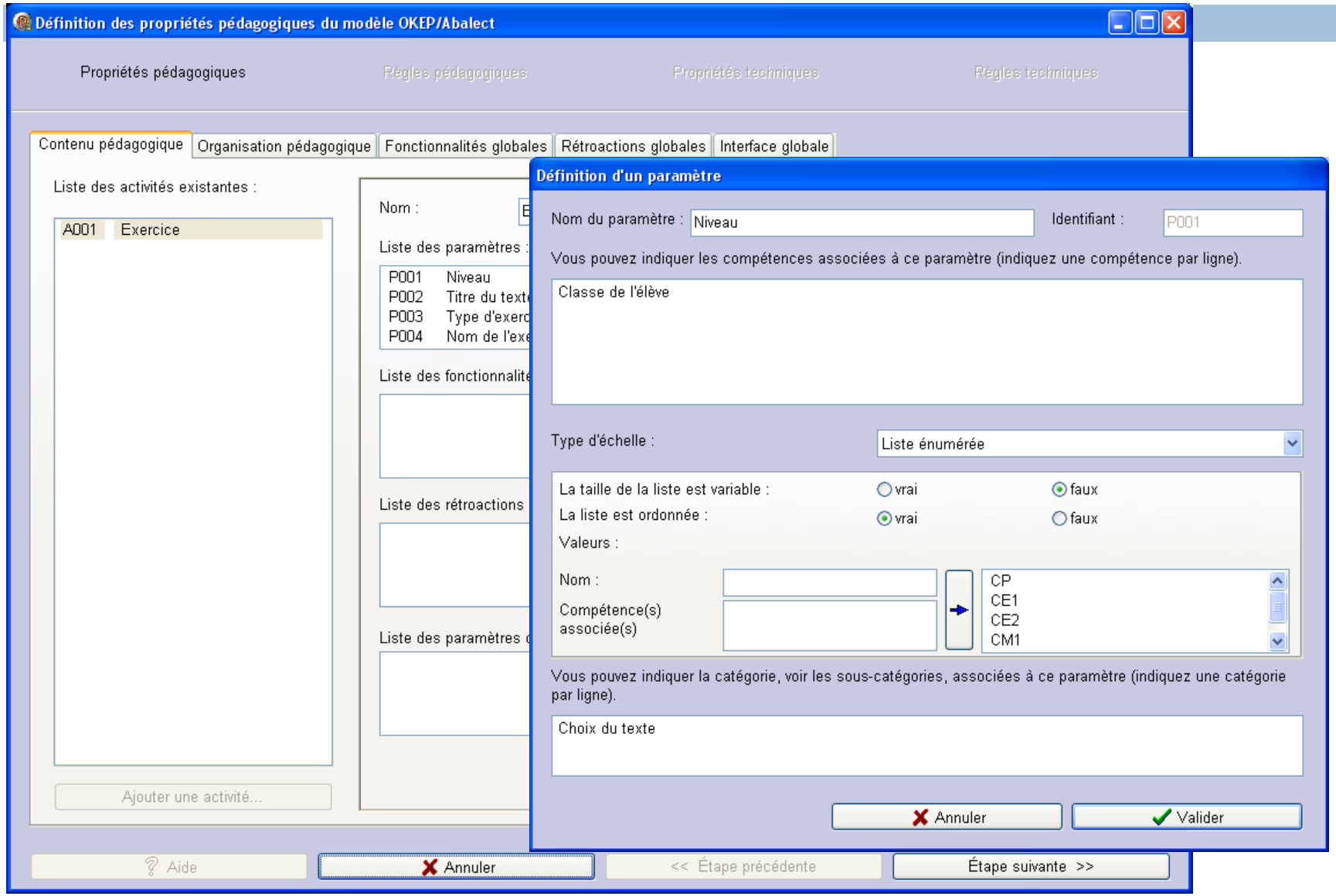
Personalization process



Batisseur - AMBRE



Defining the pedagocial properties



Pedagogical properties of AMBRE-add

```
  <Name>Difficulté de la classe</Name>
▼<Comment>
    Regroupement des classes de problèmes selon 4 niveaux de difficulté
  </Comment>
▼<ScaleNumerical>
    <LowerBound>1</LowerBound>
    <UpperBound>4</UpperBound>
    <Step>1</Step>
    <AssociatedCompetenceLowerBound>1 = très facile</AssociatedCompetenceLowerBound>
    <AssociatedCompetenceLowerBound>2 = facile</AssociatedCompetenceLowerBound>
    <AssociatedCompetenceUpperBound>3 = difficile</AssociatedCompetenceUpperBound>
    <AssociatedCompetenceUpperBound>4 = très difficile</AssociatedCompetenceUpperBound>
  </ScaleNumerical>
▼<Category>
    <Name>structure</Name>
  </Category>
</Parameter>
<Parameter ID="P003">
  <Name>Difficulté du calcul</Name>
  <Comment>Valeurs et écart des nombres, retenue</Comment>
▼<ScaleNumerical>
    <LowerBound>1</LowerBound>
    <UpperBound>4</UpperBound>
    <Step>1</Step>
    <AssociatedCompetenceLowerBound>1 = très facile</AssociatedCompetenceLowerBound>
    <AssociatedCompetenceLowerBound>2 = facile</AssociatedCompetenceLowerBound>
    <AssociatedCompetenceUpperBound>3 = difficile</AssociatedCompetenceUpperBound>
    <AssociatedCompetenceUpperBound>4 = très difficile</AssociatedCompetenceUpperBound>
  </ScaleNumerical>
▼<Category>
```

Pedagogical rules of AMBRE-add


```
▼<PedagogicalRules NameOfILE="AMBRE-add">
 ▼<Rule ID="R1">
  ▼<Condition>
   ▼<Parameter ID="P002" TypeOfCondition="Value">
      <Number Max="1"
    </Parameter>
   </Condition>
  ▼<Conclusion>
   ▼<Parameter ID="P0
      <Value>reunion_r
      <Value>retranche
      <Value>ajouter_r
    </Parameter>
   </Conclusion>
 </Rule>
▼<Rule ID="R2">
  ▼<Condition>
   ▼<Parameter ID="P0
      <Number Max="1"
    </Parameter>
   </Condition>
  ▼<Conclusion>
   ▼<Parameter ID="P0
      <Value>faux</Val
    </Parameter>
   ▼<Parameter ID="P0
      <UpperBound>30</
      <LowerBound>1</LowerBound>
    </Parameter>
```

```
▼<Rule ID="R7">
  ▼<Condition>
   ▼<Parameter ID="P003" TypeOfCondition="Value">
      <Number Max="3" Min="3"/>
    </Parameter>
   </Condition>
  ▼<Conclusion>
   ▼<Parameter ID="P005" TypeOfConclusion="Value">
      <Value>vrai</Value>
    </Parameter>
   ▼<Parameter ID="P006" TypeOfConclusion="Value">
      <UpperBound>60</UpperBound>
      <LowerBound>10</LowerBound>
    </Parameter>
   ▼<Parameter ID="P007" TypeOfConclusion="Value">
      <UpperBound>40</UpperBound>
      <LowerBound>10</LowerBound>
    </Parameter>
   </Conclusion>
 </Rule>
```

Defining the personalization strategy