

FROM A CUSTOMIZABLE ITS TO AN ADAPTIVE ITS

AIED 2013

Nathalie Guin and Marie Lefevre

Issue

2

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

Outline

3

- 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

4

- 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

5

- 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

6

- 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

7

- 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

8

- 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

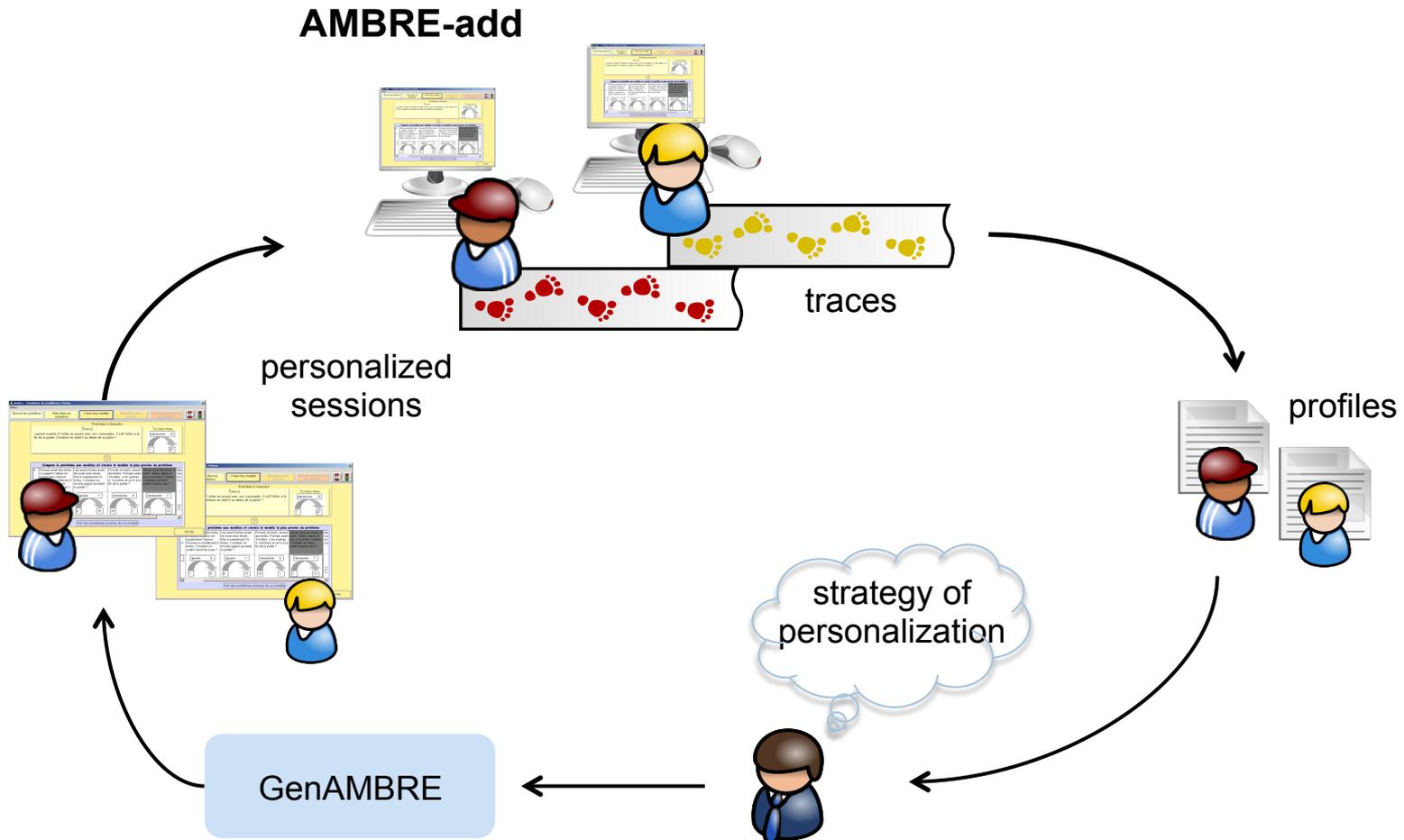
Outline

9

- 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

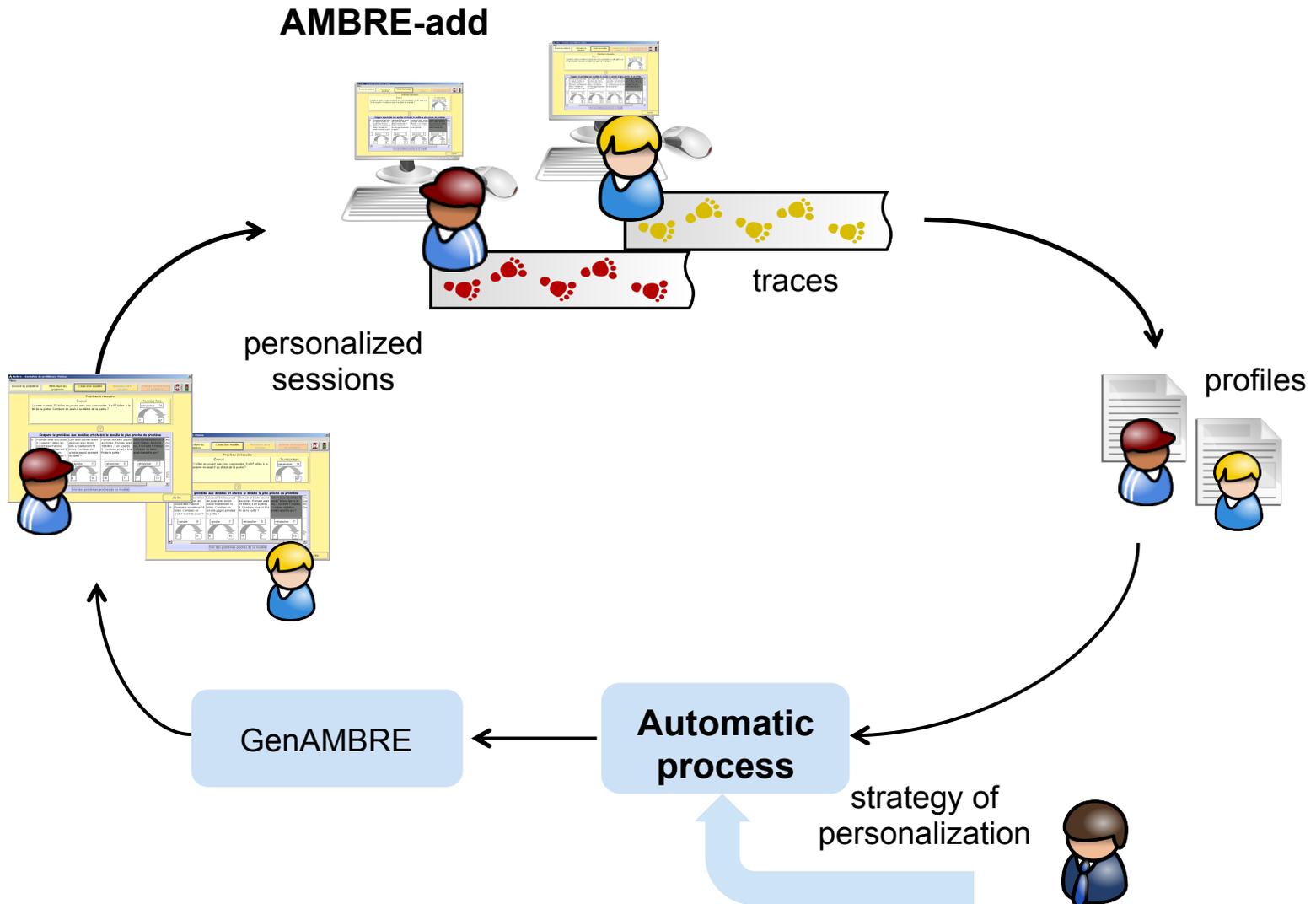
Personalizing AMBRE-add: a very heavy task for the teacher

10



Towards adaptivity

11



Outline

12

- 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

13

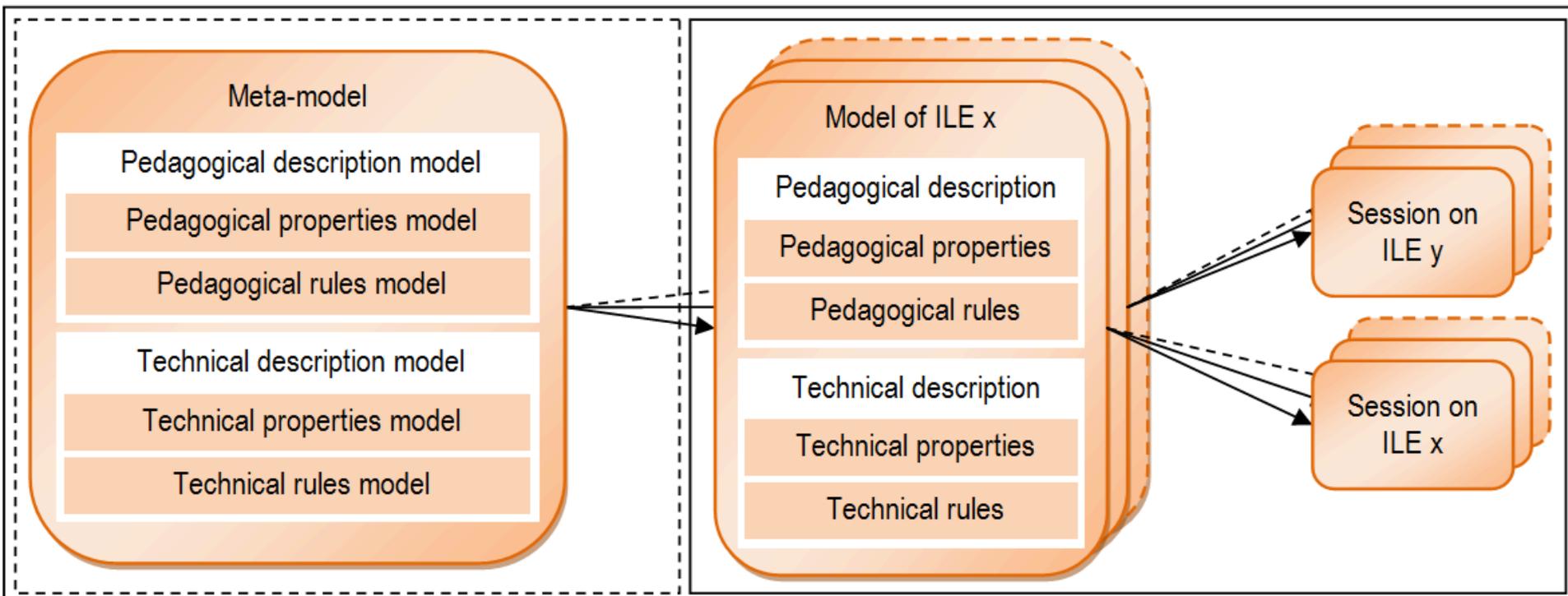
- Tool intended for the teacher
- The user can define personalization strategies
- Can be used to customize external ITS

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

Acquisition of knowledge about the ITS

14

- 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



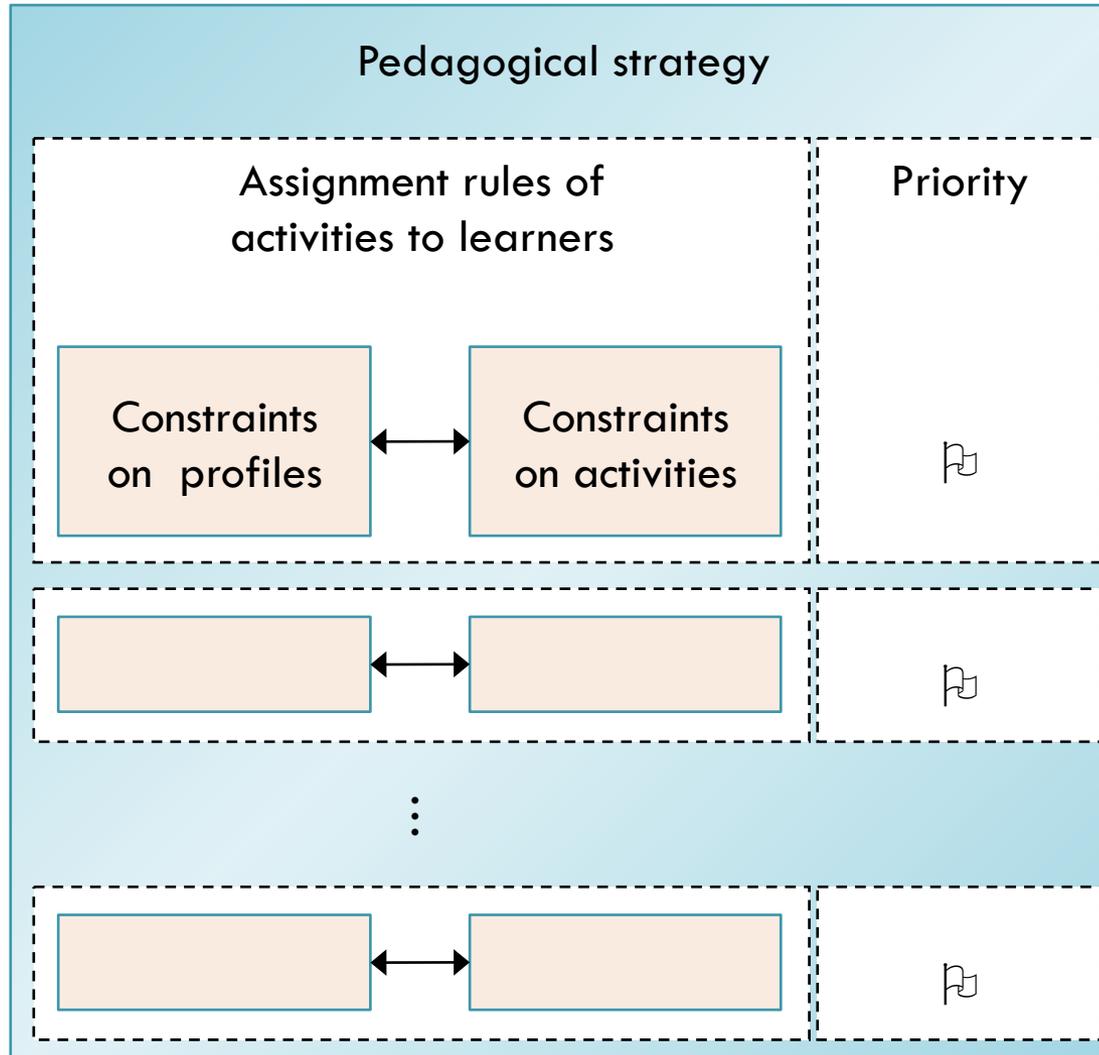
Once Adapte has a model of the ITS

15

- 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

16



What has already been proved

17

- 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*)

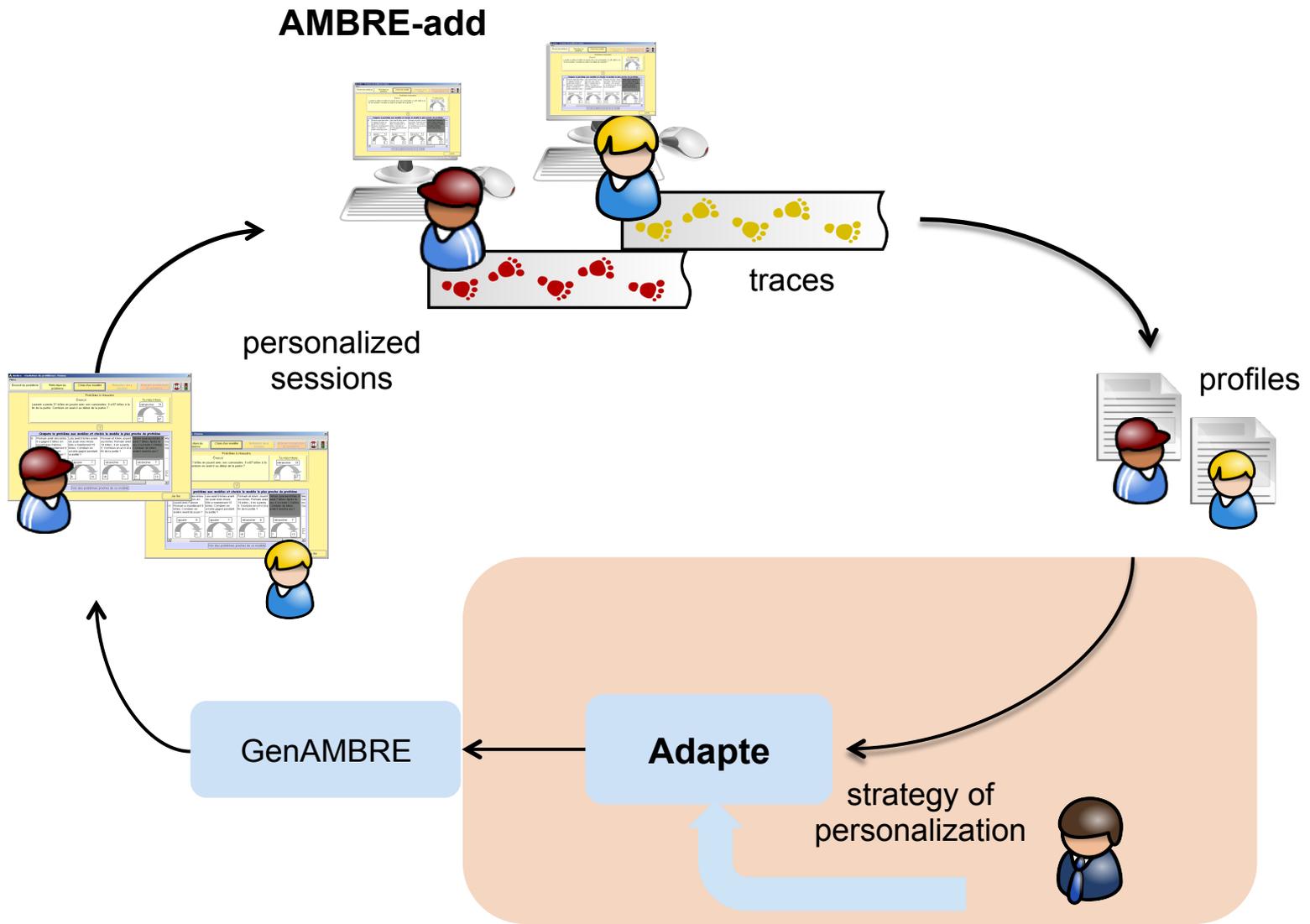
Outline

18

- 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

19



A new context for using Adapte

20

- 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

21

- 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

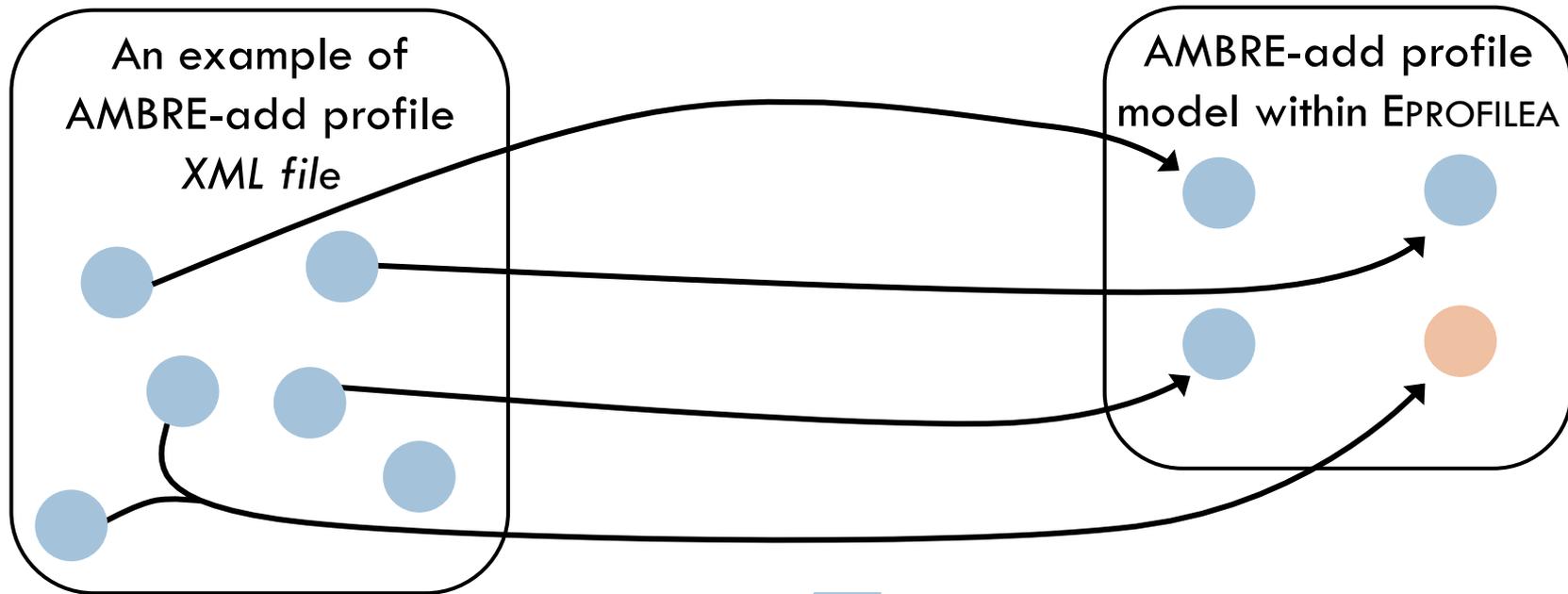
Definition of the profile model

22

- 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

23



+ how to convert values



Definition of the import process

24

Création du Tourbillon

Informations sur le Tourbillon Séparation des fichiers Description des données Création du Tourbillon Vérification du Tourbillon Exécution du Tourbillon

Données du logiciel externe

07	-	3	Jeu			correspondance	dechets-poubelles
07	-	Niveau	1				
15	-	Niveau	2				
17	-	Niveau	1				
48	-	Diagnostic					
coups réussis				2,	nombre	total	de
réussite			40				coups

Parcours des briques de la structure EcoleEte

Parcours des éléments de la brique Tri selectif de type Liste

Information sur la brique :

Date de l'évaluation : Sélection dans le fichier externe

Évaluation source :

Commentaire : Juxtaposition

Information sur lescomposantes : Moyenne Somme

composante : Correspondances dechets-poubelles	
valeur (échelle numérique)	40
composante : Correspondances couleurs-poubelles	
valeur (échelle numérique)	
composante : Chercher l'intrus	

Élément Précédent Titre

 << Brique précédente Brique suivante >> ? Aide

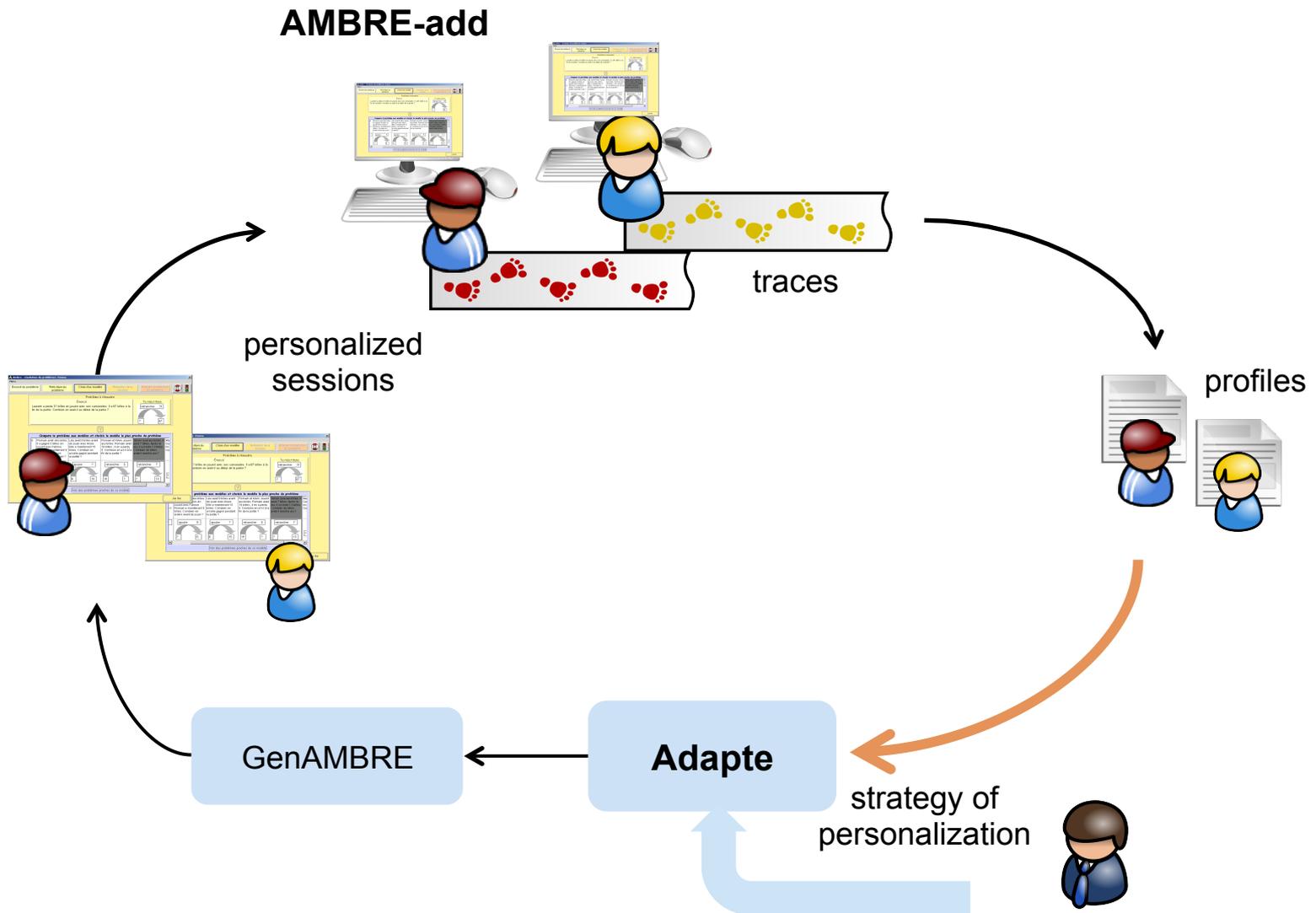
Synthesis on step 1

25

- 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

26



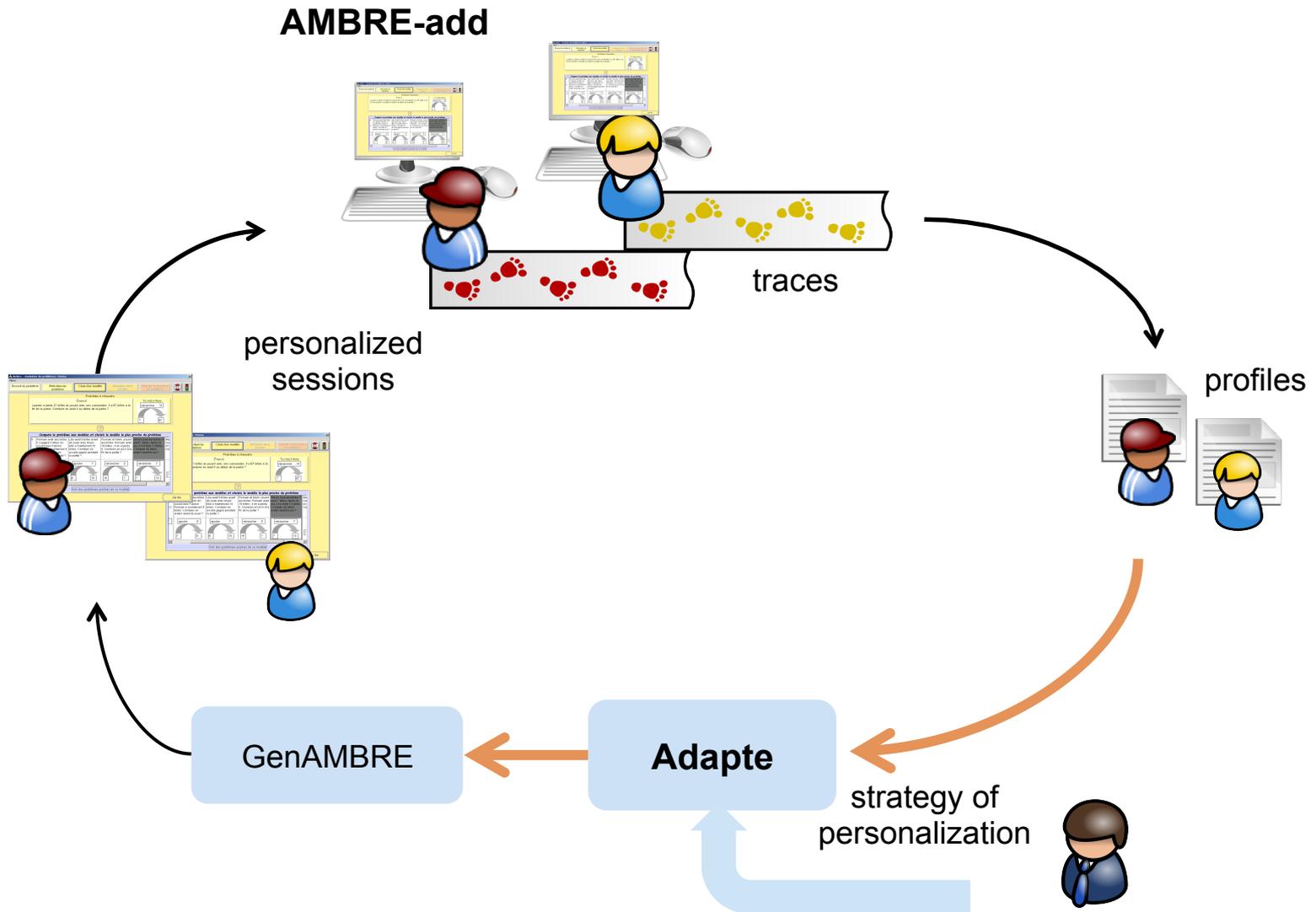
Step 2: defining a model of AMBRE-add

27

- 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

28



Step 3: defining a personalization strategy

29

- 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

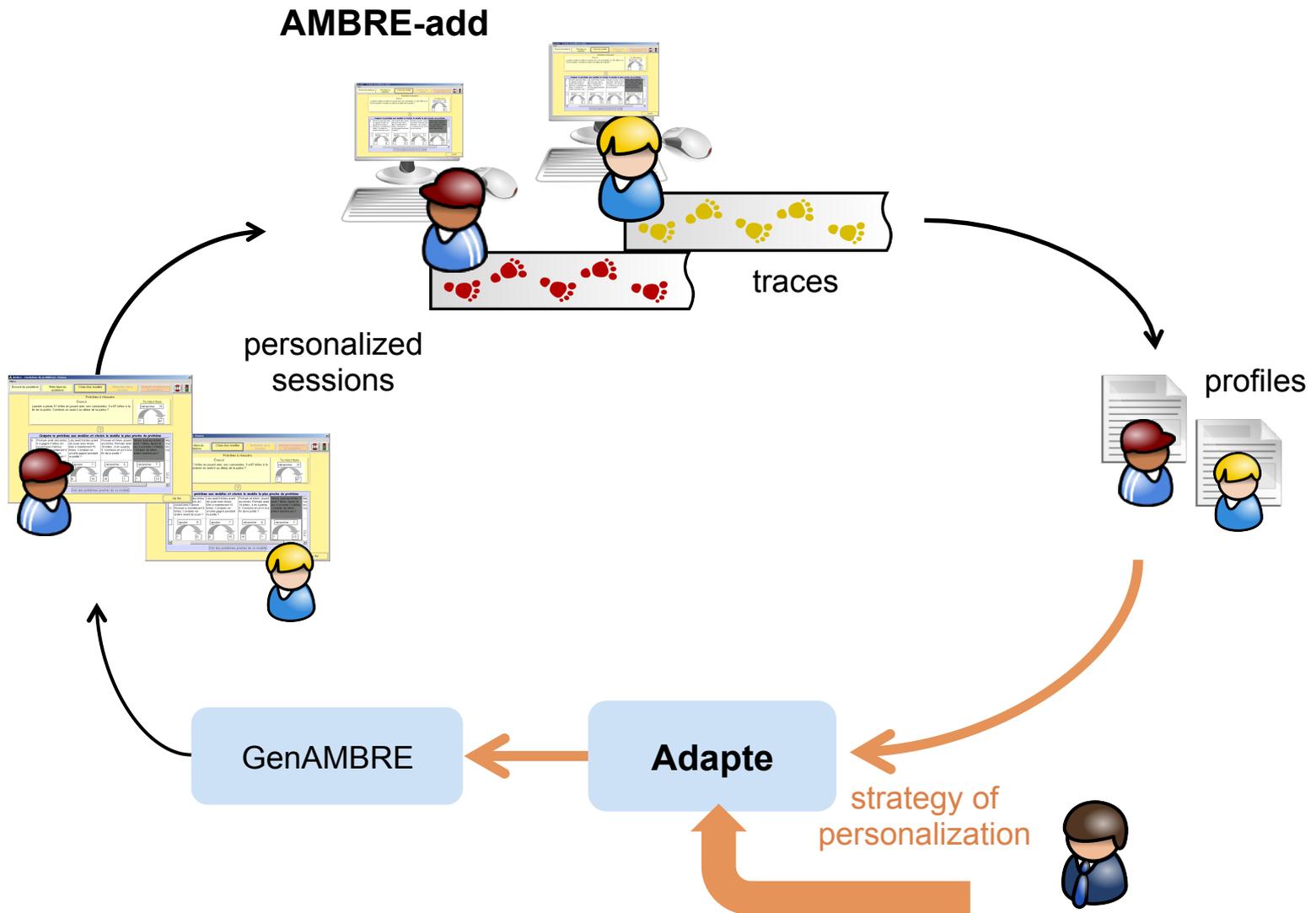
Difficulties when defining the strategy with Adapte

30

- 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

31



Synthesis of the study

32

- 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

33

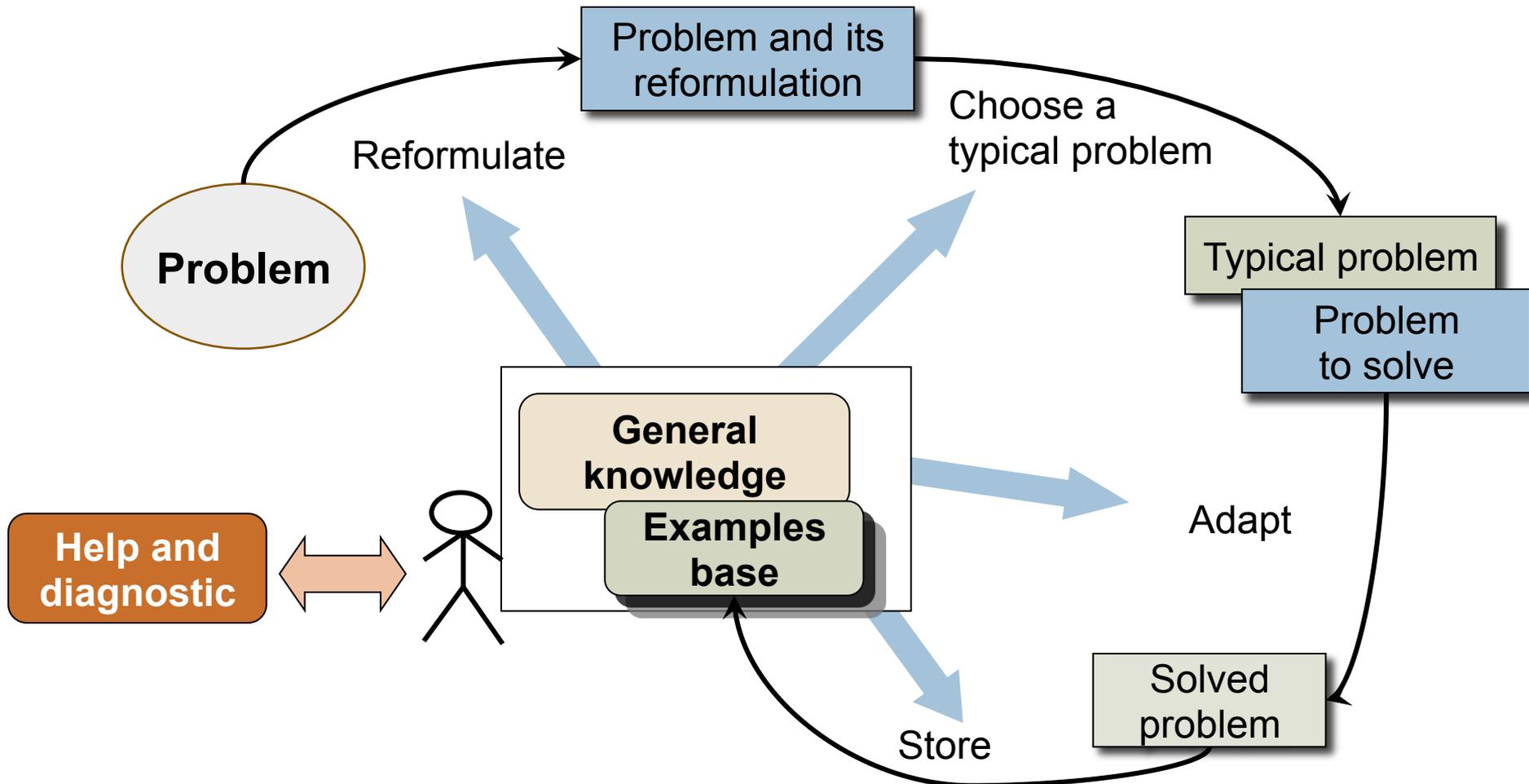
- Conduct experiments using this adaptive version of AMBRE-add
- Does an adaptive version arouses greater satisfaction or interest from students and teachers?
- Does it brings a gain on learning?
- Do the teachers adapt the ITS adaptivity?



FROM A CUSTOMIZABLE ITS TO AN ADAPTIVE ITS

AMBRE cycle

35



Adaptation step

36

Ambre - problem solving : Andy

Menu

Wording of the problem Rewriting of the problem Choice of an example **Writing of a solution** Report of the problem resolution

The example you've chosen

Wording	Rewriting
Alex and Ann played marbles. Alex had 23 marbles before playing. Now, he has 15. How many marbles did Alex lose during the play?	subtract ?  23 15

Writing of the solution

The problem is written: $23 - ? = 15$

The solution is written: $23 - 15 = ?$

The solution is: 8

The answer is: Alex lose 8 marbles

The problem to solve

Wording	Your rewriting
Julia had 17 cookies in her bag. She ate some of them during the break. Now, she has 9 left. How many cookies did Julia eat during the break?	subtract ?  17 9

Writing of the solution

The problem is written: $17 - ? = 9$

The solution is written: $17 - 9 = ?$

The solution is: 8

How to write the problem?

Julia ate 8 cookie(s)

The answer is: Julia ate 8 cookies

I've finished

AMBRE-teacher

37

Génération de problèmes



Quitter Compléments

Structure

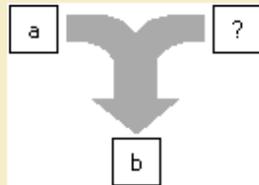
Traits de surface

Valeurs

Complication
automatique

Bilan

Structure



Traits de surface

Thèmes

promenade

Objets

fleur

Personnages

Julie
Damien

Valeurs

Intervalle pour les valeurs :

min : 1

max : 50

Écart entre les valeurs :

min : 0

max : 30

Retenue autorisée

Complication automatique

Complexité du vocabulaire : niveau 2

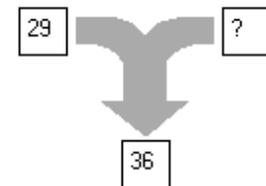
Complexité de la situation : niveau 1

Écriture des nombres en lettres

Ajouter 1 phrases de niveau inférieur ou égal à 3

Aperçu

Il est cinq heures de l'après-midi. Julie a vingt-neuf roses. Julie et Damien ont trente-six fleurs à eux deux. Combien Damien a-t-il de fleurs ?



Le problème s'écrit :

$29 + ? = 36$

L'opération s'écrit :

$36 - 29 = ?$

La solution est :

7

La réponse est :

Damien a 7 fleurs

Enregistrer la trame

Générer les problèmes

<< Aperçu



AMBRE-add profiles

38

```
▼<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_preferé>Jeu</Theme_preferé>
</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 pedagogical rules

39

IF

Value(parameter i_1) = X_1

Value(parameter i_1) \in $\{X_1 .. X_n\}$

Value(parameter i_1) is **undefined**

C_1 **and** C_2 where C_i is a constraint on the value of a parameter

THEN

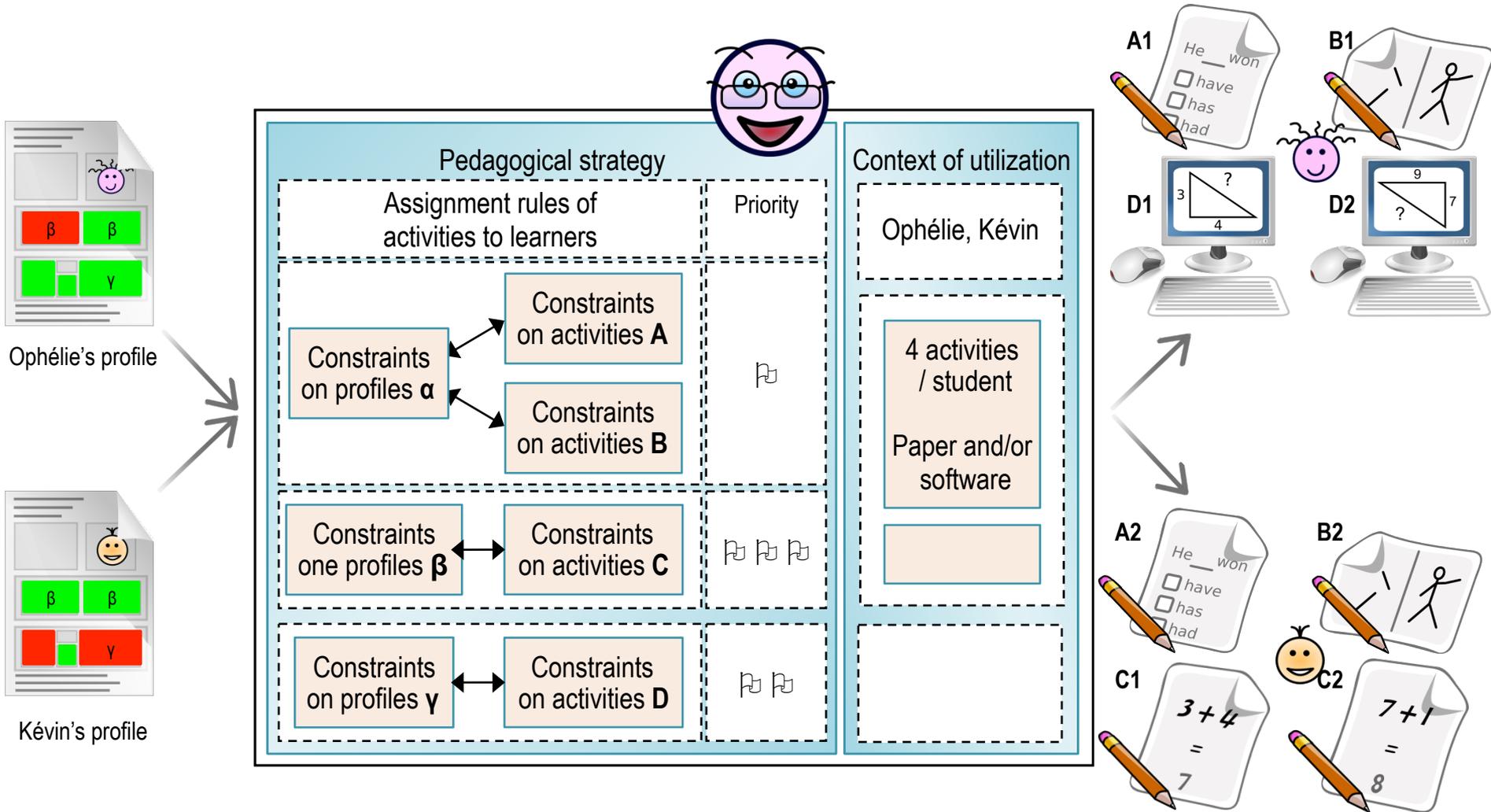
Value(parameter j_1) = Y_1

The parameter j_1 will be **inaccessible**

ValueDomain(parameter j_1) = $\{Y_a .. Y_b\}$ with $a \geq m$ et $b \leq n$, where m and n are initial bound

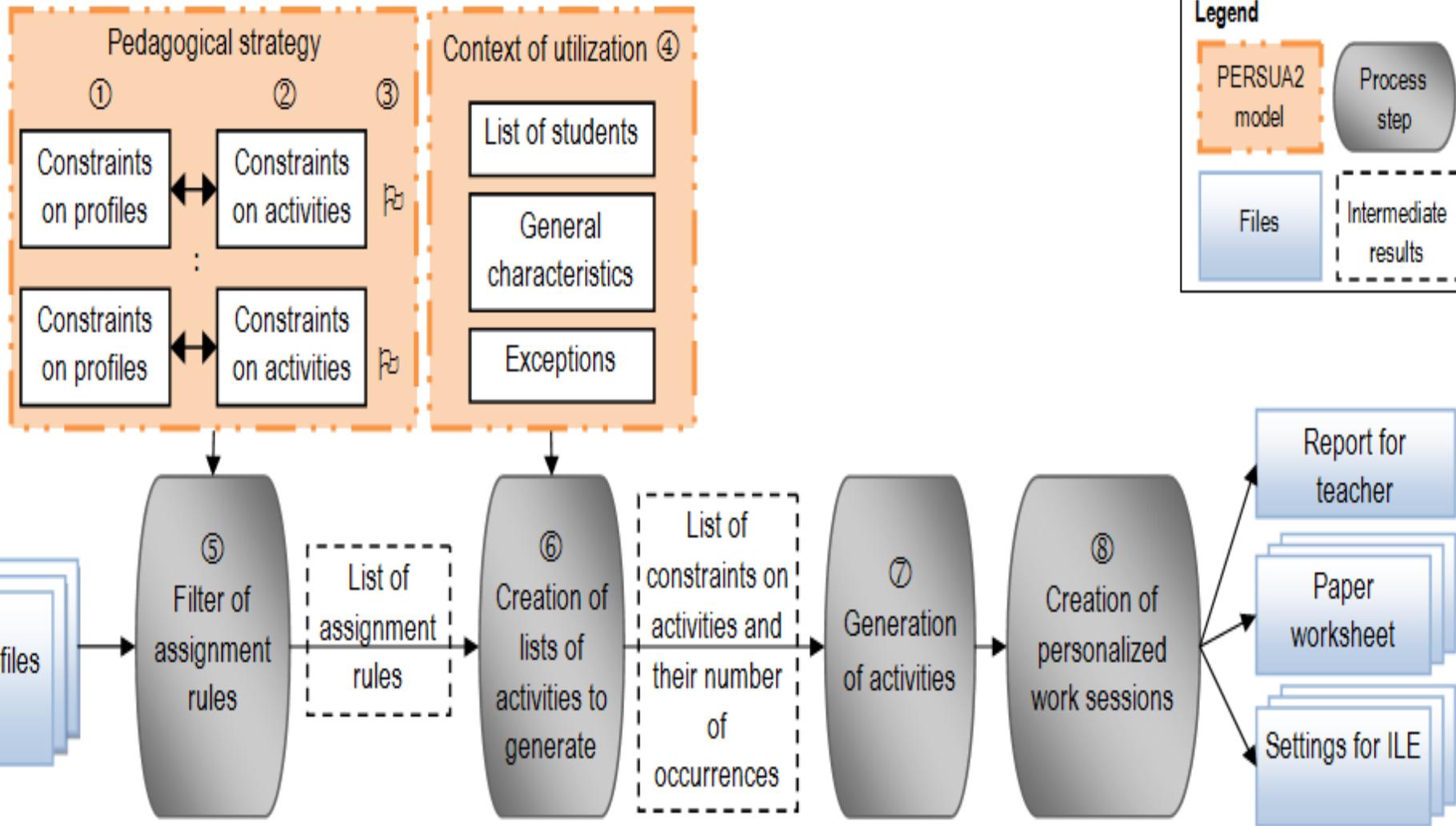
C_1 **and** C_2 where C_i is a constraint on the value or on the value domain of a parameter

Illustration of the personalization



Personalization process

41



Bâtitseur - AMBRE

42

The image shows a software interface for 'Bâtitseur' with a background of a construction site. On the left, a red sign reads 'PERMIS DE CONSTRUIRE' and contains the following information:

- Propriétaire:
- Nature des travaux:
- Nom de la structure:
- Date de dernière modification:

Below the sign is a yellow triangular warning sign with a black silhouette of a worker digging. A small white box below it says 'Types de briques disponibles'. In the foreground, there is a stack of red bricks and a white shovel.

On the right, a dialog box titled 'Brique de type Liste' is open. It contains the following fields and options:

- Nom de la brique:
- Les informations pour cette brique proviennent d'un logiciel (fichiers externes)
- Commentaires**
 - pour la brique
 - pour chaque composante
 - pour chaque sous-composante
- Valeurs**
 - Nombre de valeurs à renseigner pour chaque élément:
 - Échelle de la valeur 1: Préciser l'unité
 - Pondérer les composantes
- Composantes**
 - Nom:
 - Poids:
 - Ajouter comme:
 -
- Tree view:
 - En général
 - Dans les cas difficiles
 - Avec retenue
 - Avec des grands nombres

At the bottom of the dialog are buttons for 'OK', 'Annuler', and 'Aide'.

At the bottom of the screen, there are several buttons: 'Comportement', 'Infos de l'enseignant', 'Sait résoudre le problème', 'Sait calculer', and 'Sait reformuler'. The 'Sait calculer' button is highlighted in red.

Text labels at the bottom left: 'Répartition' (green), 'Graphe' (yellow), 'Commentaires' (red), and 'Liste' (red).

Defining the pedagogical properties

43

Définition des propriétés pédagogiques du modèle OKEP/Abalect

Propriétés pédagogiques Règles pédagogiques Propriétés techniques Règles techniques

Contenu pédagogique Organisation pédagogique Fonctionnalités globales Rétroactions globales Interface globale

Liste des activités existantes :

- A001 Exercice

Liste des paramètres :

- P001 Niveau
- P002 Titre du texte
- P003 Type d'exercice
- P004 Nom de l'exercice

Liste des fonctionnalités :

Liste des rétroactions :

Liste des paramètres :

Définition d'un paramètre

Nom du paramètre : Niveau Identifiant : P001

Vous pouvez indiquer les compétences associées à ce paramètre (indiquez une compétence par ligne).

Classe de l'élève

Type d'échelle : Liste énumérée

La taille de la liste est variable : vrai faux

La liste est ordonnée : vrai faux

Valeurs :

Nom :

Compétence(s) associée(s) : → CP, CE1, CE2, CM1

Vous pouvez indiquer la catégorie, voir les sous-catégories, associées à ce paramètre (indiquez une catégorie par ligne).

Choix du texte

Annuler Valider

Aide Annuler << Étape précédente Étape suivante >>

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>
  <Name>calcul</Name>
```

Pedagogical rules of AMBRE-add

45

```
▼<PedagogicalRules NameOfILE="AMBRE-add">
  ▼<Rule ID="R1">
    ▼<Condition>
      ▼<Parameter ID="P002" TypeOfCondition="Value">
        <Number Max="1" Min="1"/>
      </Parameter>
    </Condition>
    ▼<Conclusion>
      ▼<Parameter ID="P001" TypeOfConclusion="Value">
        <Value>reunion_r</Value>
        <Value>retranche</Value>
        <Value>ajouter_r</Value>
      </Parameter>
    </Conclusion>
  </Rule>
  ▼<Rule ID="R2">
    ▼<Condition>
      ▼<Parameter ID="P001" TypeOfCondition="Value">
        <Number Max="1" Min="1"/>
      </Parameter>
    </Condition>
    ▼<Conclusion>
      ▼<Parameter ID="P004" TypeOfConclusion="Value">
        <Value>faux</Value>
      </Parameter>
      ▼<Parameter ID="P008" TypeOfConclusion="Value">
        <UpperBound>30</UpperBound>
        <LowerBound>1</LowerBound>
      </Parameter>
    </Conclusion>
  </Rule>
  ▼<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

46

Définition de la stratégie pédagogique

Fichier Edition Outils Langue Paramètres Aide

Structure de profils "Récit subjectif" se trouvant : ".\Fichiers utilisateur\Strategie pedagogique\Récit subjectif.str"

Détail de la brique Liste : "Conjugaison"

- passé simple de l'indicatif
 - 1er groupe
 - 2ème groupe
 - 3ème groupe

Mur de briques de la structure

Ecriture récit subjectif

Orthographe Conjugaison

les valeurs des présents les différents "je" Plan du texte

Liste des contraintes

Id	Élément du profil	Opération	Valeurs concernées
C1	Orthographe > Accords des participes pas		[0.. 5]
C2	Orthographe > Accords des participes pas		[5.. 7]
C3	Plan du texte > Les changements de tem		[maîtrisé]
C4	Plan du texte > Les changements de tem		[maîtrisé, partielleme
C5	Plan du texte > Les changements de tem		[non maîtrisé]
C6	Conjugaison > passé simple de l'indicatif	moyenne	[non maîtrisé]
C7	Conjugaison > passé simple de l'indicatif	moyenne	[maîtrisé]

Définir une nouvelle contrainte...

Nouvelle règle

Nom: Non maitrise PP avoir Priorité: normal

SI: C1 ou C2 Pour tous les élèves

ALORS: Associer les structures d'activités...
F157_Conjugaison_PP_Avoir.TAB

SINON: Associer les structures d'activités...

Annuler la règle Valider la règle

Aide Retour au menu principal << Étape précédente Étape suivante >>