Bringing Learning to the Workplace

Competence and Performance in Requirements Engineering

aposdle – New ways ...
... to work, learn and collaborate

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Overview

- The Context: Work-integrated Learning in APOSDELE
- The Learning Domain: Requirements Engineering
- Our Approach: Competence Performance Approach & Modelling Methodology
- Results of the Modelling
- Three Scenarios for Supporting Work-integrated Learning
- Summary and Future Work
APOSDE in Overview

- Action Line: IST FP6
- Unit: Technology Enhanced Learning (TEL)
- Project Number: IST-027023
- Duration: March 2006 – February 2010 (48 months)
- Budget: 12.930 k€ (7.650 k€ funding European Union)
- Partner: 12 Organizations

APOSDE Partners

Coordinators
- Joanneum Research
- Know-Center

Research Partners
- City University
- University of Twente
- Fraunhofer IPSI
- ITC-IRST

Technology Partners
- SAP
- TU Graz

Application Partners
- EADS CCR
- IHK Darmstadt
- ComNetMedia
- isn – innovation service network
APOSdle: Work-integrated Learning

- **Gaining Insights**
  - How do knowledge workers work and learn?
  - What could work integrated learning support look like?

- **Supporting the knowledge worker**
  - **Work** - Getting the task at hand done fast
  - **Learn** - Improve competences to get new tasks done
  - **Collaborate** - Help others to get their tasks done

The APOSdle sidebar: Resources
Three Models for Work-integrated Learning

- **Domain**
  - Ontology of domain concepts and relations

- **Task**
  - Model of tasks and dependencies

- **Competency**
  - Competence Performance Model
  - Connection of tasks and competencies needed

RESCUE: The Learning Domain

- “Requirements Engineering” as the learning domain for the first prototype
- RESCUE - Requirements Engineering with Scenarios in User-Centered Environments (Maiden & Jones, 2004)
- An APOSDEL learning environment for requirements engineers
The RESCUE process
(Maiden & Jones, 2004)

The What & Why of Competencies

- **What**
  - Competencies are human characteristics (especially knowledge and skills) that allow someone to perform well in a number of specific situations.
  - To be differentiated from (task) performance which is a result of the combination of competencies in a concrete situation.

- **Why**
  - Competencies explain the reasons for good/poor task performance and give a better link to learning.
  - Competencies may be formalized as factual, conceptual and procedural knowledge, and provide a direct link to *learning goals*.
  - Competencies reduce complexity as one competency should be applicable to many tasks, i.e.: $N_{\text{competencies}} < N_{\text{tasks}}$
Our Approach: The Competence Performance Framework

- General Competence Performance Framework in cognitive psychology (Korossy 1997, 1999)
- Application to Competency Management (Ley & Albert, 2003; Ley, 2006)
- Competence Performance Modelling of the RESCUE process as part of the APOSDLE project (March-August 2006)

Competence & Performance in RESCUE: Modelling Method

1. Eliciting Tasks
   - Content analysis of RESCUE documentation (Focus: Human Activity Modelling, System Goal Modelling)
   - Validating the first list of tasks by RESCUE experts

2. Eliciting Competencies
   - Analyzing RESCUE documentation
   - Analyzing existing competency catalogues
   - Eliciting "competencies needed" from RESCUE experts (interview)
   - First harmonization of the list with RESCUE experts and

3. Task Competency Matrix
   - Both RESCUE experts judge which of the tasks needs which competency
Competence & Performance in RESCUE: Modelling Results

- **List of Tasks**
  - HAM (29), SGM (18)

- **List of Competencies**
  - Knowledge (20), Skills (14)

- following is an illustrative example ...

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<thead>
<tr>
<th>Tasks</th>
<th>Task-Competency Assignment</th>
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</thead>
<tbody>
<tr>
<td>3.1</td>
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<tr>
<td>4.2</td>
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<tr>
<td>4.3</td>
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<td>5.4</td>
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<td>5.5</td>
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<tr>
<th>Tasks</th>
<th>3</th>
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<th>13</th>
<th>15</th>
<th>16</th>
<th>20</th>
<th>Minimal Interpretations</th>
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<td></td>
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<tr>
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<td>(13, 15, 20)</td>
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<td>(13, 15, 16)</td>
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<tr>
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<td></td>
<td>(13, 15, 16)</td>
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</tbody>
</table>

Task Competency Assignment provides the basis for:

3. Competence Performance Structure (see slide #16)
4. Prerequisite Relation on the set of competencies (see slide #17)
Competence Performance Structure
(SGM Example)

Prerequisite Relation for SGM Competencies
Three Scenarios for Supporting Work-integrated Learning

1. Updating the User Profile from Performed Tasks
2. Suggesting Resources for Learning from a Competency Gap Analysis
3. Validating the Models

Scenario 1: creating a competency profile from performed tasks

Information on Task Performance
- + 5.1 5.2
- - 4.3 5.3 5.4

Diagnose Competence State
- \{ 13, 15 \}
Scenario 2: retrieving content for a competence gap (1)

If the goal is to perform a task

→ suggest sequence of competencies to learn

- 5.3 → {20}
- 5.4 → {16}
- 4.3 → {20} or {16}, {3}

Scenario 2: retrieving content for a competence gap (2)

- **Invoking a learning template**
  - Competency {20} Ability to produce i*model
  - Connected to knowledge type procedural learning
  - Invokes a learning template for “Learning by Example”

- **Retrieving Content from existing documents**
  - Learning Template looks for Material Use “Example” and “Procedure”
  - Domain Concepts: i*model
Scenario 3: Validating Models with the “Leave One Out” Method

- Task performance information (successful vs. not successful) is available for a subset $t_1 \ldots t_n$ of the tasks
- Apply “leave one out” cross validation procedure
  1. take out one task ($t_i$) [$i=1 \ldots n$] for which performance information is available
  2. construct a competence performance structure from other n-1 tasks
  3. From this structure, predict whether $t_i$ is performed successfully
  4. Compare prediction to actual performance in $t_i$
  5. Increase $i=i+1$ and go to step 1
- Relate correct to incorrect predictions (e.g. by using $\tau_b$)

Results for “leave one out” cross validation procedure

<table>
<thead>
<tr>
<th>$\tau_b$</th>
<th>Competence-Performance Structure (Prediction) $^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notional Solution Patterns (Assessment) $^b$</td>
<td>Expert 1</td>
</tr>
<tr>
<td>Activity Modelling $^c$</td>
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<tr>
<td>Expert 1</td>
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<tr>
<td>Expert 2</td>
<td>$0.45^{**}$</td>
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<tr>
<td>System Goal Modelling</td>
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<tr>
<td>Expert 1 $^e$</td>
<td>$0.54^{**}$</td>
</tr>
<tr>
<td>Expert 2</td>
<td>$0.32^{**}$</td>
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Summary: Why we suggest the Competence Performance Approach

- Provides close connection of learning to task performance in the workplace
- Derives dependencies on competencies without need to model them explicitly
- Expertise is not modelled linearly, but there are a number of ways to learn
- Formal model allows for validation in the process of modelling, or in the process of operation

Thank You!

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