

# A Conceptual Framework for Collaborative Learning Systems Based on Agent Technologies

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- 1 About Existing e-Learning Platforms
- 2 Toward a Conceptual Framework
- 3 Case Study
- 4 Conclusion and Future Work
- 5 Acknowledgements
- 6 Bibliography



# Outline

1 About Existing e-Learning Platforms

2 Toward a Conceptual Framework

3 Case Study

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# About Existing e-Learning Platforms I

- Some useful remarks about existing distance learning platforms can be drawn from [Dimitracopoulou, 2005, Van der Pol et al., 2008, Mühlpford and Stahl, 2007, The 1st Report of Minerva-RESET Project, 2007]
- Platforms often provide collaboration tools that:
  - ▶ are **juxtaposed** and **not truly integrated** with one another
    - Collaborating people are exposed to a series of problems coming from the visually and functionally separate nature of such tools [Dimitracopoulou, 2005, Mühlpford and Stahl, 2007]
    - Several results have shown the advantage of using integrated collaboration tools [Mühlpford and Stahl, 2007, Van der Pol et al., 2008]



# About Existing e-Learning Platforms II

- Moreover:

- ▶ provide statistical data related to on-line social interactions of students, but often they not provide an **automatic analysis of such interactions**  
→ Teachers are subject to an added overhead to make an analysis of such data
- ▶ do not lie on top of a **suitable conceptual framework**  
→ Difficult to exploit such collaboration tools altogether in a coherent and effective way



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# What is needed

- A **conceptual framework** aimed at designing integrated tools for
  - ▶ supporting collaborative activities
  - ▶ monitoring collaborative learning, in order to automatically **analyse social interactions** and **give feedbacks** to students and teachers



# Multi-Agent Systems (MAS)

- MAS is a set of autonomous, pro-active, and interacting computational entities called **agents**...
- ...situated in an **environment** where they interact typically producing a coherent global behaviour [Omicini and Poggi, 2006]
- In literature, MAS has been proven to be **suitable** for dealing with the **engineering** of complex software systems [Jennings, 2001] like **distance learning systems**...
- ...which are, by definition, interaction-oriented, distributed, dynamic, and open



# Agents & Artefacts (A&A) Meta-model

- Meta-model for MAS engineering [Omicini et al., 2008]
- Takes inspiration from **Activity Theory** and **Distributed Cognition**
  - ▶ **artefacts** enable and constrain agent actions, mediate agent interactions with other agents and with the environment
  - ▶ cognition and knowledge representation does not belong to agents only, but artefacts encapsulate knowledge too



# A&A as a Conceptual Framework for Distance CL Systems

- A&A seems to be a suitable conceptual framework for supporting the development of MAS-based collaboration environments
- By means of the A&A abstractions a designer could design mediation instruments for human collaborative activities. In particular
  - ▶ **artefact** abstraction makes it possible to design the reactive part of mediation instruments, in terms of the operations provided to users
  - ▶ **agent** abstraction makes it possible to design the pro-active part of mediation instruments, for example in order to automatically monitor and analyse human social interactions and give feedbacks to students and teachers



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# Moodle Platform as Case Study

- Moodle is a wide-used, open-source, Web-based platform in e-learning
- Presents the previous mentioned limits
  - ▶ Provides several collaboration tools that are physically and functionally dissociated
  - ▶ Allows to access statistical data related to on-line social interactions of students, but does not provide any tool for automatic analysis of such interactions
- Do not lie on top of a suitable conceptual framework that allows to overcome such limits



# Moodle Design Abstractions vs. A&A Meta-model I

- Moodle realizes collaboration tools in terms of **Web pages**
- A collaboration tool can be seen as a **service** that provides a set of functionalities
- → it is difficult to explicitly represent concepts that describe a service.  
In particular
  - ▶ **service interface**, which is set of functionalities provided by the tool
  - ▶ **service behaviour**, i.e. how the service implements the provided functionalities



# Moodle Design Abstractions vs. A&A Meta-model II

- An A&A **artefact** it is defined in terms of
  - ▶ **user interface**, by which an artefact can act for a specific purpose, i.e. the set of operations provided by an artefact
  - ▶ **structure and behaviour**, representing how the artefact is implemented in order to provide its function
- → A&A artefact allows to explicitly model any collaboration tool



# Moodle Design Abstractions vs. A&A Meta-model III

- In order to automatically monitor social interactions, entities able to observe in a proactive way are suitable
- **Web page** does not represent a viable abstraction to explicitly model the aforementioned entities
- A&A provides the **agent** abstraction that can exploit artefact properties, in particular **inspectability**, in order to observe student social interactions at runtime and to automatically
  - ▶ analyze such interactions
  - ▶ give feedbacks to students and teachers



# Chat & Wiki Integrated

Questo wiki è utilizzato dagli studenti per creare in modo collaborativo una relazione di gruppo

View Edit Links History Attachments

Thank you for your contribution.

## Tesina

### Metodologia di lavoro, obiettivi e tempi di sviluppo

**1) Obiettivi**

Studiare come i principali negozi di informatica si relazionano con il Web.

1. Generare valore aggiunto per i propri clienti (tipicamente consumatori finali).
2. Realizzare una gestione efficiente dell'innovazione tecnologica.

Analizzare i dati rilevati dall'analisi dei principali siti Web di informatica: ad esempio Computer Discount, Essedi, Vobis, etc.

Trarre considerazioni in merito ai dati analizzati: che valore aggiunto hanno del Web i rivenditori esaminati come strumento per generare un valore aggiunto.

### Related Messages

## Chat del Corso

**Monday, 25th August 2008, 22:03** Mike Green: Penso che il primo obiettivo sia quello di studiare come i principali negozi di informatica si relazionano con il Web. In particolare per: 1) Generare valore aggiunto per i propri clienti; 2) Realizzare una gestione efficiente dell'innovazione da un punto di vista tecnologico

**Monday, 25th August 2008, 22:04** Fiona Nixon: ok, allora come seconda cosa dovremo analizzare i dati rilevati dall'analisi dei principali siti Web dei rivenditori di informatica.

### Participants

 Fiona Nixon ide 1 min 11 secs  Mike Green ide 45 secs

### Send message

☐ Show only new

### Messages

21:03 Fiona: ok, allora come seconda cosa dovremo analizzare i dati rilevati dall'analisi dei principali siti Web dei rivenditori di informatica

21:03 Mike: sì, ad esempio possiamo considerare Computer Discount, Essedi, Vobis, etc.

21:02 Mike: Penso che il primo obiettivo sia quello di studiare come i principali negozi di informatica si relazionano con il Web. In particolare per: 1) Generare valore aggiunto per i propri clienti; 2) Realizzare una gestione efficiente dell'innovazione da un punto di vista tecnologico



## Forum Analysis

comandi shell che non funzionano!  
 Fiona 25 Agosto 2008

ciao a tutti io uso perSeO (boot da DVD)

Nonostante i miei tentativi ho notato che non funzionano i metacaratteri []

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 Il t  
 Qu

| Selection                | Group    | Learner        | Active Participation (*) | Inctive Participation (*) | Centrality |
|--------------------------|----------|----------------|--------------------------|---------------------------|------------|
| <input type="checkbox"/> | Gruppo 1 | Fiona Nixon    | 4 (3)                    | 4 (3)                     | 0.0        |
| <input type="checkbox"/> | Gruppo 1 | Mike Green     | 4 (4)                    | 4 (4)                     | 0.0        |
| <input type="checkbox"/> | Gruppo 1 | Ronald Winters | 3 (2)                    | 3 (2)                     | 0.0        |
| <input type="checkbox"/> | Gruppo 1 | Jonny Welsh    | 3 (3)                    | 3 (3)                     | 0.0        |
| <input type="checkbox"/> | Gruppo 1 | Ronald Winters | 3 (2)                    | 3 (2)                     | 0.0        |
| <input type="checkbox"/> | Gruppo 2 | E              |                          |                           | 0.0        |
| <input type="checkbox"/> | Gruppo 2 | C              |                          |                           | 0.0        |
| <input type="checkbox"/> | Gruppo 2 | P              |                          |                           | 0.0        |

o del tipo:  
 i, i quali  
 o | Cancella | Rispondi

(\*) For active and inactive participation much less than others) and 4 (highest – 4 buckets), and it is between 1 (lowest –

Send the following message to all selected learners:

Send the Message

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# Conclusion and Future Work

- Distance learning lack of a **conceptual framework** aimed at designing integrated tools for
  - ▶ supporting collaboration activities
  - ▶ monitoring collaborative learning, in order to **automatic analyse** social interactions and **give feedbacks** to students and teacher
- As shown through a comparison with Moodle design abstractions, MAS, in particular A&A meta-model, seems a suitable conceptual framework to design collaboration tools overcoming the previous mentioned limits
- In our future work, we will:
  - ▶ analyze other e-learning platforms
  - ▶ develop a completely new A&A-based framework for supporting collaborative systems



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# Acknowledgements

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*This work reflects the views only of the authors, and the Commission can not be held responsible for any use which be made of the information contained therein.*



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# Bibliography I



Dimitracopoulou, A. (2005).

Designing collaborative learning systems: current trends & future research agenda.

*In the 2005 International Conference in Computer Supported Collaborative Learning (CSCL 2005), Taipei, Taiwan, May-June 2005.*



Jennings, N. R. (2001).

Building complex software systems: The case for an agent-based approach.

*Communications of the ACM, Forthcoming, 44:12–23.*



Mühlpford, M. and Stahl, G. (2007).

The integration of synchronous communication across dual interaction spaces.

*In the 2007 International Conference in Computer Supported Collaborative Learning (CSCL 2007), New Brunswick, New Jersey, USA, July 2007.*



# Bibliography II



Omicini, A. and Poggi, A. (2006).

Multiagent systems.

*Intelligenza Artificiale*, III(1-2):76–83.

Special Issue: The First 50 Years of Artificial Intelligence.



Omicini, A., Ricci, A., and Viroli, M. (2008).

Artifacts in the A&A meta-model for multi-agent systems.

*Autonomous Agents and Multi-Agent Systems*, 17(3).

Special Issue on Foundations, Advanced Topics and Industrial Perspectives of Multi-Agent Systems.



The 1st Report of Minerva-RESET Project (2007).

Promoting good practice: Lessons from a collection of european elearning experiences.

Technical Report 1.



# Bibliography III



Van der Pol, J., Admiraal, W., and Simons, P. (2008).

The affordance of anchored discussion for the collaborative processing of academic texts.

*The International Journal of Computer-Supported Collaborative Learning*, 4(3):339–357.



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