Giving that to design an efficient e-learning environment, in addition to contents and technological infrastructure, it is necessary to focus on tutoring strategies; in this paper the analysis focus on the use of intelligent agents to support e-tutor activities. The idea is to allow on line tutoring activities, flexible and available 24 hours 24, through the use of an Intelligent Tutor Agent that permit a natural language communication between the learner and the agent. In particular, it is described an open source software, still in its developing phase, called TutorBot, that can be integrated in any e-learning platform. The learner, in his own natural language, “converse” with the agent to retrieve educational contents and to be helped, just as it happen within real context when we interact with human tutors. Another main aspect is the integration of TutorBot within an Adaptive Search Engine (ASE) that makes possible to search for the answers, to be given to learners, on external resources, for example Google. Thanks to these adaptive features, ASE allows to customize the contents according to the user profile. In order to asses the effectiveness of the intelligent agent it was carried on a study on a sample of university students aimed to detect the strong or weak points of the system and its overall satisfaction.

KEYWORDS: Intelligent Tutoring System; AIML; e-Learning; Artificial Intelligence; Collaborative learning.
Introduction

It is clear that nowadays the educational activity it is subjected to several transformation because of the massive presence of IT within daily social and professional routine, including the different ways of CMC, that is a technical and cultural tool that works as a filter between face to face communication and distance communication, overthrowing space/time dimensions.

The evolution and spread of currently technologies critically contributed to the experimentation and to the theoretical and practical arrangement of new educational models, not only within typical formal environments (Schools and universities) but also within Companies and Public Administration, where it is necessary a continuous and permanent updating (life-long learning).

So it triggers a virtuous circle where technological innovation favor the rising of new educational models and, since the evolve, require further technological improvements (Rivoltella, 2003). ITC potentiality completely changed the way educational contents are delivered, thereby also changing the process students use to acquire and manage knowledge (Knowledge Management – KM), according to the new model of complex society, focused on information (Information society) (Baldi, 2001) and on knowledge (Knowledge society).

Within this scenario the same meaning of education must be revised according both to technological development and socio-constructivist orientation models (Galliani, 2004), so that the “technology” does not prevail on pedagogical values of education, but must be considered one of the tools that can allow the achievement of educational objectives (Calvani, 2004). It is perfectly clear that within the current knowledge and complex society, education cannot be bounded to mere information and contents transmission but needs to give students methods and tools in order to promote cognitive autonomy and flexibility (Piu, 2006); the key word of this prospective are “teaching to learn” and “learning to learn”. Technologies are requested to support such new needs. The teacher role undertakes new features, very different form the past. The latest need to be revised according to role and function of the tutor: teachers and tutors became facilitators, mediators and didactics managers, not only knowledge and information suppliers.

Starting from these premises, in order to better meet the demands and requirements set above, more and more use of online learning environments is made or, even better, of typical e-Learning tools. Overtime, the e-Learning has taken several features that should not be considered only as a new way of distance content delivery, but also as innovative tools that enable and stimulate the achievement of high level of engagement and interaction among the actors of the teaching-learning process, in which come together pedagogical and IT skills (Falcinelli, 2005). All that allows to put the learner in the center of the teaching-learning process, giving him an active and responsible role and, moreover, a set of tools to develop basic logical skills, to improve memory, knowledge and to self-evaluate what he acquired.

Within e-Learning processes, among the different resources used, particular attention must be given to the human element, that is central to the educational activity, and also to supporting technological devices and activities in order to grant high qualitative levels that enables the triggering of social and collaborative learning forms (Calvani, 2005). From this point of view, it is the new approaches...
to the use of the web that, according to them, enable the use of simple tools and social software. Thanks to these and to the possibility of acquiring information within informal contexts and thanks to the shared use and construction of knowledge, it is started a new teaching-learning model: the second generation e-Learning (or 2.0) (Bonaiuti, 2007), where technologies are more and more considered as “Educational Communication Technologies” (Galliani et al., 2000; Galliani, 2009; De Pietro, 2008). e-Learning 2.0 represents the distance learning of the “digital generation” (Celentano & Colazzo, 2008); its main features are of enabling high levels of spontaneity and informality and of placing learners in the middle of the learning process, more and more participative, collaborative ad interactive.

From this point of view, an e-Learning system is defined as a specific informative system web based, known as WIS (Web based Information System) (De Pietro, 2009; Shouhong, 2001; Kambil & Ginsburg, 1998), that allows to classify, memorize, manage and distribute educational contents, where synergy between human resources and technologies is fundamental and peculiar: in this case it is known as WIS-Learning. As has become evident through the time, e-Learning has changed its properties, moving from simple system of distance delivery of educational content to a system that enables both learners and Team teaching (teachers and tutors) to achieve high levels of engagement and interaction and to have new devices to manage learning objects and to monitor and assist the learning process, hence the new paradigm used today, WIS-Learning (De Pietro, 2009).

In line with what has just been stated and while paying considerable attention to the optimal management of knowledge within an e-Learning platform, for some years now, the interests and the studies of the scientific community have been oriented to the analysis and the implementation of IT tools that aim both to managing and presenting knowledge (Knowledge Management) and to support online tutoring. In particular, as regards the latter, are more and more used intelligent agents to implement applications that enable a continuous and constant interaction between the technological system (the platform used) and the users of the system itself.

The aim of this work is to deal with the role and the function of the tutor within e-Learning contexts and to present technological and innovative solutions to support online tutoring activity. After introducing the main features of the tutor (functions, roles and skills), it will be analyzed the problems and the criticality of using artificial intelligence to support tutoring activity (Russel & Norvig, 2003).

Considering that in the last two decades the scientific research has benne focused mainly on the use of Intelligent Tutoring Systems (ITS) within e-Learning contexts and generally within web based learning environments, it is aimed in this work to highlight not only the technical and IT aspects to develop Intelligent Tutoring Systems but also the educational and pedagogical perspectives of the use of these systems. An Intelligent Tutoring System is a software system, based on techniques of Artificial Intelligence; it is realized to satisfy the necessity of an assistance to the specialized learning and individualized one, that is a student - a teacher / tutor type or interaction one-to-one. The ITS, in practice, develops the function of a ‘human’ teacher and is able to personalize the learning of the learner on the basis of his/her interests, of his/her knowledge, of the abilities and the errors that he/she makes (De Pietro, 2009).
Agents software but, above all, how they allow the protection of educational and pedagogical aspects, within the e-Learning platforms, of teaching-learning processes. For this reason it is described an intelligent system, called TutorBot, that can be used as a support tool for web learning tutoring activities. TutorBot, that was realized by our research team (GRIAD\(^2\)) and still in its testing phase, uses the AIML (Artificial Intelligence Markup Language) language to structure data, can be used as an interface between learner and knowledge base within an e-Learning platform. The learner, with his natural language, “talks” with the agent to execute a retrieving of educational contents and to be assisted, just how it is in real contexts with a human being.

1. The role and the function of the e-tutor within on-line education processes

An e-Learning system, as defined above, according to the WIS paradigm, it is mainly based on human and technological resources. Among the human resources in this web learning environment much attention must be given to the role of the tutor, or even better e-tutor, since most of the time the efficiency of the all teaching-learning process relies on him, especially on qualitative point of view (Piu et al., 2006). In this context it will not be deepened the figure of the e-tutor, but it will be highlighted his main functions, role and skills. This is important to understand o what extent technology, specifically an Intelligent Agent, can contribute to support tutoring activities, evaluating wisely in which functions and conditions under which an agent can act as a supporter and never as a human being substitute. The tutor in a web-based learning environment is responsible for coordinating, supporting, learning guiding, stimulating and triggering more and more engaging forms of interaction among learners. The tutor, according to the socio-educational constructivism and collaborative learning, has to trigger an adequate climate to enable team work and to negotiate knowledge; he is a teaching-learning mediator and facilitator.

The e-tutor, in virtue of the main functions which performs, can be named differently (Calvani & Rotta, 1999): Tutor instructor; Tutor facilitator; Tutor moderator. From this different types of tutors it is possible to understand the many skills that he needs to have; some of them are aimed to contents, in this case the tutor must be competent in the subjects he is involved with; some are related to the web learning environment and so his aim is to assist learners within the familiarization process with the environment; some other relate to communication processes and learning methods; others are psychological, managerial, evaluation, etc. Moreover, within really populous contexts (e.g. in academic and post-academic contexts) and with a huge quantity of contents, it is required to the e-tutor more time flexibility; for this reason, to support and optimize those tasks, it is possible to delegate automatic and repetitive functions to In-

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\(^2\) GRIAD - Gruppo di Ricerca per l’Informatica Applicata alla Didattica, Scientific Director Prof. Orlando De Pietro, Department of Humanistic Studies, University of Calabria.
Intelligent Tutoring Agents (ITA). ITA belongs to the category of Intelligent Tutoring Systems.

So, it is necessary to understand in which task it can be more useful to use an ITA instead on a human tutor. In this regard, after highlighting the technical feature of an ITA, will be described its perspectives in education and its pedagogical implications.

2. Artificial Intelligence and Intelligent Agents for tutoring in Education

To design an intelligent agent for tutoring we need to refer to Artificial Intelligence (AI) tools and methods; AI is a scientific field that is at the base of IT applications to simulate human behavior. In this regard, it can be briefly stated that when we refer to AI we should know that it is a discipline that brings together elements related to reasoning, perception, learning, acting but also mathematical functions such as probabilities, logic, and the use of digital-electronic devices, computer systems, robots, etc.. AI, according to the interdisciplinary field of cognitive science, investigates the problems inherent the simulation of human mind, that is, the possibility to make a robot perform some typical human functions and reasoning. In its mere IT aspect, it concerns the theory and the practice of the development of algorithms that make machines able to show an “intelligent” activity, for this reason the building block that forms the basic structure is a special software called intelligent agent.

Regarding AI applications within our scientific field, it is necessary to highlight that at the end of the 80s IT pedagogies’ started to understand the advantages of AI for education. This is when the first Intelligent Agents were born, information retrieving oriented, they were able to interact with educational multiple database on the Internet; we start talking about adaptive agents, able to adapt to the learner needs and give him material that was more suitable for his learning profile; but also collaborative learning agents, that were able to monitor and stimulate the interaction between the learner and the tutor/teacher, but also with peers or other multimedia support (McRoy et al., 2006). But, above all, attention is given to agents oriented tutoring, called Intelligent Tutoring Agent (ITA), belonging to the category of Intelligent Tutoring Systems, which allow us to interact with learners in order to provide all the clarifications about the content organization and management of training activities. As regards the architecture of an ITA, is constituted by a technological infrastructure (hardware/software) that must include: a knowledge base, an adaptive search engine, an educational module.

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3 The term Artificial Intelligence is being used for the first time in 1956 by John McCarthy, a researcher at MIT (Massachusetts Institute of Technology, USA), during a study conference held at Dartmouth College (New Hampshire, USA).
3. Technology and operation of an Intelligent Tutoring Agent

In the category of ITA there is TutorBot, a software agent that supports online tutoring activities. Please note that this is still to be completed and has been experienced in the course of “e-Learning”, at the Faculty of Humanities of the University of Calabria, Italy.

TutorBot is an intelligent agent that, by using the AIML language (Artificial Intelligence Markup Language) for structuring data (Thomas, 2001; Wallace, 2007), can be used as an interface between the learner and the knowledge base within an e-Learning platform (see Figure 1). The use of TutorBot in an e-Learning environment promotes a teaching-learning model collaborative oriented that “adapts” itself to the learner cultural profile, central element of this process, showing him, through an adaptive search engine, information pertaining to the logical context of his interest.

The learner, in his natural language, interacts with the intelligent agent to perform the retrieving of educational content and at the same time to receive “assistance”, just as you would do with a human tutor during a chat session (Ali et al., 2001; Descamps et al., 2001). Note that, thanks to the structure AIML, it is also possible to manage media content and not only in text format, thus making more effective the whole process of learning. In addition, TutorBot can interact with other information systems on the Web (Pirrone & Cannella, 2008) in order to expand their knowledge base and encourage the creation of virtual communities more and more extensive that contribute to the sharing of knowledge (Midoro, 2006; De Pietro, 2012).

Another peculiar aspect of TutorBot is related to the update of its knowledge base, in fact if any question asked by the learner cannot be satisfied, because it is not in the knowledge base questioned, generally that of the e-Learning system you are using (see WIS-Learning), this is automatically sent to the teacher by e-mail. Once the response by the expert (lecturer or tutor) is provided we realize a dual situation: it is satisfied the individual and personalized learning of the applicant and (Baldacci, 2005), at the same time, the response is stored in the knowledge base of Tutorbot that is fed with the contribution of the expert. The purpose of TutorBot is therefore to minimize the activities carried out by humans, in our case by the tutors in an e-Learning platform, with the advantage of also being always available (Chen et al., 2002).

4 Now changed in Department of Humanistic Studies.
4. The Interface

TutorBot, that can be integrated in any e-Learning platform, is introduced with a very simple interface, that the student uses during the interactive phases with the intelligent agent and through which he/she submits his/her own query in natural language; this latter is carried out by TutorBot, after appropriate operation analysis on the input (lexical reduction) by means of a software module\(^5\) (Kawai et al., 2011). The Query can be in whatever form, that is it can explicitly refer to the information requirement relating to the knowledge base or it can be a conversation between the student and the robot. In the following Figure 2, the interface of TutorBot, that can be implemented in any e-Learning platform, is illustrated.

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\(^5\) For an in depth study see Author et al. (2005)
As it can be noticed by the interface represented in the Figure 2, the learner directly formulates his/her own question using a simple text-box, and the answer is given by TutorBot inside a special area destined to such purpose. In fact, the simplicity of the interface and the interaction that develops during the phases of dialogue, both set the aim of simulating at best the process of tutoring on line, just as if this latter occurred in a real context with a human tutor (Piwek et al., 2007). It can be observed, that the face of TutorBot has been built on purpose using the technology 3D, to allow the movement of the mouth and the eyes, with the purpose to make the interaction more engaging. In fact, in contexts of IA it does not only need to pay attention to the technical aspects of the knowledge management, but it is also necessary to refer to the environment in which the interaction man-machine happens, making it more and more representative of the reality.

To improve the effectiveness of the learning/tutoring process, during the interaction between learners and TutorBot, it has been give much attention to multimedia content management, therefore, it is necessary to underline that the answer given by the Agent it is not only in a text format, but also by images, video lessons, link to further external resources etc, as shown in Figure 3.

Whether TutorBot is not able to find an answer because it is not in its knowledge base, or giving further deepening on the topic, it was provided the integration of an Adaptive Search Engine (see par 4.3) used to give back information as links, showed in the same interface, as shown in Figure 4.
Figure 4. Interface of TutorBot with the integration of the search engine

Figure 5. TutorBot integrated in a web-portal
4. The Artificial Intelligent Markup Language (AIML) for TutorBot-Learner interaction

As shown in Figure 3, to the question asked by the learner in natural language (TutorBot Knowledge Base is in Italian language): “potrei avere la definizione di ipertesto”; the agent answers with a PATTERN included in its own knowledge base, nevertheless, the agent, in order to do that and eliminate any chance of error, firstly analyses the data regarding the learner who has asked the question, data which are then used to profile the learner and match the final profile with the proper sections inside the AIML knowledge base identified by the topic (adaptively).

To clarify the concept, it can be said that a learner who follows a course of “Education”, will have a preference of correspondence inside the knowledge base AIML on topics associated to the subject “Education”, therefore it is possible to avoid confusion in getting a topic of conversation between TutorBot and the learner. Obviously, the topic identified may also be different from topics connected to “education” if the learner will shift the conversation on different topics. Indeed the agent can autonomously pick up a topic of conversation, from (as it was pointed out before) the profile of the learner (De Pietro et al., 2009) as well as from the same conversation. This is possible thanks to the rules entailed in AIML, which you can go to for further information.

Going back to the example in Figure 3, to the question (in Italian language): “potrei avere la definizione di ipertesto” (in English: “May I have the definition of hypertext?”), the following AIML code can be identified inside the knowledge base (in Italian language):*

```xml
<aiml>
<topic name="Database">
  <category>
    <pattern> * Database _ struttura </pattern>
    <template>
      potrei avere la definizione di ipertesto<br> Ecco un esempio di struttura ipertestuale:<br>
      <img src="ipertesto_schema.jpg" width="100" height="100" alt="" border="0" />
    </template>
  </category>
</topic>
</aiml>
```

As it is understood, from both Figure 3 and the same AIML code presented above, it is possible to manage the multimedia contents (images, videos, etc.) directly inside the code by inserting tag HTML inside the same tag TEMPLATE of AIML. The multimedia content, inserted in the TEMPLATE, is shown by TutorBot in output alongside the textual content that usually constitutes the answer of the agent.

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6 The AIML Knowledge Base of TutorBot is in Italian, as it is full of informative contents. For this reason it was decided not to provide any translation.
to the learners’ questions. For the same reason, links might be introduced, being possible to exploit hyper-textual as well as multimedia potentialities. In such a way, the interaction with the tool is highly improved, just as a human tutor would do, TutorBot can draw the user’s attention to further informative material, to have more detail on the topics of conversation.

5. The Adaptive Search Engine (ASE)

As stated above, if the question raised by the learner cannot be met because a correspondence does not exist inside the knowledge base AIML, the agent, through a search engine, ends up questioning external knowledge bases. Such search engine is of an “adaptive” kind and has therefore been denominated ASE’ (Adaptive Search Engine), illustrated in Figure 5, (De Pietro et al., 2005; Brusilovsky, 2004; Laforcade et al., 2004; McTear, 1993); this indexes the resources on the basis of two fundamental criteria:

- Key-words present in the document;
- Logical context of reference which the topic of the indexed resource and user’s profile correspond to (through the WEB platform).

With these two parameters, the resources can be found not only by means of key-words taken out from the learner’s questioning sent to TutorBot in natural language, but also by means of the logical context which the learner is referring to during the conversation and strictly linked to his/her profile. The coherence and the actual logical context is determined by the recursiveness of some key-words, that during the conversation, clearly identify the object of the conversation. In the example in Figure 4, we can synthesize what happens in background after a conversation of this kind:

In Italian language:
- Learner: “trova informazioni sugli ipertesti”
- TutorBot: “Per avere maggiori informazioni sugli Ipertesti ti consiglio di far riferimento a queste fonti sul web”

In other words, in the example, to the user’s request to carry out a research, identified by the key-word “trova” (search) (along with others included in the knowledge base), TutorBot gets started by explicitly questioning (in this case following the learner’s input) the search engine (ASE) which it is connected to, the latter, as illustrated in Figure 5, provides an output related to the search on key-words taken out from the PATTERN of conversation, in our case “hypertext” (learner’s input). In case the agent finds a lack of information in his AIML knowledge base, he automatically activates the research to external sources, always through ASE. The output of TutorBot, if we carry on with the above example and still refer to Figure 4, ends up being composed by two elements:
- A section in natural language, where the research which has been carried out, is explained to the learner;
- A section which contains the results of the research carried out by ASE, with the related links that you can click on to the corresponding resources.

7 For a depth study on the functioning of Adaptive Search Engine (ASE) see Author et al. (2006)
Both sections are completely integrated, therefore creating a homogeneous set which is by and large the answer of the agent to the learner’s questioning.

6. Results of the exploratory study on the efficiency and satisfaction of TutorBot

In order to design a more comprehensive and detailed future experimentation to test the effectiveness of TutorBot in real educational contexts, has recently been realized an exploratory research, to detect the expression and the degree of satisfaction of students who interact with the intelligent agent TutorBot. For this purpose we used the platform You@Learn, a web learning environment, created by the Research Group GRIAD, which thanks to the typical features of Web 2.0 in it implemented, allows us to integrate formal and informal learning and make the subject autonomous and protagonists of his own learning; for in-depth technical-operational You@Learn, please refer to De Pietro, Muoio, De Rose (2011), while for the exploratory study presented here, reference is made to a previous work (De Pietro et al. 2013) designed to detect the features of such an environment, through an exploratory study that involved sixty students of the former e-Learning, at the Faculty of Humanities, now the Department of Humanistic Studies, University of Calabria. On this occasion, though TutorBot still under study, as well as further possible improvements of its performance, has been made available within the platform You@Learn. Therefore, in the same period of duration of this exploratory study, exactly one week, students had the opportunity to interact with the agent TutorBot. To determine the effectiveness of the virtual tutor and the sensations perceived by the students during the interaction with it, at the end of the trial they were asked to respond anonymously to a questionnaire consisting of both closed-ended questions from open-ended questions.

The quantitative analysis of the questionnaire data, showed that the 76.66% of the sample (46 students out of 60) said they were satisfied with the answers provided by the virtual tutor; 15% (9 students of 60) did not get the answers they wanted; only 8.3% (5 out of 60 students) said they had not received any response because the question has not been recognized by the agent. The open-ended responses, analyzed in detail, have made it possible to detect not only the strengths but also the criticality of the instrument.

In reference to strengths, there were many positive aspects: broad enthusiasm in using the virtual tutor, also thanks to the interactive news provided by the instrument; appreciation about being able to receive assistance 24 hours 24; satisfaction with the mode of delivery of multimedia answers received by the I-Tutor. On the other hand, users have shown some difficulties in establishing a conversation of long duration, some difficulties in formulating the requests (queries) in order to obtain consistent responses to the question posed; lack of satisfaction, by a limited number of users, of the interface used by the I-Tutor. In conclusion, the exploratory study on the functionality of TutorBot shows that it can be used to support the activities of tutoring within e-learning environments in an integrated manner but never substituting the human tutor and there is the same level of interest/enthusiasm during the interaction, even if further work is needed on the interface and on mechanisms of its knowledge base.
Conclusions

The present work is part of the studies for the optimization of the processes of teaching-learning, within e-Learning contexts, in which act Intelligent Agents, tools, among others, that are able to facilitate a more meaningful learning (Novak, 2008). TutorBot, the intelligent agent presented in this work, must be considered and evaluated not only from a technological point of view, in reference to the optimization of human resources management and/or the flexibility with which you can make learning content retrieving, but also, and above all, from the point of view of pedagogical-didactic and of social interaction, according to the socio-educational constructivist teaching model (Galliani, 2004), which sees a “student centered learning”, and according to the just-in-time learning and collaborative learning. We believe that these latter aspects, although still being to be improved and refined since the tool still needs to be tested, will be respected because, within the interaction TutorBot-learner, it is the student who during the dialogue with the agent builds his own learning path and contributes mainly to enrich the knowledge base of the artificial tutor. This is one of the key aspects of the system, which highlights and accentuates the active and participatory role of the students (De Pietro & Frontera, 2005). In addition, the direct interaction between TutorBot and learners, can also contribute to the emergence of online learning communi-
ties (Scardamalia & Bereiter, 2006) in which all parties are involved in the construction and sharing of new knowledge. Thanks to the AIML standard, documents produced in other e-Learning platforms can be easily imported into the Knowledge Base of TurtorBot, and from this reused. Specifically, the expected benefits can be summarized as follows:

- Implementation of an online tutoring accessible at anytime, anywhere, ever more complete;
- Reduction of operating costs and working time by the teachers/tutors;
- High level of interoperability between different platforms, desired objective from the main international organizations with an interest in e-Learning.

A further advantage to be highlighted, is derived from the open source technology used for the implementation of the system. This makes it easily adaptable to other contexts web oriented, and enables the development of add-ons, for further improvement of TurtorBot by the community of developers that have the same standard. Finally, integration of the Adaptive Search Engine (ASE) is used to compensate for the possible lack of information of the knowledge base, also thanks to the techniques used in activities that are integrated with the data objects aiml, it is possible to customize the responses given to learners according to their user profile. The issues covered and the system described, still to be completed and, of course, of further improvements as demonstrated by the survey carried out, in our opinion set the stage to implement others and new tools to automate the processes of knowledge management, according to recognized standards at an international level, and at the same time, to limit human work that in environments characterized by a high number of users and a varied type of content becomes very onerous.

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