Title:
Applications of Artificial Intelligence in an Open and Distance Learning Institution

Prof Dr Mansor Fadzil
Senior Vice President
Open University Malaysia, Kuala Lumpur
mansor@oum.edu.my

Tengku Amina Munira
Executive, Office of the Senior Vice President
Open University Malaysia, Kuala Lumpur
tg_munira@oum.edu.my

Abstract

Applying Artificial Intelligence (AI) in an educational setting presents a wealth of opportunities, particularly for Open and Distance Learning (ODL) institutions. As ODL relies heavily on human-machine interactions, AI thus naturally offers open universities various means to address issues such as how do people actually learn; what constitutes effective teaching; as well as what are the advantages and limitations of computer-based systems in education. Open University Malaysia (OUM) is Malaysia's premier ODL institution and has been operating for seven years. As an ODL institution, OUM's operations and services are heavily anchored on a range of information and communication technologies (ICTs) that could potentially include AI. Though the implementation of AI has not been fully realised in education, OUM foresees many areas that can benefit from it, in terms of ensuring quality, improving pedagogical methods as well as enhancing the overall teaching and learning experience. In this paper, we will explore several fields whereby AI could be potentially utilised in an ODL institution, i.e. expert system for programme advising; automated scheduling of classes; marking of assignments; plagiarism detection; retaining learners and adapting to their diverse needs and backgrounds; maintenance of property; and ensuring security. OUM also anticipates that AI could provide a significant and highly intriguing paradigm shift in the deployment of ODL and that it could greatly influence the future of all open and distance learners.

I. INTRODUCTION

The appropriation of technology in education is not a new phenomenon. Open and distance learning (ODL) humbly began with correspondence courses through the post and evolved into broadcasted programmes over the television and radio. Today, it involves the intricate yet seemingly boundless information superhighway. Coupled with the emergence of a new student body of computer-savvy working professionals and the need for state-of-the-art information, it is anticipated that technology will continue to be the most compelling developmental factor in ODL (Casey, 2008).

In fact, the involvement of technology in education has created a cause-and-effect relationship with how courses are taught and educational services rendered. As human-machine interactions become more important, particularly in an ODL setting, scholars too are beginning to be more convinced of a paradigmatic shift in the use of Machine-Assisted Learning (Schmidt, Cottier and Choquet, 2004). The internet and its accompaniments have rendered e-learning tools familiar for transforming the nature of interactions from person-machine to person(s)-person(s) with, and through, machines (Schmidt, Cottier and Choquet, 2004). Educational technologists will continue to work towards providing the most appropriate feedback, assessment and interaction in order to achieve a desired learning outcome (Garrett and Roberts, 2004).

The technologies we speak of will include software and applications for curriculum design, course design and development, learner recruitment and enrolment, course delivery, validation and articulation (Oblinger, 2001, cited in Garrett and Roberts, 2004). Such tools are anticipated to bring learners closer together and offer creative activities of intellectual exploration and social interaction (Stahl, Koschmann and Suthers, 2006). Through the use of general technology and artificial intelligence (AI) in particular, ODL institutions will have the capacity to provide a more personalised, adaptable, customisable and interactive teaching and learning experience. As learners continue to demand for a "just in time, just enough and just for me" learning experience (Bamberger, 2004), ODL institutions must look into how learners actually learn and the paradigmatic shift mentioned above will also swing from "hey, look what the computer can do!" to "what is the learner up to?" (Schmidt, Cottier and Choquet, 2004).

Shifting from a cookie-cutter, one-size-fits-all maxim to an individualised, user-centred and self-controlled approach will inevitably require the assistance of AI, especially in ODL. It is thus, important for ODL institutions to acknowledge the capacities and promises of AI. As modern computers grow more sophisticated, educational technologists are optimistic that AI could be introduced into ODL by various means and within various contexts.

AI can be generally defined as "the intelligence of machines and the branch of computer science which aims to create it" (Wikipedia). Poole, Mackworth and Goebel (1998) also define AI as "the study of the design of intelligent agents". With regards to education, AI can also be classified as "computer software that closely mimics behaviours that might be considered intelligent if done by a human" (Stahl, Koschmann and Suthers, 2006). Where

ODL is concerned, AI could be incorporated into course management, learning management systems, support services as well as the general operations of the universities themselves. We at Open University Malaysia (OUM) are certain that AI will be a significant contributor to enhancing and improving the ODL experience.

In 2008, OUM reached its seventh year in operation and now has a 70,000-strong learner enrolment, 95% of whom are working adults. The number of academic programmes on offer currently stands at 51 and learners are both geographically and temporally distributed. They engage in learning via a blended pedagogical approach that involves online learning, self-managed learning and face-to-face tutorials that are held at 61 different learning centres nationwide. An academic year at OUM includes three semesters, and in any given semester, about 30,000 learners will be active throughout Malaysia as well as internationally in Bahrain, Yemen and the Maldives. The e-learning technologies that have been incorporated as part of the blended learning delivery system at OUM include multimedia courseware (on compact discs), iTutorials (audio and video streaming), iRadio (audio streaming), web-based modules and learning objects (web-based multimedia). These are in addition to print modules, face-to-face tutorials and online forums via OUM's learning management system, myLMS.

OUM perceives AI as a tool that can be incorporated in not just its academic programmes and learning materials, but also in how the University ensures security, maintains physical infrastructures and more importantly, to adapt to the varied needs and characteristics of its learners. Therefore, this paper aims to provide a snapshot of how AI can complement, enhance and benefit the teaching and learning experience at an ODL institution such as OUM.

II. INCORPORATING AI IN ODL

AI, computational intelligence, computer support for learning, as well as other forms of information and communication technologies (ICTs) in education has allowed for the paradigmatic shift from a generic maxim to a learner-centric approach whereby technology is used to support individualised learning styles (Santos, Rodriguez-Ascaso, Boticario and Martin, 2007). With AI, educational technologists would hope to incorporate personalised, adaptable, 'human-like' features to an ODL environment. From simply technically-oriented, the ODL system has become 'socio-technical' and the goal has swung from replacing human activity to *assisting* human activity (Schmidt, Cottier and Choquet, 2004).

Thus, in this paper, we would like to introduce several scenarios where AI could be utilised in an ODL setting, i.e. expert system for programme advising; automated scheduling of classes; marking of assignments; plagiarism detection; retaining learners and adapting to their diverse needs and backgrounds; maintenance of property; and ensuring security.

2.1 Expert system for programme advising.

OUM currently offers 51 programmes at the diploma, Bachelor's, Master's and doctoral levels. These programmes are conducted under five different faculties and cover various fields in science and technology, business and management, education and languages, applied social sciences as well as information technology and multimedia communication. One of the common problems encountered with prospective learners is the selection of the most appropriate and relevant programme. Presently, learners will seek for advice from consultants and other University personnel; and this task has proven to be fastidious and repetitive in nature.

AI could be incorporated in this exercise through the development of an expert advice system. This expert system could be made to ask a list of basic questions regarding a potential learner's educational background, career plans, interests and skills before making recommendations and giving advice on which programme he should enrol in. Subsequently, this learner can then approach an actual academic advisor for further guidance. Utilising AI in such a system will potentially provide better suggestions to and pinpoint the best programmes for each new learner.

2.2 Automated scheduling of classes.

As mentioned earlier, OUM's academic calendar is spread out over three semesters that begin in January, May and September every year. About 30,000-odd learners will be active during every semester at different levels and stages of study. In total, the University offers 337 subjects and each learner registers up to three subjects every semester. On top of that, OUM also employs about 3,500 part-time tutors every semester

as well. These rather daunting numbers translate to a complicated registration and scheduling procedure and as far as OUM has experienced, it is also rather complex to schedule classes manually. Both the learners and University administrators have difficulty in coordinating the classes for each respective learner. Despite the use of simple computer programming, OUM believes there is room for improvement and that this can be achieved through AI.

As an example, an intelligent pedagogic agent could be incorporated in the University's myLMS. Operating within course management systems (CMSs) and campus portals (Jafari, 2002), the agent could be created as a personal timetable scheduler, featuring AI with problem-solving and planning abilities. By collating a learner's personalised information and acting as an assistant, the agent can retrieve and integrate the necessary data to support various decision-making tasks required by the learner. Having an intelligent agent process automated scheduling of classes for different combinations of courses will ensure that the coordination goes smoothly and that conflicts between classes do not occur.

2.3 Marking of assignments.

Throughout their studies, OUM learners are assessed through continuous assessment (i.e. assignments and mid-term examinations) and final examinations. Learner success, especially through examinations, is a natural success indicator of a university (Hadzilacos, Kalles and Pierrakeas, 2008) and this also translates to the effectiveness of a particular tutor, class and course as well. In a particular semester, OUM learners will usually need to complete between one to three assignments, depending on the number of registered courses. Tutors are then required to mark the assignments and provide appropriate feedback to the learners.

However, one of the issues associated with the marking of assignments is quality and standardisation. As there are about 3,500 active tutors and 30,000 active learners during a single semester, the number of assignments that is handed in is also quite overwhelming. This, coupled with the varying skill, attention and experience of the tutors involved, has been known to hamper the overall quality of assessment methods. OUM has also found disparities in assignment scores and grading techniques between tutors and learning centres. Thus, there is clearly a concern of standards that needs to be addressed.

OUM has identified that randomly marking assignments can be used to analyse the marking practices of tutors. Though this method can provide a general representation of the overall marking quality, another approach could involve AI, whereby assignments that are electronically handed in by learners can be automatically marked by machines. As every assignment comes with a list of criteria which the learners are expected to meet, these can be configured using an online interface. Marks, comments and even penalties for errors can be specified for each criterion, and this intelligent system can thus be used to literally search for points and answers in a learner's work. Consequently, the system could even be configured to routinely send personalised feedback to each learner via e-

mail. Implementing such a system, particularly in ODL where electronic submission is common practice, would be beneficial in the sense that the University will have the opportunity to ensure consistency and quality in not only the marking standards, but the feedback to learners as well.

2.4 Plagiarism detection.

The wealth of information easily accessed over the World Wide Web is both a boon and a bane to education. This resource provides learners with a seemingly limitless avenue for enriching their own knowledge. Conversely, the internet has also given opportunistic learners with a short-cut to writing assignments and dissertations, i.e. through plagiarism.

Plagiarism.org, the world's first internet-based plagiarism detection service, has identified several forms of plagiarism commonly executed by learners. These may include "The Ghost Writer", whereby the writer turns in another's work, verbatim, as his own; and "The Photocopy", whereby a copious amount of text is copied from a single source without alteration. In short, there is a troubling amount of 'copying and pasting' when it comes to assignments and theses. Such a practice is not only a measure of a person's moral values, but will also dishonour the reputation of the university.

In general, plagiarism can be detected using attribute counting, i.e. a method for detecting general document plagiarism; or through a structure-based plagiarism detection that considers structural characteristics of a document (Ji, Woo and Cho, 2007). The latter, however, is more commonly utilised when detecting plagiarised material in a computer programme. Turnitin and iThenticate are two systems that are commercially available over the internet, and designed to combat the use of unoriginal material stolen from web-based resources, as well as newspapers, magazines and journals. While iThenticate is targeted at corporate organisations, Turnitin is designed to accommodate education providers and can be integrated into the CMS or LMS of an ODL institution.

AI can be employed in plagiarism detection exactly as demonstrated by the systems mentioned above. Such a system could be a web-based application that acts much like a search engine as it looks for patterns or matches against available databases and archives. The system will generate statistical reports and these can then be analysed by the tutor or lecturer. Implemented in an institution like OUM, this system could also be considered a step towards quality assurance as well as serve to caution learners so as not to resort to plagiarism during their studies.

2.5 Retaining learners and adapting to their diverse needs and backgrounds.

Retaining learners is a major challenge for many ODL institutions. Having to juggle multiple commitments and subjected to a sense of isolation causes low motivation that could ultimately lead to high rates of attrition at the University. Diversity is yet another factor that may have a hand in attrition, whereby different educational backgrounds,

working experiences, socio-economic statuses and even cultural and gender distinctions may affect the way people approach learning. High attrition rates do not only translate to a loss of income to the University, but also affects the national drive towards human capital development.

Thus, there is an urgency to get to know the user/learner and his needs, or inversely, for educational technologists to predict the use of certain techniques on the computing side of the equation (Schmidt, Cottier and Choquet, 2004). There are questions to be answered, such as what learners are really doing within their learning environment and which of and how are the devices available used for learning. Moreover, people do not only wish to have more control over how they learn but what they learn as well (Schmidt, Cottier and Choquet, 2004).

We perceive that it is through understanding these needs and addressing these diversities that the University will be able to ensure learner success and reduce failure rates. As drop-outs are such a significant issue for ODL institutions, it is an imperative that we analyse and strive to understand the mechanism and reasons for failure (Hadzilacos, Kalles and Pierrakeas, 2008). Thus, we would like to introduce two computer-assisted means for the purpose of understanding failure and retaining learners, i.e. developing user models and using intelligent pedagogic agents.

User models can be developed to explain and predict why some learners fail while others succeed (Hadzilacos, Kalles and Pierrakeas, 2008). With AI, such a model could be developed with specific algorithms and associated performance indicators and subsequently used to predict the performance of high-risk learners. With this data, tutors can take remedial steps and provide the necessary attention and focus to these learners before they sit for their examinations. By building an "early warning and reaction system" (Hadzilacos, Kalles and Pierrakeas, 2008), the tutors have an opportunity to help retain high-risk learners by lending a hand before they face failure during examinations.

Defined as "a set of independent software tools linked with other applications and databases running within one or several computer environments" (Jafari, 2002), intelligent pedagogic agents could be incorporated to function within the University's CMS or LMS. They could be employed to provide automated scheduling of classes for the learners; check on learners' progress and participation; monitor message boards; as well as send reminder e-mails when necessary, thereby relieving the instructor/tutor from manual monitoring and management of course activities (Jafari, 2002). Some of the functions of intelligent pedagogic agents, as proposed by Gregg (2007) are depicted in Figure 1 (below).

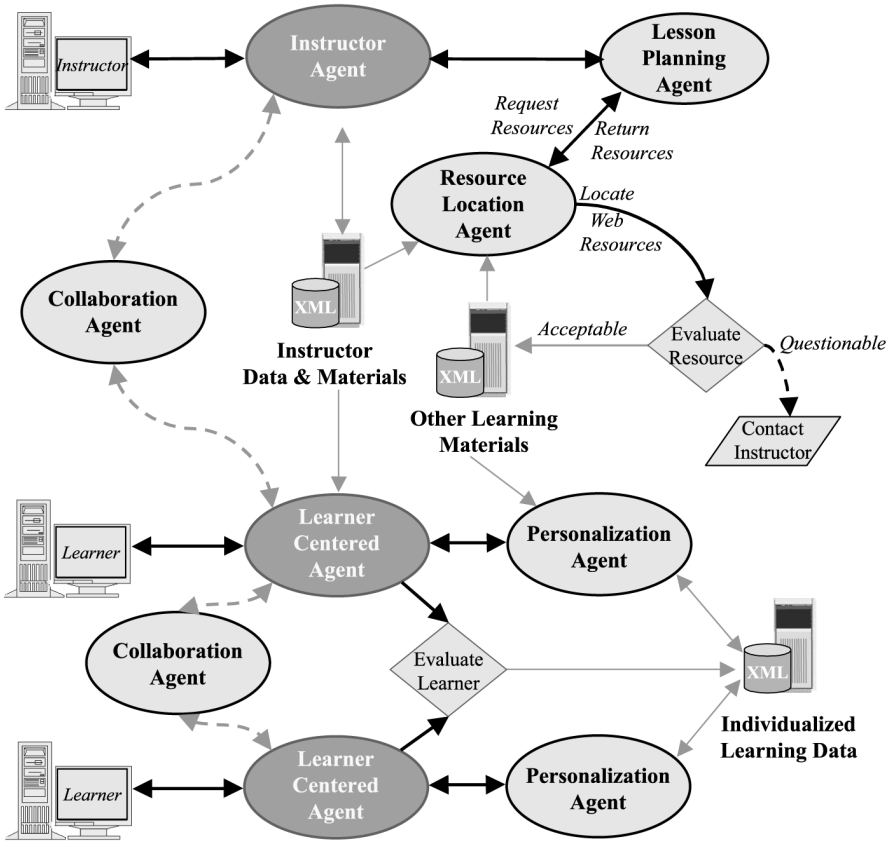

Figure 1: A proposed architecture of intelligent agents in e-learning.
Source: Gregg, 2007.

However, the more substantial role of these agents is as learning companions that might provide an opportunity to simulate social interaction in the virtual learning space (Kim and Baylor, 2006). The use of these agents to provide feedback and enhance interaction is in fact a key area for current AI researchers, and where educational applications are concerned, their future appears promising (Garrett and Roberts, 2004).

With relevance to education and ODL, intelligent agents may have a cognitive function; mediate between people and programmes; serve as an intelligent assistant; present themselves as anthropomorphic characters; as well as manifest a focused purpose and 'mimic' human mental states (cited in Garrett and Roberts, 2004).

Where learner retention and adaptation to diversity are concerned, intelligent agents also serve a motivational role, where they could be designed to collaborate with learners and facilitate the learning process by contextualising the feedback from the system and enhancing communication. Using AI to recognise patterns in terms of how a learner studies and approaches studying, such information could be exploited into how the agent interacts with the learner. By mimicking human behaviour and appearing like a partner or friend, the agent can be made to care about the learner's progress, thereby encouraging him; conveying and promoting enthusiasm so as to make learning more fun. Similarly, the agent could also provide feedback to the learner to help prevent frustration and loss of

interest. Thus, the agents can represent different instructional roles within the virtual environment, i.e. as expert, tutor, mentor and learning companion (cited in Kim and Baylor, 2006).

2.6 Maintenance of property and ensuring security.

OUM's 61 learning centres nationwide are equipped with infrastructure that serves both an administrative purpose as well as providing a teaching and learning environment for the learners. As such, these centres generally possess general amenities, office space, classrooms, computer laboratories and libraries. Despite their distributed locations, it is an imperative for the University to ascertain that these infrastructures are well-maintained and in good condition, with the main purpose of providing the most conducive environment for the learners.

The maintenance of these facilities have been proven to be a fairly complicated affair, particularly in terms of energy usage and managing systems for air-conditioning and security, as well as other electrical devices. With advances in AI and the use of automated devices, common maintenance tasks could be made easier. The learning centres could be transformed into 'smart spaces' with many highly interactive and embedded devices, and including the ability to control these devices automatically to meet the demands of the environment (cited in Begg and Hassan, 2006). It would be optimal for these devices to be controlled and managed from a distance, or even over the internet. Through various computational intelligence techniques such as neural networks, Fuzzy logic, Hidden Markov Models and Bayes Classifier (cited in Begg and Hassan, 2006), the facilities available at OUM's learning centres could be maintained and monitored remotely and intelligently. Not only will OUM be able to retain the quality of its physical infrastructures, the University will also be able to promote smart energy usage for reduced expenses and preservation of the natural environment.

When we speak of security, not only do we mean the security of our buildings and offices. As OUM is a university, a significant portion of our operation involves examinations. Security during examinations is an issue, for there have been cases of violation of common regulation, e.g. taking an examination for someone else, using prohibited aids, obtaining improper access to information concerning examinations and attempting to give or receive assistance from others. This is where we believe AI comes in. Apart from using AI for information security and to prevent outside access to confidential material, AI could also be incorporated during the administration of examinations themselves. For instance, biometrical applications such as retinal scans and fingerprinting technology could be utilised to verify that the correct individuals are present. Such a measure, though it may appear drastic in an educational setting, will be a welcome addition to ascertain security and transparency in the administration of examinations.

III. CONCLUSION

The capacity of AI to mimic human intelligence and its ability to solve complex problems make it an ideal application in ODL. As asserted by Schmidt, Cottier and Choquet (2004), diversification of AI means that machines can be taught to 'reason' like humans and that "humans teaching machines to play games has given way to using networked machines to teach humans". Realising the many issues associated with ODL institutions such as security, quality assurance as well as the drive towards an enriching and personalised learning experience, AI appears to be an integral part of ODL development. At this point in time, the incorporation of AI in an educational environment may appear Utopian. However, it is important to note that the internet itself was once considered an impossibility. In the not-so-distant future, we may yet see a life-like pedagogic agent lurking within OUM's myLMS as well as the systems of other ODL institutions. After all, as Schmidt, Cottier and Choquet (2004) have stressed, "whatever the distance, learning must be made fun".

REFERENCES

Begg, R., & Hassan, R. (2006). Artificial Neural Networks in Smart Homes. In Augusto, J.C., & Nugent, C.D. (Eds.), *Designing Smart Homes* (pp.146-164). Berlin: Springer.

Casey, D. M. (2008). A Journey to Legitimacy: The Historical Development of Distance Education through Technology. *TechTrends*, *52*(2), 45-51.

Garrett, B. M., & Roberts, G. (2004). Employing Intelligent and Adaptive Methods for Online Learning. In Ghaoui, C. (Ed.), *E-Education Applications: Human Factors and Innovative Approaches* (pp.208-219). Pennsylvania: Information Science Publishing.

Gregg, D. G. (2007). E-learning agents. *The Learning Organization, 14*(4), 300-312.

Hadzicalos, T., Kalles, D., & Pierrakeas, C. (2008). On Developing and Communicating User Models for Distance Learning Based on Assignment and Exam Data. *Studies in Computational Intelligence, 104*, 137-155.

Jafari, A. (2002, Number 3). Conceptualizing Intelligent Agents for Teaching and Learning. *Educause Quarterly*, pp. 28-34.

Ji, J. H., Woo, G., & Cho, H. G. (2007). A Source Code Linearization Technique for Detecting Plagiarized Programs. Proceedings of the 12th Annual SIGCSE Conference on Innovation and Technology in Computer Science Education.

Kim, Y., & Baylor, A. (2006). A Social-Cognitive Framework for Pedagogical Agents as Learning Companions. *Educational Technology Research and Development, 54*(6), 569-596.

Poole, D., Mackworth, A., & Goebel, R. (1998). Computational Intelligence and Knowledge. In *Computational Intelligence: A Logical Approach* (pp.1-22). New York: Oxford University Press.

Santos, O. C., Rodriguez-Ascaso, A., Boticario, J. G., & Martin, L. (2007). User Modelling for Attending Functional Diversity for ALL in Higher Education. In Weske, M., Haeid, M. S., & Godart, C. (Eds.), *Lecture Notes in Computer Science: WISE 2007 Workshops* (pp.301-312). Berlin: Springer.

Schmidt, C. T., Cottier, P., & Choquet, C. (2004). Learning with the Artificial Sciences: A Paradigmatic Shift. Proceedings of the 18th World Congress on Computing (WCC–2004 HCE).

Stahl, G., Koschmann, T., & Suthers, D. (2006). Computer-supported collaborative learning: An historical perspective. In Sawyer, R. K. (Ed.), *Cambridge Handbook of the Learning Sciences* (pp.409-426). United Kingdom: Cambridge University Press.