Intelligent Adaptation Framework for Children e-Learning

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Abstract: Personalization is an essential concept for introducing efficient and interactive learning via the internet. Personalization contributes to the improvement of children’s cognitive and language skills. As well as, it contributes to the speed of learning and make children more innovative. Adaptive e-Learning frameworks works to achieve these results accurately. Adaptation plays a distinctive role in providing educational material to suit age, types and learned degree of children. In this study, an original framework for developing an adaptive and intelligent e-Learning system for children has been proposed. Simplicity, ease of use and changeability are 3 keys considerations in the design of this framework. Online courses for children may be designed according to this framework as a means of enhancing their learning process. Furthermore, machine learning techniques are adopted across this research in order to incorporate intelligent concepts while adapting child-orientated online courses. Ultimately, machine learning techniques can extract useful information from text pattern, then these techniques are adopted to effectively classify contents and users in the proposed framework.

Key words: e-Learning, personalized e-Learning, adaptive e-Learning, children learning, machine learning, accurately

INTRODUCTION

During traditional learning, teaching quality is dependent on teacher-student interactions, alongside the curriculum structure and organization (Biggs, 2011). Electronic technologies provide an array of opportunities for strengthened learning outcomes. Learning delivered via the internet is currently described as e-Learning (Mayes and De, 2004; Duus, 2006; Falch and Tadayoni, 2006; Deminy, 2010; Khan and Ally, 2015; Trelease, 2016; Kowitlawakul et al., 2017). The e-Learning is a unique context for general learning, through the application of Information and Communication Technologies (ICT). Despite transitioning, the educational curriculum to the internet (e-Learning) assisting the ease of accessibility, availability and circulation, a degree of interaction is necessary between teachers and students. Such interaction may be supported by personalization and adaptation methods. In addition to organization, the curriculum can overcome this limitation intelligently. Adaptive and intelligent e-Learning has been shown in past research to result in the desired interaction to establish efficient learning (Brusilovsky, 1996; Dominic and Francis, 2015).

The e-Learning orientated towards children often requires implementing a mechanism for greater interaction with the provided resources (Pacini-Ketchabaw et al., 2015) while also necessitating a degree of intelligence in order to evaluate and respond to the children’s behavior. The research undertaken in this study was founded on two questionnaires: one was distributed to companies developing e-Learning programs for children while the second questionnaire is directed at parents. Overall, this research supports devising an original framework for adaptive and intelligent e-Learning applications for children.

This framework gives a way to introduce the simplicity in creation of online courses. Additionally, the structure of the framework will support the ease of use, since, any adaptation system created based on this framework needs a little effort from users to control adaptation process. Finally, the changeability concept in this framework is based on the design of the online course with a simple and innovative structure that allows machine learning techniques to reconstruct the online course based on children’s characteristic and behavior. This research seeks to respond to various questions exploring the future of personalization and adaptation for children’s e-Learning. These questions can be summarized as follows:

• Are machine learning techniques appropriate to discover the children’s learning behavior patterns?
• What type of information can be generated by using machine learning techniques?
Can machine learning techniques be used to generate an efficient and accurate learner model?

Are machine learning techniques appropriate to rearrangement the contents of courses based on learner model?

Can machine learning techniques introduce intelligent contents?

How can machine learning techniques create a flexible content for children based on their behavior and characteristics?

Such areas of enquiry which the study deals with in turn are based on a background for personalization and adaptation of e-Learning, followed by machine learning usage in the classification of contents and users which will be illustrated in the subsequent section.

**Literature review:** Adaptive e-Learning systems amend the material, according to each student’s requirements and abilities. Past research into e-Learning adaptation and personalization proposed amending and obscuring links, for example, by Brusilovsky (2003). Brusilovsky and Pesin (1998) introduced an educational hypermedia system, named ISIS-Tutor which applies adaptive navigational support. An array of systems and frameworks (Essalami et al., 2010; Surjono, 2011) are able to facilitate adaptation and gain from it while attempting to deliver e-Learning that is appropriate for and engages the majority of users. Although, these traditional techniques are widely used we are working on the proposed framework to introduce a new concept, the changeability to manage the adaptation process.

Surjono (2011) introduced an adaptive e-Learning system that corresponds to student’s learning styles. It is dependent on a questionnaire completed by the student when registering for the adaptive course. The system NetCoach diminishes the burden on the researchers because no programming knowledge is required. This method will be used as a base to support the idea of ease of use in the proposed frameworks. Essalami et al. (2010) introduced an original approach for e-Learning personalization. Furthermore, they summarized the most pervasive personalization parameters adopted within the e-Learning domain. The 16 personalization parameters (Learner’s level of knowledge, cognitive traits, progress on task, etc.) are introduced in 1996. These parameters will be used to support the changeability concept in the proposed frameworks.

The e-Learning for children has proven highly successful because it encourages children to learn and attempts to avert any loss of engagement (Surhaloo et al., 2009). Moreover, it supports idea exchange between parents and teachers while working to involve parents in developing the adopted methodology for their children’s education (Kong, 2018). Personalization for children’s e-Learning facilitates teacher’s identification of children’s strengths and weaknesses (Fullan et al., 2006). In 2017, various case studies of educational facilities are presented, to illustrate how personalization effectively fulfills individual children’s requirements. Numerous adaptive e-Learning applications have been designed for children’s education. Hassan proposed a model for designing personalized e-Learning systems for children.

Machine learning techniques have been used in the past to support e-Learning adaptation as outlined in the following. Machine learning has previously been adopted in user modeling (Bauer, 1996; Finlay, 1997; Webb et al., 2001). Bauer (1996) implemented machine learning techniques as a means of planning a recognition process to track user behavior. The challenges of using machine learning for user modeling are explored in 2001 with such difficulties listed being: the requirement for large data sets; the need for labelled data, concept drift as well as computational complexity. Tan and Shao (2015) investigated three machine learning methods (ANN, DT and BN) in order to predict student’s performance in e-Learning programs. They estimated that e-Learning programmer’s effectiveness is dependent on learner’s individual traits and academic attainment. Furthermore, machine learning techniques are implemented for categorization of documents and document contents, thus are consequently used in the e-Learning field for manipulating course materials (Shehata et al., 2007; Nyberg, 2011; Yunis, 2016). We use this idea (categorization of documents and document contents) and develop it to support the changeability concept in the proposed framework.

**MATERIALS AND METHODS**

A controlled case study was undertaken, drawing on two questionnaires. These questionnaires were designed in order to assess the need for shape an innovative framework for adaptive e-Learning systems. One questionnaire was passed to parents while the second was distributed to companies producing e-Learning systems for children. Both the parents and companies were based in Saudi Arabia due to the lack of presence of such systems.

**Parents:** Parents from Jeddah city in Saudi Arabia received the first questionnaire via an email containing a link to a questionnaire URL. Their children age 6-17. About 273 questionnaires were sent out. The questionnaire comprised 14 questions targeting the
parents and their expectations about their child’s learning. General data was collected through the questionnaire’s first section while the internet’s role in their children’s lives was explored during the second section. This section sought to investigate the attitudes of parents who are interested in providing their children with internet access and teaching them through it. The questionnaire’s subsequent section measured e-Learning’s effect on increasing their children’s comprehension, academic progress in addition to the preferred materials for designing and providing online instruction. A further questionnaire section investigated the effect of the type of machine used and their screens for entering the internet for learning. The questionnaire’s last section sought to understand parent’s perceptions of the personalization of e-Learning. The questionnaire results were collected and are presented in the results section.

Companies: The second questionnaire was disseminated to companies developing e-Learning applications for children. 6 companies were contacted. It comprised of 17 questions with some being open questions and others being multiple choice questions. The first part of the questionnaire collected general information about the companies, for example, the company’s size as well as the type of e-Learning programs they develop. Furthermore, the percentage of e-Learning applications directed towards children was asked. One question directed to the companies sought to identify which incorporated personalization and adaptation techniques in their e-Learning products. Additionally, the effect of adopting such techniques in terms of enhancing company income as well as encouraging customer sentiment were explored. Finally, companies were asked about personalization and adaptation technique’s advantages in terms of enhancing children’s education. These questionnaire results are also presented in the results study.

RESULTS AND DISCUSSION

This study explores the analysis of the questionnaire responses. About 273 responses were received from parents while 6 responses were returned by companies. The following 2 sub-sections summarize the results for the parents and companies, respectively.

Parent’s responses: The responses pertaining to the frequency of internet access revealed that most parents 63% permit their children daily access to the internet as illustrated in Fig. 1.

![Fig. 1: How often do you allow your children to visit the Internet?](image1)

![Fig. 2: Do you allow your children to study online?](image2)

When questioned about being permitted to study online, the majority of parent respondents 77% indicated that they always allow their children to study online. Furthermore, 23% of parents indicated that they sometimes permit their children to study online. Lastly, no respondents said that they do not allow their children to undertake learning online (Fig. 2). Therefore, these results evidently support the basic requirements for e-Learning applications.

Drawing on parent’s responses regarding the utility of online learning programs, all parents concurred regarding the significance of online courses for learning effectively with no respondent rejecting these statements (Fig. 3). Moreover, responses regarding the relationship between online study and improved grades showed that 5% said this always occurs 22% said often, while 73% said it sometimes occurs (Fig. 4).

The majority of children use their smartphone for internet access, however, the smartphone screen’s size is insufficient for many learning programs thus requiring a design interface that fits such screens. The majority of parents affirmed that software was not readily designed to fit smartphone screens 84% said sometimes while 16% said mostly no (Fig. 5).
Fig. 3: Do online courses help your children to understand the courses effectively?

Fig. 4: Do your children get high grades when they study online?

Fig. 5: Did any of the online courses use reasonable screen outline for your child’s device?

Concerning adaptation availability within e-Learning applications, the answers were generally pessimistic. The majority of respondents, 70%, indicated that e-Learning application’s adaptation features are rare while 30% noted that they are sometimes available. No respondents stated that adaptation is very frequent among e-Learning applications (Fig. 6).

Fig. 6: Did any of the online courses adapt to your child’s preferences?

Fig. 7: Is the personalization enhancing children’s learning?

Fig. 8: Is the personalization increasing the effectiveness of the learning process for children?

Finally, all parents agreed that the personalization and adaptation in e-Learning applications has an impact on improving children’s assimilation and increasing the effectiveness of learning (Fig. 7 and 8).

Company’s responses: The different sizes of the companies providing their responses are presented in
Fig. 9: Size of business

Fig. 10: Is the personalization enhancing kids learning?

Fig. 11: Is the personalization increasing the effectiveness of the learning process for the children?

majority permitted their children to learn online, due to their perception about the greater utility of such methods, compared with traditional techniques. Furthermore, these answers showing that they believed their children obtain higher grades as a result of using internet-based courses. It was also believed that the social dynamics of online courses enhanced their utility. Moreover, parent’s responses confirmed the dearth of e-Learning systems available via the internet that are adaptable to the child’s preferences or needs.

The responses to the first questionnaire provided insights into the potential and requirements of e-Learning applications from a consumer’s perspective. Regarding the human-computer interaction principle and device types available to children, parents require that applications should be adaptable to their children’s devices. Additionally, personalized and intelligently delivered content is a strong requirement from the parents and children’s perspectives. Overall, personalization and adaptation of e-Learning applications was highly sought after. Concerning companies, the questionnaire evidenced that all companies were producing online children’s courses that enhance the credibility of results. It was apparent that all companies adopted 3 distribution channels, namely their own company website, web-applications and social networks in order to publish their online courses.

The online course type (math, science, languages and so forth) was mentioned multiple times as being an influential variable, given that certain companies stated that the course type has an effect on the program’s performance. This explains the differences in the ability of children to learn a certain science in a particular way. Generally, based on parent’s feedback and effect on children’s educational level, the company perspective was that personalization and adaptation techniques
enhance learning effectiveness among children while also comprehensively improving the educational experience.

However, the adaptive e-Learning system has a myriad of obstacles remaining to overcome. As companies seek to respond to such obstacles, intelligent techniques are the foremost method for incorporating personalization and adaptation into e-Learning applications. Now, based on global trends and technological development it is apparent that adaptive and intelligent e-Learning systems will be positioned as the primary learning method for both companies and parents.

**Proposed framework: IAEM:** This research’s third area of enquiry has been addressed via the construction of an original framework, the Intelligent Adaptable e-Learning Model (IAEM) as a means of enhancing e-Learning experiences for children. The superiority of this framework stems from strong and continuous involvement of the teacher in adapting online courses. In addition, machine learning techniques are used to present a different structure of the online course for each user based on their behavior and characteristics and the teacher guidance. This smooth change in online course structure makes the framework precede other frameworks that rely primarily on the concealment or appearance of parts of the online course. The idea of this change depends on aspects of pedagogy that relate to the learning and teaching of different subjects and the differences between children and their behavior. Moreover, this framework has been designed to allow for the creation an adaptive e-Learning system with simplicity, ease of use and changeability properties. The salient features extracted from the previous literature, questionnaires results and aspects of pedagogy that relate to the learning and teaching were adopted to construct this framework. The proposed framework is illustrated in this section. As is apparent in Fig. 12, the model’s architecture comprises 5 major mechanisms that mutually interact. The framework’s processing study contains 2 components which are the machine learning tool and delivery engine. Three other components, namely teacher instruction, child’s learner (kid’s) model and contents, represent the adaptation rules repository, user model and domain model, respectively.

Machine learning was adopted within the framework, in order to fulfil two purposes. The first is concerned with an intelligent restructuring of course content, according to, certain teacher interactions while the second function is focused on modifying the kid’s model. These tools access the contents entity, so as to restructure it based on the type of material and adaptation rules comprising the teacher instruction model. Moreover, it undertakes tracking of user (learner) behavior in order to simultaneously update the kid’s model. The delivery engine entity is responsible for sending personalized material to the users with the entity communicating with the structured contents and the kid’s model to generate relevant contents for a particular user.

![Fig. 12: Proposed framework IAEM](image-url)
The teacher instruction entity provides a repository for the adaptation rules. Such rules are regulated by the teacher as a means of supporting and simulating teacher-student interaction. The teacher sets the rules to guide the machine learning tool in restructuring, arranging and connecting contents while also guiding the machine learning tool in updating the kid’s model. The kid’s model entity encompasses the personal data of each individual user (learner). The model is updated by the machine learning tool in order to better reflect the user’s behavior. Finally, the contents entity represents the domain model within the framework, comprising of material that is organized in a particular manner to assist the machine learning tool with restructuring the contents.

**CONCLUSION**

The e-Learning’s incorporation of adaptation and personalization has become a primary focus of attention among all education professionals and companies who are developing e-Learning applications. Typically, personalization and adaptation are deemed essential foundations for enhancing learning. The research results evidenced that parents prefer their children to use adaptive e-Learning applications, believing that it positively affects their academic progress, attainment and grades received. Additionally, companies producing such applications believe that personalization and adaptation increase children’s appetite for such applications, strengthens their capacity to learn and engage with lessons while also increasing the income of these companies.

Drawing on the research results, an innovative framework for adaptive e-Learning applications has been introduced. This framework implements machine learning techniques for adaptation of the e-Learning application. We anticipate that machine learning’s adoption for classifying and reconstruction of the course content as well as for determining accurately children’s characteristics and behavior should prove to be a significant contribution to e-Learning application’s adaptation. In addition to the previously mentioned, simplicity, ease of use and changeability gives the framework its novelty.

**REFERENCES**


