Towards a Deep Learning-Based Personalized Learning System for a Better Student Academic Performance

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Abstract-Several Personalized learning management systems have been developed in literature. However, there is need to develop a model that can properly categorize individual learners according to their preferred mode. Although personalized learning management systems exist in literature, there is a need to improve existing models and frameworks with a combination of an active learning model which leverage on the learning ability of deep learning neural network and interactive embedded indices of learning style. An extensive discussion is given on existing learning systems and their limitations; a personalized learning system framework is presented thereby suggesting a solution which involves the application of deep-learning approaches to improved personalized categorization of student specifics.

Keywords- E-Learning, Learning Management Systems, Deep Learning, Neural Networks, Student Performance

I. INTRODUCTION

Learning involves acquisition of knowledge, skills, behaviors or competencies [1]. Knowledge can however either be tacit or explicit. Explicit knowledge refers to knowledge that can be formalized, coded and communicated. It is found in manuals, formula and specifications while tacit knowledge refers to personal, experience-based knowledge that is difficult to explain to others. Due to the current trend involving the application of Information Technology techniques and tools to education, electronic learning has become a very useful and vital tool for communicating knowledge across among students and teachers [2]. Learning Management Systems (LMS) are designed to facilitate electronic learning. Previous Research works on personalized learning system mainly focused on improving student learning achievement based only on single-source of personalization information, such as learning style and cognitive style with more attention is focused on learner's distinct background, knowledge level, Learners skills and motivation through the use of learning style questionnaires [3], [4].

However, there is need to develop a model that can properly categorize individual learners according to their preferred mode of learning by extending the single source of personalization with a combination of an active learning model which leverage on the learning ability of deep learning neural network and interactive embedded indices of learning style and web crawling agent This paper intends to discuss the various existing techniques used in the development of LMS in recent literature and presents a framework for developing deep learning-based learning systems to improve categorization of student-personalized learning needs.

II. THEORETICAL BACKGROUND

Electronic Learning (E-learning), also referred to as online learning is one of the prominent application area of computer in education system, it is a learning system based on formalized teaching, acquisition of knowledge which takes place through electronic technologies, media or electronic resources ([5], [6]). E-learning is an electronic means of transferring skills and academic knowledge to one or more individuals through virtual means at same or different times. ([7], [8]). E-learning systems are usually integrated as web-based systems that support numerous learning activities, ranging from class notes and lectures to evaluation activities such as tests and self-assessments. Over years it has been used to improve the learning curve of students, as well as to enhance the communication, presentation and collaboration between the instructors and students or learning group [9]. The system has changed the face of educational training from traditional classroom facilitated sessions to online, web-based, mobile learning that meets the needs of the modern learners ([10], [11], [12]).

[13] further stated that while in-classroom, teaching with face-to-face communication allows clear understanding between teachers and learners, such direct communication is typically unavailable with e-learning. This teacher/instructor–learner relationship, however, has to be carefully mediated by technology throughout the process of teaching and learning. This together with other instructors and learner's activities as carried out on the e-learning system often generate numerous data which is usually collected and analyzed to achieve an effective learning system. E-learning systems are integrated web-based systems designed with computing techniques which support numerous learning activities ranging from class notes and lectures, to evaluation activities such as tests and quizzes. This integrated system is often referred to as Learning Management System (LMS). Using the typical web-based LMS, teachers have an option to design the syllabus for the

course, and post all the learning materials, from lecture notes, presentations and videos, to homework assignments, tests and quizzes [14].

To mention a few LMS, [15] applied Unified Modelling Language (UML) tools achieve personalization of learning systems for students. Specifically use case diagram, flow chat and data flow diagrams were employed based on each learner's specific interest and needs. Graph theory methods was applied to develop personalized learning systems [16]. A learning system were modelled as weighted directed graphs with courses as nodes. [17] used ontological engineering approaches to develop a learning management system. [18] applied data mining and learning analytics approaches in their design of LMS. The use of computing techniques to improve learning systems cannot be over emphasized.

The introduction of Artificial Intelligence (AI) techniques however, in teaching and learning processes has further improved electronic teaching and learning ([19], [20]). Personalized learning systems use AI tools to track information about the learning process of students and ensure proper resources allocation. These systems can record information about how students learn, analyze information and also generate warnings about certain students with slow progress. At the heart of a personalized learning systems, is a set of AI techniques which includes machine learning, deep learning, natural language processing, uncertain reasoning, cognitive modeling, case-based reasoning, speech recognition and others. These AI techniques when synergized with traditional teaching methods improves the quality, delivery, and nature of education system.

Recent research have applied machine learning techniques to improve personalized learning systems ([21], [22], [23], [24]). In [25]'s work, machine learning techniques were employed in the development of a learning management system to predict student's success rate and to also detect at-risk students. Also, machine learning algorithms were employed to develop a virtual learning environment in order to detect student's engagement level in various courses and also the effect on their assessment scores [26]. Internet of Things (IoT) Capabilities have also been applied to LMS which simulates academic activities and offer adaptive self-learning procedures [27].

III. PERSONALIZED LEARNING SYSTEM FRAMEWORK USING DEEP LEARNING

Deep learning involves large neural networks which model abstractions from data using several layers [28]. Deep learning when applied to learning systems provide the learners with stored knowledge that match their specific individual needs and preferences [21]. The major aim of deep learning models is to offer solutions to predictions, associations and classification problems. This work uses a combination of deep learning models and learning styles to solve classification problem in

personalized learning systems. There are however four commonly used deep learning models used in personalized learning systems as indicated by [24]. They are Recurrent Neural Network ([29], [30]), Convolution Neural Network ([31], [32]), Deep Belief Network ([33], [34]) and Deep Neural Network ([35], [22]).

Deep learning frameworks for learning management systems is a current research. [24] developed a deep learning framework for eLearning environments as shown in figure 2. It explains how existing learning resources, learner's historical data, facial expressions of learners, mentor's skills and experience and information can be used by deep learning models to improve learning management systems [24].
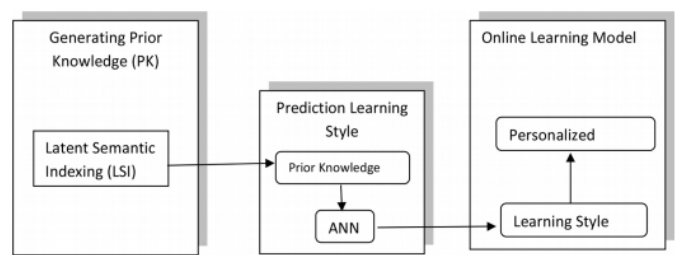

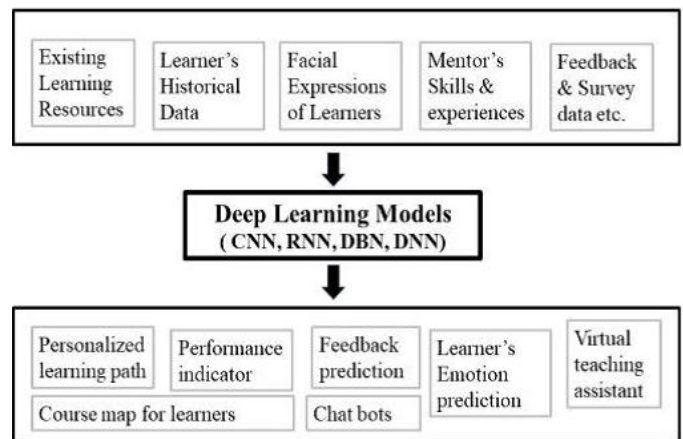Figure 1. Personalized Learning System [2].

Figure 2. Deep Learning Framework for the eLearning environment [24]

A Deep Learning Framework for Personalized Learning Management System (figure 3) is presented which makes use of embedded index of learning style, intelligent navigation Agent, Quiz Response Evaluator as an extension to the prior knowledge generation which was used in the research carried out by [2] and [24] shown in figure 1 and 2 respectively.
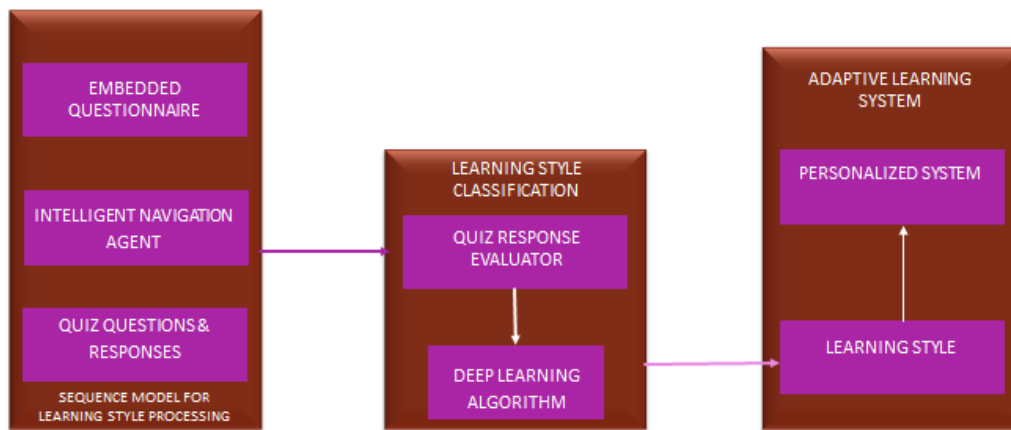
Figure 3. Deep Learning Framework for Personalized Learning Management System

IV. CONCLUSION

This work extends and improves on existing deep learning frameworks for personalized learning management systems with the inclusion of an intelligent navigation agent, embedded index of learning style and a quiz response evaluator. This features when implemented, are expected to produce a more robust and user friendly personalized learning management system.

REFERENCES

[1] C. Şentürk and G. Baş. "An Overview of Learning and Teaching from the Past to the Present: New Learning and Teaching Paradigms in the 21st Century". In Orakcı, Ş. (Ed.), Paradigm Shifts in 21st Century Teaching and Learning (pp. 1-19). IGI Global. http://doi:10.4018/978-1-7998-3146-4.ch001, 2020.

[2] M. S. Hasibuan, L. E. Nugroho and P. I. Santosa. "Model Detecting Learning Styles with Artificial Neural Network". Journal of Technology and Science Education, 9(1), 85-95, 2019.

[3] C. R. Judy, C. Hui-Chun, H. Gwo-Jen and T. Chin-Chung. "Development of an adaptive learning system with two sources of Personalization Information". Computers & Education 51, 776–786, 2008.

[4] S. Graf and Kinshuk. "Personalized Learning Systems". In: Seel N.M. (eds) Encyclopedia of the Sciences of Learning. Springer, Boston, MA, 2012.

[5] O. S Adeola, O. S. Adewale and B. K. Alese. "Integrated E-Learning System (IES) for the Nigeria Universities: An Architectural Overview". American Journal of Database Theory and Application, Vol. 2(1) 1-8. 2013. doi: 10.5923/j.database.20130201.01.

[6] S. K. Basak, M. Wotto, and P. Be´langer. "E-learning, M-learning and D-learning: Conceptual definition and comparative analysis". E-Learning and Digital Media, Vol. 15(4) 191–216. 2018.

[7] A. Kalaivani. "Role of E-Learning in the Quality Improvement of Higher Education". IOSR Journal of Humanities And Social Science Volume 19(11), Ver. V. aapp 15-17, 2014.

[8] G. S. Babu and K. Sridevi. "Importance of E-Learning in Higher Education: A Study". International Journal of Research Culture Society Volume 2(5), 84-88, 2018.

[9] M. Raspopovic and S. Cvetanović. "Implementation of Adaptive E-Learning through Workflow Technology". The Second International Conference on e-Learning (eLearning-2011), 29-30 September 2011, Belgrade, Serbia 124-129.

[10] N. David, S. T. Sreenivas, and B. Nilufar. "Personalized Learning: Current status and potential". INUTEC Institute of Technology, 2014.

[11] D. Nandigam, S. S. Tirumala and N. Baghaei. "Personalized learning: Current status and potential," 2014 IEEE Conference on e-Learning, e-Management and e-Services (IC3e), Hawthorn, VIC, 2014, pp. 111-116, doi: 10.1109/IC3e.2014.7081251.

[12] J. D. Basham, T. E. Hall, R. A. Carter and W. M. Stahl. "An Operationalized Understanding of Personalized Learning". Journal of Special Education Technology, 31, 126-136, 2016.

[13] S. Ghavifekr, T. Kunjappan, L. Ramasamy and A. Anthony. "Teaching and Learning with ICT Tools: Issues and Challenges from Teachers' Perceptions". Malaysian Online Journal of Educational Technology, volume 4 (2), pp 38-57, 2016.

[14] A. P. Lopes. "Learning Management Systems in Higher Education". In Proceedings of Edulearn 14 Conference 7th-9th July, Barcelona, Spain. 5360-5365, 2014.

[15] N. Gavrilović, S. Jovanović and A. Mishra. "Personalized Learning System Based On Student Behavior and Learning Style. In proceedings of the 8th International Conference on eLearning (eLearning-2017), 28 - 29 September 2017, Belgrade, Serbia

[16] I. A. Alshalabi, S. E. Hamada, K. Elleithy, I. Badara and S. Moslehpour. "Automated Adaptive Mobile Learning System using Shortest Path Algorithm and Learning Style". International Journal of Interactive Mobile Technologies. Vol 12(5), 4-27, 2018.

[17] M. Rani, K. V. Srivastava and O. P. Vyas., "An Ontological Learning Management System", Computer Applications in Engineering Education, Wiley Online Library, 2016.

[18] D.M. Olivé, D.Q. Huynh, M. Reynolds, M. Dougiamas and D. Wiese. "A supervised learning framework for learning management systems". DATA '18. 2018

[19] E. Bachari, E. Abelwahed and M. Adnani. "E-Learning Personalization Based On Dynamic Learners' Preference". International Journal of Computer Science & Information Technology (IJCSIT), Vol 3(3). 200-216, 2011.

[20] M. Fahimirad, and S. S. Kotamjani. "A Review on Application of Artificial Intelligence in Teaching and Learning in Educational Contexts". International Journal of Learning and Development, Vol. 8 (4) 106-118, 2018.

[21] A. Chanaa, and N. E. Faddouli. "Deep learning for a smart e-Learning system," 2018 4th International Conference on Cloud Computing Technologies and Applications (Cloudtech), Brussels, Belgium, pp. 1-8, doi: 10.1109/CloudTech.2018.8713335. 2018.

[22] A.C. Martín, C. Alario-Hoyos, and C.D. Kloos. "Smart Education: A Review and Future Research Directions. Proceedings 2019, Volume 31, 57.

[23] J. Martin. "Adaptation using Machine Learning for Personalized eLearning Environment based on Students Preference". International Journal of Innovative Technology and Exploring Engineering (IJITEE), Volume-8 Issue-10, August 2019 4064-4069.

[24] A. Muniasamy and A. Alasiry. "Deep Learning: The Impact on Future eLearning". International Journal of Emerging Technologies in Learning (iJET) 15(01):188-199, 2020.

[25] A. Buschetto Macarini, C., Cechinel, M.F.Batista Machado, R. V. Faria Culmant and R. Munoz. "Predicting Students Success in Blended Learning-Evaluating Different Interactions inside Learning Management Systems". Appl. Sci. 2019, 9, 5523.

[26] M. Hussain, W. Zhu, W. Zhang, S. Muhammad & R. Abidi. "Student Engagement Predictions in an e-Learning System and Their Impact on Student Course Assessment Scores". Computational Intelligence and Neuroscience, 2018.

[27] K. Mershad and P. Wakim. "A Learning Management System Enhanced with Internet of Things Applications". Journal of Education and Learning, 7, 23-40, 2018

[28] A. Moubayed, M. Injadat, A. B. Nassif, H. Lutfiyya and A. Shami, "E-Learning: Challenges and Research Opportunities Using Machine Learning & Data Analytics," in IEEE Access, vol. 6, pp. 39117-39138, 2018, doi: 10.1109/ACCESS.2018.2851790.

[29] Z. C. Lipton, D. C. Kale, C. Elkan and R. Wetzel. Learning to Diagnose with LSTM Recurrent Neural Networks. International Conference on Learning Representations (ICLR), 2016.

[30] F. Okubo, T. Yamashita, A. Shimada, Y.Taniguchi, and S. Konomi. "On the Prediction of Students' Quiz Score by Recurrent Neural Network". Proceedings 8th International Conference on Learning Analytics & Knowledge, 2018.

[31] A. Sun, Y. Li, Y. Huang, and Q. Li. "Using Facial Expression to Detect Emotion in E-learning System: A Deep Learning Method". In: Huang TC., Lau R., Huang YM., Spaniol M., Yuen CH. (eds) Emerging Technologies for Education. SETE 2017. Lecture Notes in Computer Science, volume 10676. Springer, Cham 2017

[32] A.P. Patil, K. Ganesan and A. Kanavalli. "Effective Deep Learning Model to Predict Student Grade Point Averages". 2017 IEEE International Conference on Computational Intelligence and Computing Research (ICCIC), 1-6. 2017

[33] L. Deng, G. Hinton, and B. Kingsbury. (2013). New Types of Deep Neural Network Learning for Speech Recognition and Related Applications: An Overview. In Proc. Int. Conf. IEEE Acoustics, Speech and Signal Process., Vancouver, BC, Canada, pp.8599–8603.

[34] H. Zhang, T. Huang, S. Liu, H. Yin, J. Li, H. Yang and Y. Xia "A learning style classification approach based on deep belief network for large-scale online Education". Journal of Cloud Computing: Advances, Systems and Applications 9(26), 2020.

[35] P. McClure and K. Nikolaus. "Representational Distance Learning for Deep Neural Networks". Front Comput Neurosci, 10: 131, 2016.