Metacognitive Proactive Hybrid Learning Model Using ICT Tools

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***Abstract*— Many aspects characterized novelty. In both practical and theoretical regards, the difficulties observed in technical education are addressed from the psycho-cognitive and the psycho-pedagogical point of view. The modern education system slowly adapts itself to the most powerful educational tools such as Web-based learning, problem-based learning, and collaborative learning methods. Still, they have their scope and limitations, such as difficulty in integrating online and offline, lack of an assessment tool for quality assurance, etc. Hence, the research work's objective was to develop a Metacognitive Hybrid Model (MHM) for enhancement of the transformative potential of outcome-based, blended learning in the higher technical institutions. The MHM model consists of both full-fledged online as well as conventional classroom instructions. Hence, the proposed MHM is highly effective and an efficient model to improve the basic knowledge of the heterogeneous student community and improve their technical knowledge and progression rate. The analysis of the proposed model's results was computed based on C.O. (Course Outcomes) attainments, grading statistics, and the success rate. The research results show that the success rate of students who adopted the MHM improved by ~8% compared to conventional teaching methods. MHM increases Course Outcome-1 and Course Outcome-2 by 18% and 9%, respectively, which leads to the improvement of basic understanding and application of technology. A minimal impact on Course Outcome-3 and Course Outcome-4 was observed, which is less than 6% due to an increase in the design aspects of the respective courses that were adopted. MHM has been progressively recognized as one of the essential components for the faculties to nurture their students in an Outcome-Based Education (OBE) System**

Keywords: ***Metacognitive Hybrid Learning Model, Outcome Based Education, Bloom Taxonomy, Course outcome***

I. INTRODUCTION

Concerning the 21st century's students' progress level and further enhancing their performance, we need to adopt some innovative teaching methods and the traditional classroom teaching. For example, suppose in a class there are sixty students. We are aware that all are not on the same level with respect to their thinking, perception, attention, remembering level and learning ability, then in order to address the above issue and also to achieve better attainment with respect to Outcome Based Education (OBE) system. In that case, a new innovative hybrid model is required. In the OBE system, if we follow only the Web-based ICT teaching or only the traditional classroom teaching, it had its pros and cons, and it's not possible to achieve an enhanced teaching-learning process. Suppose we adopt metacognitive[1,2] hybrid learning model. In that case, we can improve heterogeneous student levels such as slow learners, the students irregular to the traditional class due to their interaction with the external world, and the magnificent students in the higher technical education. The metacognition describes thinking about thinking [3], knowing about higher-order thinking skills, which gives more clarity of concepts. Expanding beyond thinking leads to explicit teaching-learning strategies for metacognition, which leads to improvement in OBE course outcome attainment [4]. Concerning Education Endowment Foundation (EEF), the metacognition approach is described to have "consistently high levels of impact, while acknowledging that they can also be changed for implementation" [5]. There are three phases in metacognition: planning, monitoring, and evaluation, which talks about refractive thinking. This helps the teachers figure out whether the current approach is working and what can be improved to encourage students to change their strategies if necessary. As we are aware, it's not about what one needs to learn or teach in academic terms, but it is about how one can learn or teach the best. If we deliver the right content and reach out to students, then they can achieve their goals at a high excellence level. Hence, metacognition knowledge improves self-confidence and academic performance in several ways to regulate cognitive processes such as changing learning strategies, learning tasks planning, comprehension monitoring, evaluating progress, and receiving thinking approaches [6-9]. To address all these, we need to design the complete course content in offline mode, i.e., traditional classroom and Web-based e-content mode. The package of these two approaches is widely known as the metacognitive proactive hybrid learning model using ICT tools [10].

Therefore, the present manuscript introduces a real-time model which has been analyzed to show that hybrid modelling offers better customizable and quality knowledge delivery system. The paper is organized as following: Section 2 discusses about the existing approach towards improving the knowledge delivery system while Section 3 discusses about the research problem associated with existing approaches. Section

IV highlights about the proposed design while Section V discusses about the results obtained after implementing the proposed model. Section VI summarizes the paper

II. Literature Review

At present, various research work has been carried out towards improving the process management of the modernized education system. There is a consistent evolution of ICT tools and innovative approaches to impart quality education. At present, both educational institutions and students strongly feel that there is a need to design more innovative teaching-learning process in higher education. One of the recent works carried out by Nassr et al. [11] and Supriyatno [12] has discussed the challenges of imparting education during emergency time. This study offers an alarming situation where there is a need to adopt various ICT tools to impact education precisely. Another recent research by Wang et al. [13] has emphasized the collaborative learning model using Internet-of-Things (IoT). The work carried out by Vagarinho et al. [14] has discussed process-oriented learning to improvise the teaching quality focusing on the e-learning system. A similar direction has also been carried out by Pham et al. [15], where a smart education system using digital transformation is emphasized. Besides fostering and adopting the latest technologies of IoT fog computing and blockchain is also adopted by Chaiyarak et al. [16] towards evolving up with a novel smart education management system. Chen et al. [17] have further discussed artificial intelligence in an education system. According to the author, apart from effective content management, artificial intelligence could significantly help customize the learning management system. This fact was further advocated in Ciolacu et al. [18] where blended learning mechanism is adopted smartly towards better performance by the student. The inclusion of automation standard 4.0 was emphasized in the work of Mourtzis et al. [19] and Leal et al. [20]

Different researchers have emphasized the approach of blended learning, which combines both conventional and electronic media to perform knowledge delivery system (Albano et al. [21], Boyle et al. [22], Garrison et al. [23], and Badawi et al. [24]). It was observed that there is creating adoption for blended learning in the education system since long term perspectives, e.g., Delialioglu et al. [25], Dzakira et al. [26], and Hameed et al. [27] have investigated the effectiveness of the blended learning methodology long back considering various use-cases. A current study carried out by Lim et al. [28] and Yuen et al. [29] have discussed the advantages of the same approach.

This system is applicable for various levels of education among heterogeneous students' community [30-31]. Numerous benefits drive this technique; its implementation has seen a significant increase in today's education scenario [32]. The hybrid model uses ICT tools to create online lecture content for education, and its adoption makes a web-based approach to teaching, learning, and research [33-35]. These ICTs are used in blended learning to develop the course content online, deliver lectures, and share the learners' generated course content [36-40]. It keeps the students, teachers, and research scholars connected regardless of time differences, geographical barriers, fostering better teaching and improving students' academic achievement [41-42]. Hence, integrating ICT with a hybrid model will impact higher education, increasing the quality of education [43-44].

In an outcome-based education, the teacher's role is vital in determining a good design to achieve the targeted learning outcomes [45-49]. To achieve better learning outcome attainment, teachers have to adopt various innovative teaching methods to achieve effective learning mechanisms [50-52]. The objective learning achievement and the impact of the teaching-learning process can be measured based on the learning outcome scores secured by the students [53-54]. The higher learning motivation across the student's course will lead to better academic success [55-56].

Another important aspect is to measure the hybrid learning model through the learner's interaction with the students and the faculties [56-57]. The learner's' interaction includes thinking, pairing, and sharing contents, creating a platform for discussions, problem solving, providing responses to others' perspectives, and sharing expertise [58-61].

The next section discusses about the limitation associated with existing approaches.

III. Research Problem

A closer look into the existing trend of literatures shows the usage of advance technologies as well as various innovative approach in order to offer better knowledge deliver system. However, there are certain prime loopholes in this regards as follows:

- The emphasis is given mainly towards inclusion of latest technologies without assessing if they will be suitable for execution in any device or user's resources. Usage of advance technologies also demands usage of equivalent supportive tools.
- Existing studies doesn't emphasize much into creating more innovation in blending methodology. Existing blending methodologies are hypothetical model which are yet to be assessed.
- Existing studies doesn't emphasize on the grasping capability of the student, which may differ from one to another student. The literatures doesn't offer any framework or model which is meant for student's with weak grasping capability.

Therefore, from the above highlighted limiting factors of existing study, it can be said that developing a simplified and highly customizable tool considering the hybrid methodology is an emergent need.

IV. Proposed Design

The proposed study presents a framework to offer a comprehensive knowledge delivery system prioritizing the students' quality and circumstantial demands. The proposed metacognitive proactive hybrid learning model aims to improve students' self-confidence and academic performance. This method is aggressive because of its cognitive process, ability to create awareness and controlling power, and proper feedback.

The proposed system consists of two models, which are discussed as follows:

A. Metacognitive Proactive Hybrid Learning Model

This model's prime purpose is to facilitate a knowledge delivery system considering both online and offline modes. It prioritizes the situational demand of the student to impart education customized to their needs.

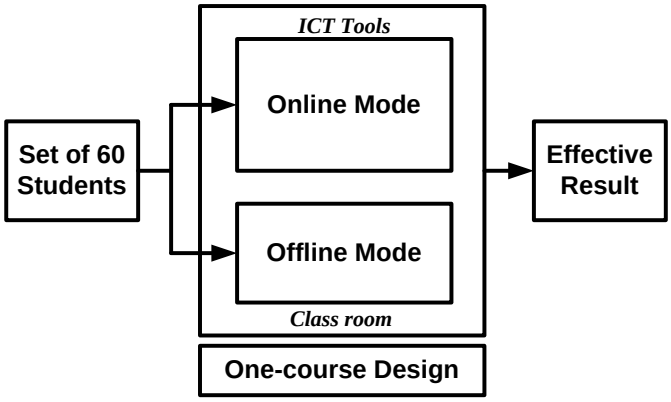

Figure 1 Metacognitive proactive hybrid learning model

The proposed model as shown in Fig.1, is designed for one of the undergraduates because of a set of fifty students. This model is the integration of 100% web-based course content design using ICT tools. It will mean that content management is carried out using online mode while the complete course content is delivered in the traditional classroom teaching i.e., offline mode. This hybrid's advantage is that the students can obtain the course contents either from the online way or from the offline mode or both. Hence, the model ensures better availability of the course contents and study materials. Students who are slow learners are facilitated to opt for both online and offline classes. In offline teaching mode, the entire course content is delivered through the chalk and talk. It is hard for them to grasp the classroom concepts only through offline teaching due to their lack of prior knowledge, lack of concentration or communication problems, and repetitive education. The entire course has been recorded in online teaching, and the Jeopardy lab tool was used to create an interactive application concerning the course's specific topic. In addition to this TED-Ed tool offers teachers a great platform to build their flipped class or make a new lesson about their videos. The ThingLink was used to embed videos on images, create the tag and annotations maps, or create a story tag**.** The above mentioned online contents were embedded into the Google sites LMS platform. Hence, the pre-recorded lecture videos available in the web portal will allow them to watch the videos repetitively to help them understand the concepts clearly. This online course content design can also help some of the students with their participation in intra, and inter-college level events or their absence from traditional classroom teaching because of health issues. During these circumstances, the students can get regular lecture updates through the online mode. The proper integration and synchronization between the online and offline course content design help the student's community improve their academics and thinking ability. Both surveys and offline, there is an evaluation process that acts as a feedback for the students and the teachers to understand their capacities and shortcomings. There are three Continuous Internal Evaluations (CIE) followed by one Semester End Examination (SEE) for each semester in offline mode. In an online way, for every lecture, an online quiz is conducted through the Google form.

B. Modelling ICT Tools:

Adopting an innovative teaching process using these ICT tools is not an easy step for teachers. This is because they find it challenging to step out of their comfort zone, given the chances for failure. Hence, a good and firm step must be taken towards experimenting with new methods and strategies instead of worrying about losses. It is essential to realize that the new process will improve the student's involvement, attainment, and motivation and it is a win-win situation for both students and teachers. The adoption of technology-based innovative teaching provides active based learning and makes the classroom more attractive due to a fun based learning. Today's technology offers teachers many resources to fulfill the needs of modern, active students. There are many ICT tools are used in the proposed design, such as Google sites, ThingLink, Ed Ted, YouTube, Google forms, jeopardy, plikers, VideoNot, Screencast-o-matic, Voice Threading is as shown in Fig.2

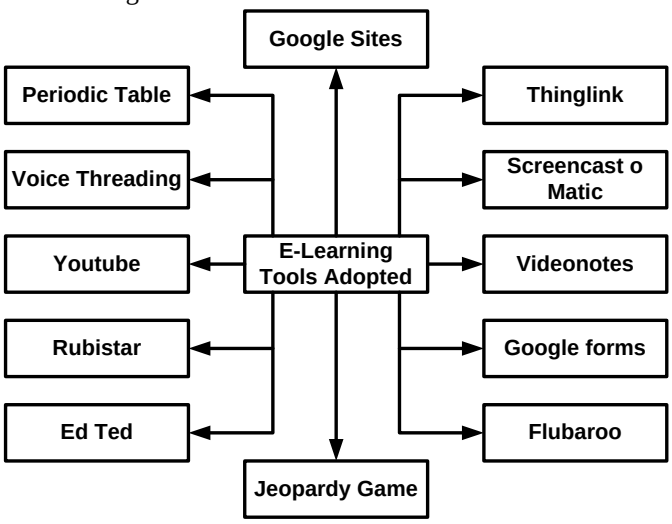

Figure 2 list of ICT tools to create an online course

The briefing of these ICT tools are as follows:

- ***Google sites:*** It is used for designing the course web page and is a structured wiki. This tool creates a platform for the courses and other tools mentioned above to make this web page more effective by aiding actions such as adding videos, embedding video to image and creating games, etc.
- ***ThingLink:*** It is used to add videos on the images to the collage of images related to a specific subject, create the tag and annotations maps, or create a story tag on the photos. In our course, we used to place the videos and for annotation tags. For example, when you discuss four-wheeler engines, if you place the animated engine video

near the engine's position in the car image, it is more understandable than talking orally.

- ***Ed Ted:*** With the help of this, we can create the customized and animated videos. This establishes the quiz questions in synchronization with video timing to cross verify the right answer for the questions, which will save the student's time in finding solutions.
- ***YouTube:*** In the proposed model, we have used YouTube to upload lecture videos and have called those videos into the Google Sites virtually because there is less space for each user in Google sites.
- ***Google forms:*** It is used to conduct online quizzes, taking course end surveys and for course registration, etc.
- ***Jeopardy:*** It is used to create a game concerning a specific topic of the course. This takes a complete 180º turn around on the normal quizzes. In this game, students get the answer for which they are required to frame a question. This method amplifies the student's understanding level much better than the usual way quizzes are conducted. This is more fun and interesting for the students.
- ***Plikers:*** It is an assessment tool that helps the teachers test the student's understanding level by creating an on the spot formative assessment without using paper or devices or a pencil.
- ***VideoNot:*** It allows the teachers to synchronize their textual lecture notes while students watch the videos. This helps the students directly see the frame of content required in a lengthy video, and the students obtain the typed content.
- ***Screencast-O-Matic:*** This is a desktop activity recorder that helps ti.e.students recall the faculties' activity when explaining any new simulation concerning design. The recorded video can then be uploaded to YouTube and virtually called in the Google Sites for future reference.
- ***Voice Threading:*** This tool helps the faculties and students to share and create images, Powerpoint presentations, videos, and audio files, word documents, and PDF using webcam, text, microphone, and audio-file upload.

V. Result Analysis

The proposed model MHM (Metacognitive Hybrid Model) performance is tested and measured concerning CIE marks Course Outcome (C.O.) attainment, progression in SEE grad points, and pass percentage result analysis when compared with WMHM (Without Metacognitive Hybrid Model). The proposed MHM model was deployed for the course – 'Digital Logic Design' of Third Semester of Electronics & Instrumentation Program - for one group of 50 students of Undergraduate in - Rastreeya Vidyalaya College of Engineering, Bengaluru, India. It was deployed in a flipped classroom environment that combined online and face-to-face content delivery. Another set of 50 students were taught through the traditional classroom, i.e., WMHM (Without Metacognitive Hybrid Model). To attain eligibility for the regular Continuous Internal Evaluation (CIE) conducted by the Institution, the students must clear online assessment of each unit by obtaining at least 70% of the marks after completing each unit in both learning models. Otherwise, students should expose themselves to both models once again until he/she clears the online assessment tools with a 70%. For all three CIE conducted per semester, the questions are formulated based on Bloom Taxonomy (B.T.) and Course Outcomes (C.O.s). Course Outcome (CO1) refers to the remember & understand the combinational and sequential circuits, Course Outcome (CO2) refers to apply the concepts and implement digital logic circuits, Course Outcome (CO3) refers to Analyses. It evaluates the combinational and sequential circuits design and Course Outcome (CO4) design and development of state machines for specific applications.

A. *Analysis of C.O. – Attainment Statistics*

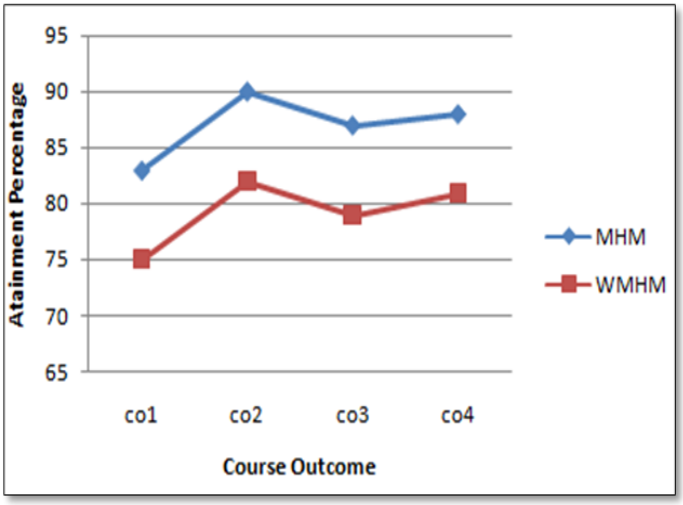

Figure 3 Course Outcome (C.O.) Attainment Statistics between MHM v/s WMHM

The Fig.3 graph shows the average course attainment of all the 60 students from Course Outcome -1 – Course Outcome - 4 for WMHM (Without Metacognitive Hybrid Model) and the proposed MHM (Metacognitive Hybrid Model). The Course Outcome attainment of each student is calculated based on the following formula (1).

$$\text{C.O.} = \frac{\text{Obtained Marks } (\sum_{k=1}^{3} \text{CIEk+LAB+EL})}{\text{Maximum Marks } (\sum_{k=1}^{3} \text{CIEk+LAB+EL})} \quad \text{---------} \quad (1)$$

CIE is Continuous Internal Evaluation for all the three CIE's in a semester, LAB is laboratory marks, and E.L. is Experiential Learning Marks. The average of each Course Outcome, i.e., Course Outcome 1 to Course Outcome 4, is calculated by taking the mean of all the student attainment concerning formula (2).

$$\text{COn} = \frac{\textit{Sum of all the students attainment of the COn}}{\text{N number of students}} \quad \text{---------} \quad (2)$$

Where n= 1,2,3,4.

The results analysis was computed based on Course Outcome's attainments and success rate. The research results show that the group of students who adopted the MHM success rate improved by ~8% compared to the conventional teaching method. MHM increases the success rate in Course Outcome-1 (BT-1 and 2) and Course Outcome -2 (BT-3) by 18% and 9%, respectively, which leads to the improvement of basic

understanding and application of technology. A minimal impact is observed on Course Outcome -3 (BT-4) and Course Outcome -4 (BT-5&6), which is less than 6% due to the more design aspects of the respected courses adopted. Hence the proposed model is well suited for the OBE system.

B. Analysis of Grade Point Progression statistics

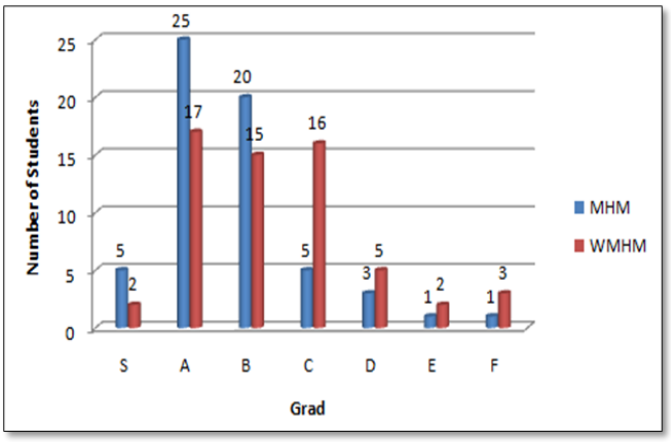

Figure 4 Grade Point Progression statistics between MHM v/s WMHM

Fig.4 clearly shows that the proposed model enhances the SEE grad points compared to WMHM. The students in grades B and C in WMHM are moving to grade A and B, respectively, using the proposed MHM, and F grades are gradually reduced. S is the highest grade, E is the lowest grade, and F is the failure.

C. Analysis of Pass Percentage Result Analysis Statistics

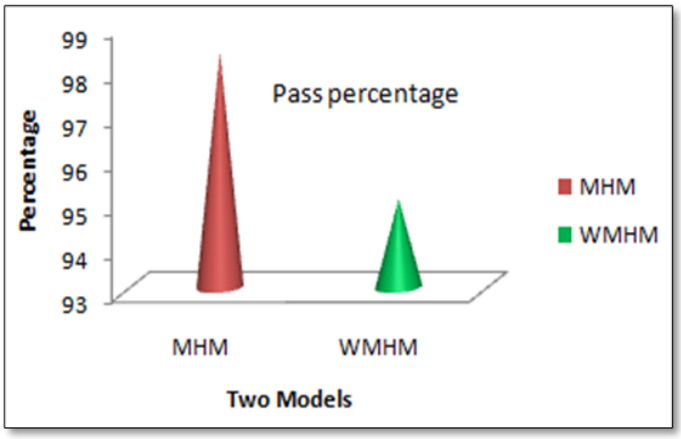

Figure 5 Pass Percentage Result Analysis Statistics between MHM v/s WMHM

The above graph, Fig.5, shows the pass percentage analysis. The proposed method gives an improved pass percentage when compared with the WMHM

D. Study Findings

This survey investigates the relationship between hybrid metacognitive model usage in teaching and students' learning outcomes and satisfaction. Learning outcomes are measured on the students' perceived level of attainment of learning Outcome and the perceived quality of learning experience in online classes. Student's satisfactions are measured by their willingness to retake online courses or recommend the instructor of online courses taken to other students. All of the multi-item constructs were measured using five-point Likert scales. Six constructs were used to measure the data, including Student motivation, Student Instructor relationship, Course Design and Structure, Self-regulation, Learning outcomes, and User satisfaction. The survey was administered to 50 students who took up this course.

Table 1 provides the mean, standard deviation, and correlation factors among the constructs. The mean and standard deviation is measured based on the mean and standard deviation of the Likert scale (1 being completely disagreed and 5 being wholly agreed). It is observed from the survey that students have given positive feedback about the hybrid learning methodology, and analysis proves that hybrid learning adopted for course design and delivery is effective as compared to regular classroom course delivery.

Table 1 shows the descriptive statistics and correlation among the constructs

Construct	1	2	3	4	5	6
Student motivation	0.87					
Student-Instructor relationship	0.53	0.91				
Course Design and Structure	0.12	0.15	0.78			
Self-regulation	0.27	0.25	0.60	0.79		
Learning outcomes	0.71	0.74	0.17	0.19	0.84	
User satisfaction	0.78	0.48	0.18	0.17	0.86	0.89
Mean	3.84	3.97	3.93	3.62	3.57	3.79
Standard deviation	0.85	0.73	0.94	0.81	1.02	1.11

VI. CONCLUSION

The MHM model improves the self-confidence of the students as well as their academic performance. This is because of its cognitive process's proactive nature, ability to create awareness, and controlling power with a proper feedback mechanism. The result and the feedback analysis depicted in Fig.3, Fig.4, Fig.5, and Table.1 describes the proposed MHM model, and it is likely to emerge as the predominant instructional model in future technical education. In addition to this, MHM helps the professor focus more on the modeling and design aspects of the course rather than introducing concepts in conventional classroom teaching. The cons of the model are that the faculties have to stretch their work bandwidth at the initial stage of model design

REFERENCES

[1] Hall, A. E., Danielewicz, J. & Ware, J. (2013). Designs for writing: A metacognitive strategy for iterative drafting and revising. In M. Kaplan, N. Silver, D. LaVaque-Manty, & D. Meizlish (Eds.), Using reflection and metacognition to improve student learning: Across the disciplines, across the academy (pp. 147-174). Sterling, VA: Stylus.

[2] Jaschik, S. (2011). Can Students Learn to Learn? Colleges experiment with metacognition as a means to change behaviors and improve performance. Inside Higher Education, January 31, 2011.

[3] Lovett, M. C. (2013). Making exams worth more than the grade. In M. Kaplan, N. Silver, D. LaVaque-Manty, & D. Meizlish (Eds.), Using reflection and metacognition to improve student learning: Across the disciplines, across the academy (pp. 18-48). Sterling, VA: Stylus.

[4] Ekemini T. Akpan, "Blended Learning Opportunities And Challenges In Mathematics Education: Perspective In Higher Education", South American Journal of Academic Research, Volume-2, Issue-1, 2015.

[5] Hoffman, B. (2009). 5 pitfalls to understanding people's motives: An educational psychologist reveals why it can be so tricky to interpret the behavior of others – and ourselves. Retrieved from https://www.elsevier.com/connect/5-pitfalls-to-understandingpeoples-motives

[6] Lee, S., & Carpenter, R. (2015). Creative thinking for 21st century composing practices: Creativity pedagogies across disciplines. Across the Disciplines, 12(4), 1–24. Retrieved from https://wac.colostate.edu/atd/performing_arts/lee_carpenter2015.cfm.

[7] Larson, L. C., & Miller, T. N. (2011). 21st century skills: Prepare students for the future. Kappa Delta Pi Record, 47(3), 121–123. doi: 10.1080/00228958.2011.10516575

[8] Husamah, H. (2015a). Blended project based learning: Metacognitive awareness of biology education new students. Journal of Education and Learning, 9(4), 274–281. doi: 10.11591/edulearn.v9.i4.2121

[9] López-Pérez, M. V., Pérez-López, M. C., & Rodríguez-Ariza, L. (2011). Blended learning in higher education: Students' perceptions and their relation to outcomes. Computers and Education, 56(3), 818–826. doi: 10.1016/j.compedu.2010.10.023

[10] Azizan, F. Z. (2010). Blended learning in higher education institution in Malaysia. Proceedings of Regional Conference on Knowledge Integration in ICT.

[11] R. M. Nassr, A. Aborujilah, D. A. Aldossary and A. A. A. Aldossary, "Understanding Education Difficulty During COVID-19 Lockdown: Reports on Malaysian University Students' Experience," in IEEE Access, vol. 8, pp. 186939-186950, 2020, doi: 10.1109/ACCESS.2020.3029967.

[12] J. Wang, X. Chen and X. Gao, "Economic Management Teaching Mode Based on Mobile Learning and Collaborative Learning," in IEEE Access, vol. 8, pp. 200589-200596, 2020, doi: 10.1109/ACCESS.2020.3033774.

[13] T. Supriyatno and F. Kurniawan, "A New Pedagogy and Online Learning System on Pandemic COVID 19 Era at Islamic Higher Education," 2020 6th International Conference on Education and Technology (ICET), Malang, 2020, pp. 7-10, doi: 10.1109/ICET51153.2020.9276604.

[14] J. P. Vagarinho and M. Llamas-Nistal, "Process-Oriented Quality in e-Learning: A Proposal for a Global Model," in IEEE Access, vol. 8, pp. 13710-13734, 2020, doi: 10.1109/ACCESS.2020.2965619.

[15] T. V. Pham et al., "Proposed Smart University Model as a Sustainable Living Lab for University Digital Transformation," 2020 5th International Conference on Green Technology and Sustainable Development (GTSD), Ho Chi Minh City, Vietnam, 2020, pp. 472-479, doi: 10.1109/GTSD50082.2020.9303086.

[16] Sakchai Chaiyarak, Alongkorn Koednet, Prachyanun Nilsook, "Blockchain, IoT and Fog Computing for Smart Education Management", INTERNATIONAL JOURNAL OF EDUCATION AND INFORMATION TECHNOLOGIES, vol.14, 2020

[17] L. Chen, P. Chen and Z. Lin, "Artificial Intelligence in Education: A Review," in IEEE Access, vol. 8, pp. 75264-75278, 2020, doi: 10.1109/ACCESS.2020.2988510.

[18] M. Ioniță Ciolacu, P. Svasta, D. Hartl and S. Görzen, "Education 4.0: Smart Blended Learning Assisted by Artificial Intelligence, Biofeedback, and Sensors," 2020 International Symposium on Electronics and Telecommunications (ISETC), Timisoara, 2020, pp. 1-4, doi: 10.1109/ISETC50328.2020.9301034.

[19] Mourtzisa*, E. Vlachoua, G. Dimitrakopoulosa, V. Zogopoulos, "Cyber-Physical Systems and Education 4.0 –The Teaching Factory4.0 Concept", Elsevier-8th Conference on Learning Factories 2018 - Advanced Engineering Education & Training for Manufacturing Innovation, vol.23, pp.129-134, 2018

[20] Lorenna F. Leala, André Fleurya, Eduardo Zancul, "Starting up a Learning Factory focused on Industry 4.0", Elsevier-10th Conference on Learning Factories, CLF2020, vol.45, pp.436-441, 2020

[21] Albano, G. (2012). Mathematics education: teaching and learning opportunities in blended learning. Retrieved on 06/07/13 from www.igi-global.com/chapter/mathematics-educationteaching-learning-opportunities/57934

[22] Boyle, T., Bradley, C., Chalk, P., Jones, R., & Picard, P. (2003). Using blended learning to improve student success rates in learning to program. Journal of Educational Media, 28(2-3), (pp. 102-178). DOI: 10.1080/135816503200015316

[23] Garrison, D. R., & Vaughan, N. D. (2004). Blended learning in higher education: framework, principles, and guidelines. San Francisco, CA: Jossey-Bass.

[24] Badawi, M.F. (2009). Using Blended Learning for Enhancing EFL Prospective Teachers' Pedagogical Knowledge and Performance. Conference paper: Learning & Language - The Spirit of the Age. Retrieved from: http://eric.ed.gov.

[25] Delialioglu, O., & Yildirim, Z. (2007). "Students' Perceptions on Effective Dimensions of Interactive Learning in a Blended Learning Environment". Educational Technology & Society, 10 (2), 133-146.

[26] Dzakiria, H., Mustafa, C.S., & Abu Bakar, H. (2006). "Moving Forward with Blended Learning (B.L.) as a Pedagogical Alternative to Traditional Classroom Learning". Malaysian Online Journal of Instructional Technology (MOJIT), 3 (1).

[27] Hameed, Sh., Badii, A., & Cullen, A.J. (2008). "Effective E-Learning Integration with Traditional Learning in a Blended Learning Environment". European and Mediterranean Conference on Information Systems.

[28] Lim, D.H., Morris, M. L., & kupritz, V.W. (2006). "Online vs. Blended Learning: Differences in Instructional Outcomes and Learner Satisfaction". Retrieved from: http://eric.ed.gov.

[29] Yuen, A.H.K. (2010). "Blended learning in Higher Education: An Exploration of Teaching Approaches". Proceedings of the 18th International Conference on Computers in Education.

[30] Holland, F. (2012). Assessing the cost-effectiveness of online and blended learning. Presented at PACE Seminar, Centre for Technology and School Change, Teacher College, Columbia University.

[31] Gülbahar, Y. & Madran, R.O. (2009). "Communication and Collaboration, Satisfaction, Equity, and Autonomy in Blended Learning Environments: A Case from Turkey". International Review of Research in Open and Distance Learning, 10 (2).

[32] Lu, H.P. & Chiou, M.J. (2010). "The impact of individual differences on e-learning system satisfaction: A contingency approach". British Journal o Educational Technology, 41 (2).

[33] Perera, I. (2010)." What will users expect from virtual learning methods?—A conceptual model to analyze future leaning method enhancements". US-China Education Review, 7 (11).

[34] Rovai, A.P, & Jordan, H.P. (2004). "Blended Learning and Sense of Community: A comparative analysis with traditional and fully online graduate courses". International Review of Research in Open and Distance Learning, 5 (2).

[35] Sethy, S.S. (2008). "Distance Education in the Age of Globalization: An Overwhelming Desire towards Blended Learning". Turkish Online Journal of Distance Education, 9 (3).

[36] Tayebinik, M. (2009). "The Effect of Learning Style and Motivation on EFL Achievement Test in Virtual Learning Environments". M.A. dissertation, Payame Noor University, Tehran.

[37] Wang, M. J. (2010). "Online collaboration and offline interaction between students using asynchronous tools in blended learning". Australasian Journal of Educational Technology, 26(6), 830-846.

[38] Downes, S. (2010). Learning networks and connective knowledge. In H. H. Yang & S. C. Yuen, Collective intelligence and e-learning 2.0: implication of web-based communities and networking, (pp.1-26). Retrieved on 03/07/2013 from www.igi-global.com/chapter/learningnetworks- connective-knowledge/37067 DOI: 10.4018/978-1-160566-729-4

[39] Komlenov, Z., Budimac, Z., Putnik, Z., & Ivanovic, M. (2013). Wiki as a tool of choice for students' team assignments. International Journal of Information System and Social Change, 4(3), (pp.1-16). Retrieved on 20/06/2013 from www.igi-global.com/article/wiki-as-a-tool-ofchoice-for-students-team-assignment/84798 DOI: 10.4018/jissc.20/3070101

[40] Owston, R., Wideman, H., Murphy, J., & Lupshenyuk, D. (2008). Blended teacher professional development: a synthesis of three program evaluations. DOI: 10.1016/j.ihedu.2008.07.003

[41] Siemens, G. (2013). Connectivism: A learning theory for digital age. International Journal of Instructional Technology and Distance Learning. Retrieved on 12/04/2013 from www.connectivism.ca.

[42] Lim, D. H., & Morris, M. L. (2009). "Learner and Instructional Factors Influencing Learning Outcomes within a Blended Learning Environment". Educational Technology & Society, 12 (4), 282–293.

[43] Delialioglu, O., & Yildirim, Z. (2007). "Students' Perceptions on Effective Dimensions of Interactive Learning in a Blended Learning Environment". Educational Technology & Society, 10 (2), 133-146.

[44] Singh, H. (2003). Building effective blended learning program. Educational Technology, 43(6), (pp.51-54)

[45] Lizzio, A., Wilson, K., & Simons, R (2002). University students' perceptions of to the learning environment and academic outcomes: Implication for theory and practice. Studies in Higher Education, 27(1), (pp. 27-52). DOI: 10.1080/03075070120099359

[46] Holland, F. (2012). Assessing the cost-effectiveness of online and blended learning. Presented at PACE Seminar, Centre for Technology and School Change, Teacher College, Columbia University.

[47] Alhadi, S., & Saputra, W. N. E. (2017). The relationship between learning motivation and learning outcome of junior high school students in Yogyakarta. In C. S. A. Jabar, L. Purnastuti, M. F. A. Ghani, M. Khairudin, S. Indartono, R. Utari, … F. Fatimah (Eds.), Proceedings of the 1st Yogyakarta International Conference on Educational Management/Administration and Pedagogy (YICEMAP 2017): Advances in Social Science, Education and Humanities Research (Vol. 66, pp. 138–141). Yogyakarta: Atlantis Press. doi: 10.2991/yicemap-17.2017.23

[48] Ambrosi-randi, P. N., & Ruži, H. (2010). Motivation and learning strategies in university courses in Italian Language. Metodički Obzori, 10(5), 41–50. Retrieved from https://hrcak.srce.hr/file/98889

[49] Barak, M., & Dori, Y. (2009). Enhancing higher order thinking skills among in-service science teachers via embedded assessment. Journal of Science Teacher Education, 20(5), 459-474. doi:10.1007/s10972-009-9141-z. Bas, G. (2012).

[50] Dunlosky, J., Rawson, K. A., Marsh, E. J., Nathan, M. J., & Willingham, D. T. (2013). Improving students' learning with effective learning techniques: Promising directions from cognitive and educational psychology. Psychological Science in the Public Interest, Supplement, 14(1), 4–58. doi: 10.1177/1529100612453266

[51] Ersoy, E., & Baser, N. e. (2014). The effects of Problem-Based Learning method in higher education on creative thinking. Procedia - Social and Behavioral Sciences, 116, 3494–3498. doi: 10.1016/j.sbspro.2014.01.790

[52] Everaert, P., Opdecam, E., & Maussen, S. (2017). The relationship between motivation, learning approaches, academic performance and time spent. Accounting Education, 26(1), 78–107. doi: 10.1080/09639284.2016.1274911

[53] Kudryashova, A., Gorbatov, T., Rybushkina, S., & Ivanova, E. (2016). Teacher's roles to facilitate active learning. Mediterranean Journal of Social Sciences, 7(1), 460–466. doi: 10.5901/mjss.2016.v7n1p460

[54] Mohzan, M. A. M., Hassan, N., & Halil, N. A. (2013). The influence of emotional intelligence on academic achievement. In Procedia - Social and Behavioral Sciences (Vol. 90, pp. 303–312). Elsevier B.V. doi: 10.1016/j.sbspro.2013.07.095

[55] Yoo, S.J. & Huang, W.D. (2013). Engaging online adult learners in higher education: Motivational factors impacted by gender, age and prior experiences. Journal of Continuing Higher Education, 61(3), 151-164. doi:10.1080/07377363.2013.836823

[56] Usta, E., & Özdemir, S.M. (2007). "An Analysis of Students' Opinions about Blended Learning Environment". Retrieved from: http://eric.ed.gov.

[57] Ginns, P. & Ellis, R.A. (2009). "Evaluating the quality of e-learning at the degree level in the student experience of blended learning". British Journal of Educational Technology, 40(4), Pages: 652-663.

[58] Tselios, N., Daskalakis, S., & Papadopoulou, M. (2011). "Assessing the Acceptance of a Blended Learning University Course". Educational Technology & Society, 14 (2), 224–235.

[59] Masino, S., & Niño-Zarazúa, M. (2016). What works to improve the quality of student learning in developing countries? International Journal of Educational Development, 48, 53–65. doi: 10.1016/j.ijedudev.2015.11.012

[60] Tofade, T., Elsner, J., & Haines, S. T. (2013). Best practice strategies for effective use of questions as a teaching tool. American Journal of Pharmaceutical Education, 77(7), 1–9. doi: 10.5688/ajpe777155

[61] Sean B. Eom, Nicholas J. Ashill. "A System's View of E-Learning Success Model", Decision Sciences Journal of Innovative Education, 2018.