

TECHNOLOGY ENHANCED DIGITAL LEARNING A REVIEW ON LEARNING OUTCOMES, INSTRUCTIONAL DESIGN PRINCIPLES, AND INNOVATIVE CONTENT DELIVERY METHODS

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Abstract

E-learning could be successful only if we design and offer learning courses according to the needs and abilities of each student. The need of the hour is to redesign the teaching-learning paradigm considering the desired learning outcomes, instructional design principles, and innovative content delivery methods. Some aspects like Learning through Mobile Apps, Learning through segmented instructional Videos, Learning in flip classrooms by embedding self-regulated learning prompts, Blended learning and its effectiveness, Learner mindset and self-efficacy, Adaptive e-learning its influence on learning effectiveness, Insights into instructional video design and its impact on the learning process, Gamification and its effects, Instructional quality of Massive Open Online Courses (MOOCs), Computer-based homework, Teacher candidates' attitude towards technology use and integration, Technological Pedagogical Content Knowledge, Self-Confidence, and Perception Teachers towards Instructional Technologies, Future Ready Information Technology Policy for National Education Systems and Evolving Learning Paradigm are being investigated in the present review paper.

Key words: Gamification, Blended Learning, Learner mindset, Instructional

INTRODUCTION

The COVID-19 pandemic has led to a situation where physical classrooms are now empty. To overcome this situation, some institutions are experimenting with the use of technology. But these efforts have been disjointed and without concern for the efficacy of these methods. Parents, teachers, policymakers, and the government are worried about the new normal in the dissemination of education. E-learning could be successful only if we design and offer learning courses according to the needs and abilities of each student. The need of the hour is to redesign the teaching-learning paradigm considering the desired learning outcomes, instructional design principles, and innovative content delivery methods. Some aspects that are being investigated extensively include:

Learning through Mobile Apps

“Mobile technologies have become popular worldwide with smartphones and tablets being used in classrooms, including by students at all levels of education” (Dhir, Gahwaji, & Nyman, 2013; Kinash, Brand, & Mathew, 2012). The current generation of students use mobiles to play games, engage with each other on social networking sites and messaging platforms. In short, they are born digital or are digital natives. So how effectively can we use mobile as a learning tool?

“The impact of mobile technology in classrooms has been extensively studied and most children showed improved performance after repeated practice in the touchscreen modality” (Huber, 2016)

Domingo, (2016) studied the perception of teachers about “how mobile technology impacts learning and how it is related to the use of mobile apps in the classroom”. The key findings are that.

- It provides a new way to learn. (Collaborative learning)
- Promotes authentic learning and a better connection with classroom learning.
- It enhances confidence and gives high motivation too.
- It encourages students to take control of their learning. (self-learning)
- It enables students to communicate and share learning material with their classmates.

A worrying factor is the excessive usage of mobile and increased screen-time that can lead to adverse effects on a students' social, emotional, and physical development.

Learning through segmented instructional Videos

Multimedia training helps understand the concepts better as it triggers the motor learning process. Neuroscience research has highlighted the role of mirror neurons in learning through imitation. The use of videos in education and training has been increasing, but it might be difficult for novice learners to understand concepts if they view the videos without any segmentation. The problem for novice learners would be their ability to cope with cognitive overload. Segmented instructional videos help in reinforcing the instructions or concepts for novice learners. It will also reduce cognitive-load. The hypothesis used by the author is based on the cognitive-load hypothesis and temporal-cueing hypothesis.

The author opined that “since students cannot immediately use the pause button (As they do not know when to stop the video), procedural learning can be improved if the learner-paced pausing is added with system-paced segmentation.” (Biard, 2017) In a segmented instructional video, the information is divided into many segments so that the information does not flow altogether, and students get time to process the information before learning the content in the next segment. To avoid overloading students working memory, Mayer & Pilegard (2014) described the segmentation principle that splits pedagogical content into multiple units instead of keeping it in a single continuous presentation.

Learning in flip classrooms by embedding self-regulated learning prompts

Flipping-the-Class (FTC) is a new approach where students are expected to watch content before their class and actively participate when the topics are taught in the class. This is a new way of learning where there is an alternative transition of online learning and face-face learning. The best outcome of FTC is that students get better clarity of the concepts and gives motivation. The impact FTC on improving the learning outcome has been researched in the past and the intervention of self-regulated learning prompts in the instructional video was seen to help the student to analyze, introspect, and self-reflect their thought process in learning.

Students have been given the flexibility to go back and see the videos umpteen number of times. They are allowed to proceed to the next video only after completing the Self-Regulated Learning (SRL) prompts (SRL online activity/test/self-reflective questionnaire). Though certain students find it a distraction to their learning process, the performance test of the students who have been subjected to SRL prompts gave excellent results in primary and middle school level. This was not the case with students at the secondary school level.

There is no doubt about the success of flip classes with embedded SRL prompt videos. It makes the learner get acquainted with the topics to be taught in the class. This approach gives a lot of confidence for the child to come for the next day class as he/she is prepared well. Any doubts they have could be solved during face-face sessions with the teacher. The learner gets a lot of time to think, process, and reflect on the concepts. The topics learned through this approach will be never be forgotten. The retention power is also increased, and learning would be long term.

Blended learning and its effectiveness

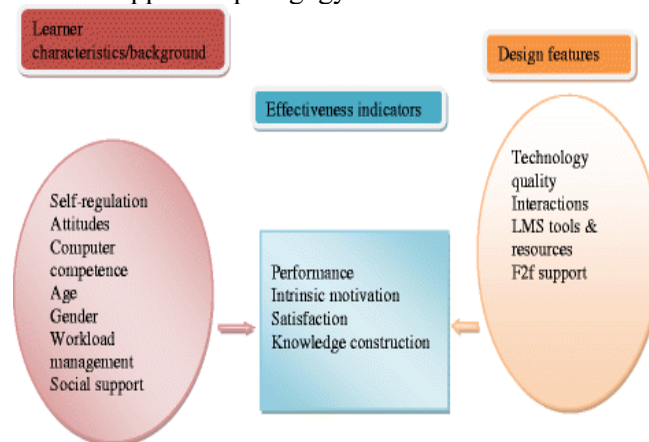
Blended learning is an innovative pedagogy which involves a balanced combination of online and face-face teaching-learning techniques. We are all experiencing right now a paradigm shift to a complete online-dependent learning methodology in our schools and colleges. For the same reason, a blended learning approach to learning style should be thought about in our Indian schools and colleges.

The biggest advantage of this pedagogical approach is that students learn & retain concepts better leading to learning satisfaction. Many studies have gone into the effectiveness of blended learning in higher education. The effectiveness of blended learning depends largely on the attitude, self-regulation, computer proficiency, social and family support, and background of students. Students should also learn to manage time and doubt clearing skills in this approach. Apart from the characteristics of the learner, the success of blended learning also depends on the teacher's confidence and competency in using ICT.

A major concern for teachers, with regards to online teaching, is the distance between the learner and the teacher. Teachers are unable to gauge and understand the emotions, gestures, facial expressions, and

attitudes of the learner. As a result, the learning transaction could be difficult if we solely depend on online teaching. A blend of online and face-face interaction could help solve this issue to a large extent.

The learning outcome can be tested based on the performance of students. We can compare it with a control classroom where blended approach/pedagogy is not followed.



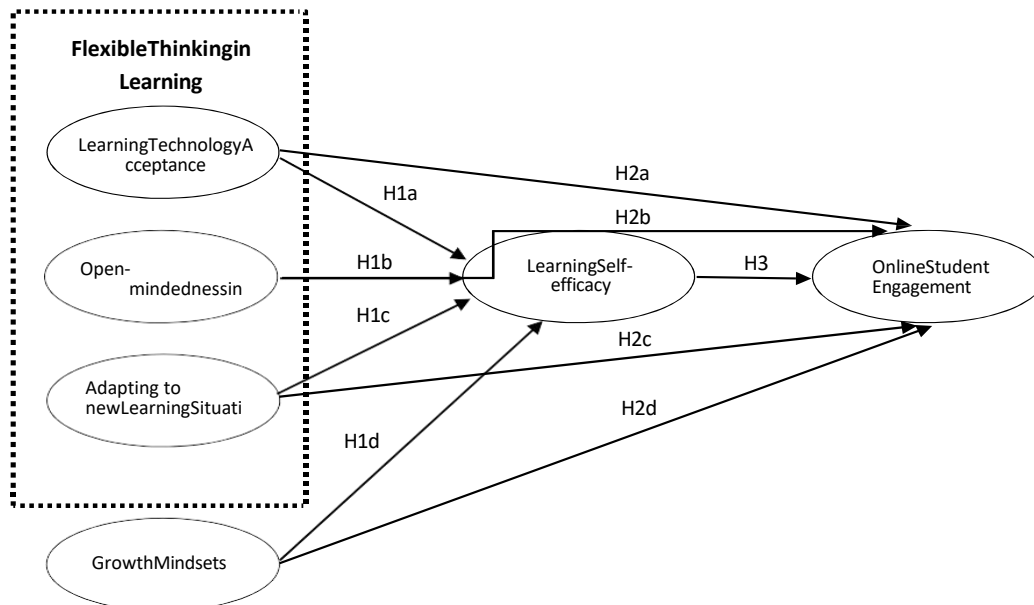
Source: Kintu, M.J., Zhu, C. and Kagambe, E., 2017

While a blended approach and flipped classrooms are alternative, innovative pedagogy that can be used in the classroom for an effective teaching-learning process, further research is required to understand the learning effectiveness of technology-assisted learning better. This review discusses four papers that look at some aspects of learning effectiveness that we should be mindful of before starting with technology-enhanced learning.

- Learner mindset and self-efficacy
- Adaptive e-learning its influence on learning effectiveness
- AI technologies employed in Adaptive e-learning
- Insights into instructional video design and its impact on the learning process

Learner mindset and self-efficacy

Barak and Levenberg (2016b); Griffin et al. (2012); OECD (2013) have mentioned that ‘Flexible Thinking’ is a critical factor in the success of technology-enhanced learning environments. Growth mindset and learning self-efficacy are two crucial variables that have a strong positive relation to online engagement for first-time online students. In Hungwei Tseng et al (2020) a model was created and tested (see Fig. 1) to “reveal the characteristics and complexity of today’s first-time online students in a higher education setting from the perspectives of social and cognitive learning and the twenty-first century thinking skills by investigating the impacts of flexible thinking, mindsets, and self-efficacy in learning on first- time online students’ online learning engagement.”



Source: “Fig. 1 Hypothetical relationships between flexible thinking, growth mindsets, learning self-efficacy, and online student engagement” (Tseng, H et.al, 2020)

Furthermore, the problems faced by a learner when they first use the online mode of learning need to be studied in detail.

Adaptive e-learning its influence on learning effectiveness

The issue of e-learning in primary education is explored and the effect of learning analytics and cognitive computing for bringing in innovation in learning is looked at. It is also suggested by the author that the e-learning material should strengthen the curriculum and be a support to the full-time education. It can be effective only under the leadership of teachers who can guide and motivate the learner. Also, e-learning material should be interactive and less tedious. It should also have all the elements of gamification. The difficulty level of exercise should be ascending, from simplest to difficult.

Learning analytics is the measurement, collection, analysis, and reporting of data of the learner while using the e-learning material. The objective behind adaptive learning is learning according to the comfort of students. This will increase the learning outcomes and is in sync with the goal of cognitive computing (simulation of the human brain in decision making). The assessment of the influence of adaptive e-learning on learning effectiveness is key as we look at the efficacy of e-learning.

AI technologies employed in Adaptive e-learning

Every learner has a different learning process and adaptive systems in e-learning platforms are built to mimic this aspect of learning.

“In order to provide adaptive e-learning services and study materials that are tailor-made for adaptive learning, this type of educational approach seeks to combine the ability to comprehend and detect a person’s specific needs in the context of learning with the expertise required to use appropriate learning pedagogy and enhance the learning process.”

“It is thus critical to create student profiles and models based on analysis of their knowledge level, personality traits and skills.” (Alghazzawi, 2017). These learner centric models can

- drive the pedagogy used by experts and educational systems designers
 - give educational system self-learning capabilities based on the behaviours of teachers and students
- Artificial intelligence (AI) techniques can be useful in such a situation due to their ability to develop and mimic human reasoning and decision-making; and minimize uncertainty to achieve an effective learning-teaching context. This ensures both learner and system improvement. Almohammadi (2017) presents a “survey of the field of AI used for adaptive systems in e-learning, their advantages and disadvantages”. The paper also “presents a discussion on achieving a more intelligent and adaptive e-learning environment using AI techniques.”

Insights into instructional video design and its impact on the learning process

Although there are many researches on the impact on learning of instructional, videos, there was very little research on how learning/performance is impacted by the addition of specific features. (Tembrink, Szoltysek, & Unger, 2013) studied the impact of cues to direct a learner's attention to a specific something. Numerous studies had shown the value of cues in resources such as texts, pictures, and animations, but very few studies have looked at the impact of cues in instructional videos on learning. It was not clear as to the extent different cues helped learning in the instructional videos. Neither was it clear on the types of cues, or functions of cues, that led to a positive, negative, or no results.

The study used "eye tracking to see if specific cues were used by learner and the impact it had on learning in retention and transfer-tasks" (Wang et.al, 2020). The intention of the study was to inform instruction designers of the type of cues that lead to optimal learning outcomes.

There has been a rapid growth in technology and innovation in the last few decades and the education industry has used this by adapting and integrating new methods like virtual collaboration tools, mobile applications, and technology-enhanced learning, augmented classrooms and blended learning in educational settings/programs. Research exploring these alternative processes aimed at improving learning outcomes have been plenty. But changing the existing teaching-learning structure is not always easy due to logistical and resources limitations. The search for alternatives that can be implemented easily has led educators to look at gamification.

Gamification and its effects

Gamification is fast emerging as a method aimed to enhance instructional content and it presents itself as a cost-effective and efficient tool/method to improve learning outcomes. It refers to the use of game-design elements and characteristics in non-game context like learning to enhance student learning

"Despite the widespread application and burgeoning research on gamification, the effects of gamification, its theoretical and psychological underpinnings, and individual differences that may affect gamification still lack understanding."

But what is lacking is the theoretical basis of the effects of gamification. "Application of the theory of gamified learning and exploration of the benefits of gamification on learning, through the testing effect is studied." (Sanchez, 2020)

Instructional quality of Massive Open Online Courses (MOOCs)

Every teacher is very aware of the shortcomings of the learner in a normal classroom interaction. And can assist the learner according to his/her pace by putting in extra efforts and giving them extra time. Learning becomes more effective when it is self-regulated or paced according to the learner's knowledge, learning style, skill level. Such individual attention becomes a concern, especially in a synchronized e-learning condition, where the learning is instructor-led and distant.

Many universities and institutions have started offering MOOCs generating significant public and academic discourse around the world. They have been hailed as a major advancement in higher education. Critics however have voiced concerns about the lack of novelty in MOOCs and the exaggerated predictions on their impact on education and learning. The concerns relate to the focus of MOOCs on "access to 'high quality content' rather than on instructional design and the learning experience". There is no globally recognized system for measuring the quality of MOOCs and even those that are available and their metrics for measurement are highly debatable. Despite the growing number of MOOCs as well as people taking these MOOCs, there is very little empirical research into MOOCs and their effectiveness for learning.

Although there is some research on MOOCs, they are focused on developing typologies rather than on the analysis of their instructional quality/effectiveness. "Conventional course evaluations are based on course participants' and key stakeholders' opinions of the quality. While learners' and other stakeholders' experiences are important, the instructional design quality of a course is a critical indicator and prerequisite to evaluate potential of the course for effective learning." (Margaryan et al, 2015)

The quality and pedagogic effectiveness of a learning experience is impacted by instructional design, as it is a key component. In 2015, Margaryan et al espoused instructional design quality of MOOCs using a set of key criteria based upon First Principles of Instruction. These include;

- "Problem-centered: Learners acquire skills in the context of real-world problems."

- “Activation: Learners activate existing knowledge and skill as a foundation for the new skill.”
- “Demonstration: Learners observe a demonstration of the skill to be learned. ”
- “Application: Learners apply their newly acquired skills to solve problems.”
- “Integration: Learners reflect on, discuss, and defend their newly acquired skills.”
- “Collective knowledge: Learners contribute to the collective knowledge. ”
- “Collaboration: Learners collaborate with others.”
- “Differentiation: Learners are provided with different avenues of learning, according to their needs.”
- “Authentic resources: Learning resources are drawn from real-world settings.”
- “Feedback: Learners are given expert feedback on their performance.”

There is no published research regarding the instructional design quality of MOOCs. The paper examines the instructional design quality MOOCs. “Quality is analyzed from first principles and from the perspective of instructional design experts. The aim was to identify whether and to what extent the design of these MOOCs reflects these fundamental principles of instruction.” (Margaryan et al, 2015)

Computer-based homework

“Advances in educational technology and increasing access to computers has given teachers a wide range of options and tools for assigning homework and assessing student progress. Intelligent tutoring systems and computer-based homework are quickly gaining popularity across the world.” (Fyfe, 2016). The bedrock of these systems is the availability of individualized, just-in-time feedback. Indeed, many researchers have attributed the “effectiveness of computer tutors and computer-based homework to greater frequency and immediacy of feedback”. But there is little empirical evidence on how to optimize student learning through computer-based homework. The aim of the study was to test the effects on computer-based homework of different types of feedback. “Computer-based homework provides a means to experimentally test the effects of feedback in an authentic learning setting of homework assignments given to students. One of the advantages of computer-based homework is the ability to provide second attempts and to guide student learning.” (Fyfe, 2016)

Teacher candidates’ attitude towards technology use and integration

“Early childhood technology integration is on the rise and this is forcing teachers to help students acquire skills needed to use these technology tools. Teachers immersing themselves in experiences with these tools and employing strategies to build confidence to use these technologies, provides an opportunity to develop expertise and learning of these skills” (King, 2011). So, “it is important for teachers to develop the confidence needed to effectively use technology in their classrooms. Without such confidence, teacher is not likely to incorporate technology in their classrooms and therefore the students will not be exposed to these technology tools” (Michelle Giles, 2019). The problem teacher training programs face today is how to positively change teachers’ attitudes toward use of technology in classroom. Another issue is how to encourage teachers to integrate best practices in technology use in their classrooms. Teachers should be proficient with technology, have clear understanding of the advantages of technology in classrooms and be able to improve classroom instruction through integration of technology. Integrating technology into teacher training courses is an important component that need to be investigated. It is found that many teacher training programs do not currently provide such comprehensive training to make candidates proficient at integrating technology in the classroom.

“If teachers have negative attitudes towards technology, they will not integrate technology in their classrooms. So, it is necessary that teacher training programs incorporate experiences that help inculcate positive attitudes towards technology and its use.”

Strategies such as peer mentoring/paired grouping need to be investigated, with regards to technology use and its impact on teachers’ attitudes towards technology. Providing a collaboration tool, evaluation of teacher effectiveness and improving teacher attitudes are some of the benefits of peer mentoring/paired grouping in teacher education. “Peer mentoring is defined as paired grouping of students of varying abilities to meet instructional needs”.

Technological Pedagogical Content Knowledge, Self- Confidence, and Perception Teachers towards Instructional Technologies

The debate is how to integrate technology into education. The knowledge of technology cannot be separated from the knowledge of education. The effective use of technology is the only way to integrate it as a part of our educational settings. This is possible only if the teacher is confident and has a good perception of technology-enhanced distant learning. The learning outcome will also be rich and accurate if a teacher uses all technological instructional methods wisely. Students tend to follow their teachers. So the perception and confidence of teachers are reflected in their students.

“Teachers are individuals who provide appropriate methods, techniques, and materials in the process of education either as the source of the information or as a guide during the teaching process” (Yalın, 2000; Şimşek, 2000).

Today, technology has become an integral requirement for any teacher so that technology can be used more frequently in education. A major factors affecting the “perception and competency of pre-service teachers concerning technology use in education” is gender.

“Technological pedagogical content knowledge (TPACK) is the knowledge acquired by teachers to integrate technology into education while teaching a particular content to students”

“TPACK related self-confidence, and TPACK related perception of pre-service teachers were investigated based on the grade level of pre-service middle school mathematics teachers to analyze whether there is a difference or not among grade levels. This study is expected to contribute to the literature and close the gap to overcome the complexity of the integration of technology into teaching environments” (Karatas, 2017). The beliefs and perceptions of teachers towards technology should be grasped by teacher educators in order to prepare courses for the effective integration of technology. It is crucial understand and investigate these for seamless integration of technology into teaching.

Future Ready Information Technology Policy for National Education Systems

The digital age allows everyone to contribute to sustainable development and economic vitality of the nation. This requires educational policymakers, researchers, and practitioners to re-think the processes, structures, support systems, and role of technology-enhanced learning.

“With the increasing relevance of ICT and the global transition towards the knowledge society, school systems and higher education now face increasing challenges involved in preparing students for successful participation in the digital age” (Henshon, 2017; Zhao and Frank, 2003).

Basis this changes to national policies, concerning ICT integration into education systems, are in the works to support the idea that education should be available to all. This is in alignment with UNESCO’s Sustainable Development Goal 4 (UNESCO, 2015) to “ensure inclusively and quality education for all and promote lifelong learning”. Zagami et al, 2018, “envisions a future where advanced technologies and analytics will be used alongside research.”

“Researchers and policymakers such as those who developed and discussed the new framework, believe that the full potential of educational technology will be ultimately realized only when educational leaders and teachers effectively integrate and authentically incorporate technology enhancements along with data science concepts into their practice and curriculum”. (Forkosh-Baruch et al. 2009; Webb and Gibson 2015).

“Policy makers commonly face several key challenges at many levels from families to schools to communities and the nation” (Davis 2017).

“Four key challenges were identified while developing the new framework for the development of national policies for implementation and evaluation and strategy perspectives that can be applied to advance a nation’s educational system empowered by technology.” (Zagami et al, 2018)

The challenges are:

“Challenge A. Creating future ready policy visions” “Challenge B.

Achieving systemic perspectives” “Challenge C. Promoting commitment to policy learning”

“Challenge D. Developing and implementing policy processes”

“Education policy is a strictly time-bound process that is context-specific, and highly dependent on economic and socio-political conditions and interactions.” (Zagami et al, 2018)

Evolving Learning Paradigms

“Successful integration of ICT into teaching and learning requires rethinking the role of teachers and reforming their preparation and professional development. It calls for promoting a culture of quality in all its aspects: staff support, student support, curricula design, course design, course delivery, strategic planning, and development” (UNESCO, n.d). Learning happens only if the concept is conveyed to the students effectively through an instructor. A teacher is a prime source of knowledge for a learner. There might be a number of ways to gain knowledge, but nothing could be compared with the efficacy and competency of a teacher. The knowledge gained from a teacher can be enhanced further by referring to books, learning materials, or audio-visual aids. For the same reason, a teacher has to be very confident in delivering the learning content. We are all seeing the need of the hour -21st-century skill, Technology-assisted learning -teaching methods. We cannot live further in a system where we can do away with technology. So, the teacher should be confident while using these technology-assisted teaching techniques. Any adaptive e-learning becomes effective only when that fine line of the boundary of inhibition is removed. This is possible only if teachers are trained well for it. Emphasis on Preservice and Inservice teacher training programmes are a must in School education

Key research questions that are addressed

Learning through Mobile Apps

Effectiveness of mobile technology apps based on a teachers perception. Key questions include

1. The impact on learning due to the use of mobile technology in the classroom
2. Frequency of use of various apps in the classroom
3. The differences in the perception of the impact of mobile technology on learning among users and non-users of apps.

Learning through segmented instructional videos

Effectiveness of segmented instructional videos in reducing the cognitive load and increasing memory retention in learners.

Learning in flip classrooms by embedding self-regulated learning prompts

Effect of embedded self-regulated prompts in instructional videos in FTC

Blended learning and its effectiveness

Effectiveness of blended learning depends on learner's characteristics, blended learning design, and learning outcome.

Learner mindset and self-efficacy

Based on prior research and the implicit theories of intelligence, the authors (Tseng, H et.al, 2020) hypothesized that “flexible thinking and growth mindsets have a positive relation to learning self-efficacy.”

They used Questionnaire method and Likehert scale to understand the correlation between flexibility thinking, mindset, and student engagement with learning self-efficacy. “The Flexible Thinking in Learning (FTL) Scale, Implicit Theories of Intelligence Scale, and Online Student Engagement (OSE) Scale were distributed in an online survey format and a survey invitation letter was sent to students. All scales were expected to take about 20 min to complete.” (Tseng, H et al, 2020).

Adaptive e-learning its influence on learning effectiveness

The authors realize that “learning efficiency can be influenced by the introduction of adaptability to e-learning” (Hubalovsky, 2018). Therefore, they established the following research questions:

1. “Can effectiveness of primary e-learning training be increased by utilizing of elements of adaptive e-learning?”
2. “Can any e-learning exercise of lower cognitive levels of Bloom's taxonomy be skipped without affecting the cognitive thinking for solution of the e-learning exercises on upper cognitive levels of Bloom's taxonomy?”

These research questions lead to the formulation of the research hypothesis:

- “Skipping any e-learning exercise of lower cognitive domains of the Revised Bloom's Taxonomy does **not negatively affect the completion time of solution of e-learning exercises** of higher cognitive domains of Revised Bloom's taxonomy.”
- “Skipping any e-learning exercise of lower cognitive domains of the Revised Bloom's Taxonomy **does not negatively affect the effectiveness of e-learning exercise** solutions of higher cognitive domains of Revised Bloom's taxonomy.”

Insights into instructional video design and its impact on the learning process

The key research questions include

1. “How do different cues (i.e., textual cues, visual cues, and combined textual & visual cues) affect the learning outcomes during video-based learning?”
2. “Are more cues more effective in promoting video-based learning?”

The participants in the study (Wang, X et al) (Eye-tracking movement in cues and retention of concepts) included 120 UG students (22males and 98females) from a Chinese teacher's college. “Before the experiment, the participants were evaluated for their task-specific prior knowledge and none of the participants had prior knowledge of the materials. All the participants were native Chinese speakers and had normal or corrected to normal visions. The participants were randomly and conveniently assigned to one of the four conditions, The four conditions included one Control Condition (no cues) and three Experimental Conditions: the 1) textual cues, 2) visual cues, and 3) combined textual &visual cues. A Tobii X120 remote eye tracker with a sampling rate of 120 Hz was used to track eye movements while each of the participating students watched the instructional video. Each participant could sit about 50 cm in front of the eye tracker while having their head positioned at a natural distance from the screen and moving their head freely without paying attention to the eye tracker. This setting minimized device interference with the learning process.” (Wang et.al, 2020).

Gamification and its effects

The goals of this study are to “(a) apply the theory of gamified learning as a theoretical model for the assumed effects of gamification, (b) replicate the testing effect in a web-based learning environment, (c) test if gamification can enhance the testing effect, and (d) determine if there are student characteristics that affect the effects of gamification.” (Sanchez, 2020)

“The current study aims to contribute to research showing the value of the theory of gamified learning for developing theoretical models for the effects of gamification. This study also provides instructors with insights on the potential effects of gamification within the setting of online quizzes and shows that instructors need to be aware of student characteristics that may moderate the effects of gamification.”

“The ten-principle framework was applied and tested for evaluation of instructional design quality of over one hundred online courses in a corporate university. A data collection instrument termed Course Scan was devised to measure the course design quality about eachof the ten principles. In this study the author used a refined and extended version of the Course Scan instrument developed by Margaryan and Collis (2005). Data was collected in October- December 2013 and the researcher carried out an in-depth examination of the course environment of 76 MOOCs in the sample, closely studying the course description, materials, and resources, learning activity descriptions, learners' submissions, and discussions in the course fora. Thus, all course-related information that could be accessed from the course website was examined in detail. Subsequently, the researcher assessed the instructional design quality of each course using the Course Scan questionnaire.” (Margaryan et al, 2015)

Computer-based homework

The study tested “the effects of feedback for middle school students solving algebraic equations on computer-based homework via the ASSISTments system”. Middle school students completed a computer-based pretest, homework assignment, and post-test containing challenging algebraic problems. Students were assigned to different feedback conditions. In one experiment, after each problem, students either received no feedback or correct-answer feedback. In another experiment, after

each problem, students received no feedback, or correct- answer feedback, or try-again feedback, or explanation feedback.

Teacher candidates' attitude towards technology use and integration

The purpose of the study is to “investigate the influence of paired grouping on teacher candidates’ perceived attitudes towards technology after completing a required educational technology course within their programme of study”. The research questions that guided this study include:

“(1) Is there a statistically significant mean difference in teacher candidates’ perceived attitudes towards technology use and integration after completion of an educational technology course as measured by the Attitude Toward Technology Scale (ATTS) when teacher candidates are grouped based on paired grouping?

(2) How do teacher candidates’ perceptions of the paired grouping influence their attitude with regard to technology use and integration?”

“The theoretical framework for this study is based on: (a) social constructivism and (b) zone of proximal development (ZPD)” (Michelle Giles, 2019).

“Social constructivism is a theory based on the principle that knowledge construction is achieved by the interaction that takes place within oneself through reflective thinking and by the interaction that occurs in communications and collaboration with other people” (Vygotsky, 1978) “ZPD is described as the gap between actual developmental levels as determined by independent problem solving, and under guidance or in collaboration with more capable peers. ZPD utilizes the view that interactions with peers are an effective way of developing skills and strategies.” (Vygotsky, 1978)

The researcher used “some aspects of constructivist course design such as collaborative discussions, reflections, student-centred teaching methods that incorporated input from students, collaborative group projects and authentic learning tasks.”

The Attitude Toward Technology Scale (ATTS) utilizes “a 31-item survey using a 5-point Likert scale to evaluate teacher attitude with technology in the classroom. Responses range from 1 = Strongly Disagree to 5 = Strongly Agree. The survey includes reverse-coded items such as ‘time spent incorporating technology could be better spent teaching the basics’ and ‘the benefits of technology to education are overrated’ to increase the reliability of the survey in confirming consistent responses from participants” (Michelle Giles, 2019)

The author conducted a survey (5 points Likert Scale) on 83 teacher candidates enrolled for an educational technology course with a college of Education. Attitude towards the technology scale was the survey instrument used to monitor the teachers' attitude towards technology as an instructional tool, engagement strategy, evaluation tool, or as an organizational tool. The independent variable used was paired group training and the outcome was noted based on the post /pre-survey. A paired two-tail t-test was conducted and Standard Deviation, percentage, and Mean difference were calculated.

Technological Pedagogical Content Knowledge, Self- Confidence, and Perception Teachers towards Instructional Technologies

“The purpose of the study is to investigate the TPACK, TPACK related self-confidence, and perception of pre-service middle school mathematics teachers towards technology use. The participants of the study were pre-service middle school mathematics teachers who had adequate knowledge to use the technology in mathematics education. The data collection tools were administered to 427 pre-service middle school mathematics teachers, 104 freshmen, 77 sophomore, 193 junior, and 53 senior students in elementary mathematics education program. Three surveys were administered to pre-service teachers including a) Technological Pedagogical Content Knowledge Survey (TPACK-S), b) Technological Pedagogical Content Knowledge Self-confidence Survey (TPACK-SCS) and c) Survey of perception towards technology” (Karatas, 2017) Karatas (2017), conducted a Multivariate analysis of variance (MANOVA) test to investigate whether there was a significant statistically difference between male and female pre-service teachers. Also another MANOVA test was conducted to observe whether there was a significant difference among the grade levels of pre-service teachers.

Future Ready Information Technology Policy for National Education Systems

“ The four key challenges identified in the paper are:

- Creating future ready policy visions
- Achieving systemic perspectives
- Promoting commitment to policy learning
- Developing and implementing policy processes

There is a broad international agreement that the purpose of education technology policy is to help lead nations toward their digital future.” (Zagami, 2018).

Result and Discussion

Learning through Mobile technology Apps

The use of mobile apps as a learning-platform, allows students to access the learning content in the app from any location. It could be used as an instrument to gather data required for further analysis. It is an excellent medium to interact with other students to share and exchange views with other users. When used in the right way, it leads to the holistic development of the learner. Mobile technology cannot be unique and homogeneous technology. So, it is crucial to not only consider mobile technology but also pay attention to the content as well as design of the apps. This gives a clear indication of the “instructional benefits from the combination of mobile technology and apps.” (Falloon, 2013). The design and content reliability/validity of the app given to the learner should be doubly checked by the curriculum expert.

The key findings from the research include:

“ The two main effects of mobile technology in the classroom are access to information and increasing engagement to learning. The choice of apps is based on teacher's ‘perception of how mobile technology impacts learning’. Teachers can take advantage of the combination of affordability of mobile technology and apps to improve aspects of learning.” (Domingo, 2016)

Learning through segmented instructional videos

- Novice learners don't know when to press pause button in interactive-video
- Based on cognitive-load and temporal-cueing hypotheses, participants in a segmented interactive-video situation are likely to perform better on a recall test than participants in the other control groups.
- As per the cognitive-load and temporal-cueing hypotheses, participants in the segmented interactive video condition would perform better on a learning task than participants in the non-interactive video condition.
- Segmented instructional videos are better for a better understanding of concepts and memory retention. It reduces the cognitive-load.

Mayer (2014), explained that “the effectiveness of learning by segmented instruction videos with reference to the cognitive theory of multimedia learning. This theory is based on the idea that information is processed via two separate channels - auditory/verbal & visual/pictorial”

“There is a combination of visual and auditory information when an individual watches a video,. Learners can process and retain the information efficiently due to this. A very heavy cognitive-load is generated due to the continuous flow of the information in a video, and this is a problem” (Sweller, van Merriënboer, & Paas, 1998).

Learning in flip classrooms by embedding self-regulated learning prompts

- The solution that the author derives from his research is that the effectiveness of SRL prompts depends basically on the importance given to the design of flip class sessions by the student. Students have been asked to revert their opinion by filling the questionnaire given to them. SRL prompts were given before (Forethoughts)viewing the video, (performance test) in the middle of the clip and later (a self-reflecting prompt) after the completion of the clip.

- SRL prompts did not increase the learning outcome and such prompts disturbed their concentration while learning. Many got demotivated and it causes stress to the learners. There was not much difference in the performance level among the senior students.

This research study did not support the role of SRL in flip-the-class sessions in secondary education. The prime reason could be that SRL activities were not embedded as a part of the instructional video. They had to perform SRL activities separately after watching the video. The effectiveness could be better if SRL activities are also part of the instructional curriculum. Then the learners do not find it as boring or a tedious task. They will enjoy doing the activities.

Too much unnecessary intervention could be the reason for showing the poor effect of SRL prompt.

Blended learning and its effectiveness

- It was found that the effectiveness of blended learning majorly depends on the characteristics of the student. High intrinsic motivation (self -regulation) of the student is the secret success of this innovative approach.
- Relative to the traditional classroom, blended learning is fast emerging as a hybrid innovation that is a sustaining innovation. This hybrid form is an attempt to deliver "the best of both worlds"— the advantages of online learning, along with all the benefits of a traditional classroom. (Christensen et al, 2013). Learner's satisfaction is another predictor of blended learning. This is possible only with an excellent technology back up.
- The excellent design of blended learning is also another significant predictor of the new innovative approach.

There is no end to learning, also the ways to attain it. The scope of the blended learning approach can be best utilized if students have a will and teachers gain confidence in this way of teaching. Students have the flexibility to follow the teacher's pace or as per their situation. It is going to be beneficial for the students who have difficulty in attending the regular school. With the support of excellent internet and team of professional subject experts, any educational leader can follow and implement this innovative pedagogy in their schools. Various limiting factors should be researched well. Policymakers should think and change their decisions to enhance the 21st-century skills. We further need to explore the effect of blended learning at all levels of school education.

Learner mindset and self-efficacy

“Looking at it from a cognitive perspective, flexibility is reflected in diverse human behaviours and occurs when a person is open-minded to new ideas and able to transfer knowledge to different situations and circumstances; we should consider multiple viewpoints and perspectives, and always try to seek multiple solutions and answers.”(Mincemoyer et al., 2001).

In online learning environment learning takes place during constructive and flexible thinking is required to construct knowledge from different perspectives. So, students must have an open- mindset to receive information from different sources and be flexible to make an alternative decision and also process knowledge through different learning-situations and tasks.

While “learning and interacting in an online learning environment, cognitive engagement is important for students to be self-regulated and strategic” (Tseng, H et.al, 2020), so that they can focus on the deeper learning process. Learning self-efficacy is strongly influenced by three dimensions of flexible learning - "adapting to new learning situations" and "open-mindedness"; however, "learning technology acceptance" did not impact self-efficacy.

The study also shows that “students with growth mindsets are more likely to be engaged in online learning tasks” (Tseng, H et.al, 2020). This encourages students to focus on the learning process and improvement and as a result they would be consistently engaged and motivated in their learning. Hierarchical sequence of presenting course content and ordering assessments would help in engaging students with a fixed mindset in the learning process. The study also suggests that instructors should

- “Pay attention to first-time online students’ skills of adaptability and their perceptions of challenges in online learning. Students may experience uncertainty and insecurity when they begin with online courses as online learning requires students to be self- directed and due to the nature of online

learning.”

- “Provide information about online learning strategies to increase the confidence of first-time students on online learning.”
- “Pay keen attention to students’ participation in learning activities and provide feedback and further guidance especially for those with low self-efficacy.”
- “Providing a growth-mindset training workshop to students in order to help them understand the characteristics of a growth mindset as well as help them overcome challenges they might encounter in online learning.”
- “Create mixed teams by including fixed mindset and growth mindset student to engage in team activities, encourage goals setting, and provide opportunities for reflection on their learning processes.”

Adaptive e-learning its influence on learning effectiveness

The two common hypotheses were split into four sub-hypotheses:

- H1: Skipping of all three lower domains of revised taxonomy did not affect the completion time of e-learning exercise related to “**analyze**” of the domain.
- H2: Skipping of all three lower domains of revised taxonomy did not affect the completion time of the e-learning exercise related to “**Evaluate**” of the domain.
- H3: Skipping of all three lower domains of revised taxonomy did not affect the learning effectiveness of e-learning exercises related to “**analyze**” of the domain.
- H4: Skipping of all three lower domains of revised taxonomy did not affect the learning effectiveness of e-learning exercise related to “**evaluate**” of the domain

Thus H1, H2, H3, and H4 were accepted and confirmed.

Scope for further Work

- The research concentrated on the learning effectiveness and competition of only one subject, mathematics. It should be investigated on other subjects too.
- The research emphasized the learning effectiveness of primary students. It should be escalated to middle and secondary education.
- Learning effectiveness was calculated based on the learning analytics received from the learner alone, but the mastery and leadership of teachers also should be evaluated.

Insights into instructional video design and its impact on the learning process

The author (Wang et.al, 2020) explained that the “study made contributions to video-based learning practices in two important areas. First, from a learning perspective, there is a direct connection between information processing and learning outcomes. The patterns of eye movement in this study showed that while learning with the video, the learners should organize and integrate subtitles and cues simultaneously to capture the most important information in the video”.

“This studying method would promote the cognitive processes of selecting, organizing, and integrating information, and improve video-based learning outcomes” (Mayer, 2014a, 2014b).

“The second important contribution to practices relates to the design of instructional videos. The textual cues (i.e., the written texts to guide learners’ attention to specific locations) are usually easy to implement in instructional videos. They can improve information retention of the instructional video. However, if the instructional goal is to improve both the retention and transfer knowledge, the visual cues (e.g., the dynamic lines, highlighted coloring and moving dots to guide attention, emphasizing structures and relationships of the video information) and the combined textual-&-visual cues (i.e., including both the textual cues and visual cues) are more effective design methods. This study demonstrated that appropriate designs and uses of cues could have significant positive impacts on improving retention and transfer knowledge of instructional videos. Instructional videos are important tools for teaching online, MOOCs, and flip classrooms.” (Wang et.al, 2020).

Scope for further work

The author (Wang et.al, 2020) concluded that “Instructional videos can not only provide information

and demonstrate a variety of things, they can also be used to direct learners' attention to specific aspects of materials being shown and, in some cases, get learners to react or respond appropriately. The visual cues and the combined textual-&-visual cues could promote the cognitive processes of selecting, organizing, and integrating information, and they were both effective design methods to aid video-based learning. Although the correlation analysis between eye movement data and test results showed the connections between information processing and test outcomes, future studies could incorporate interviews and focus group discussions to add more data points."

Other instructional videos and populations can be used the replicated this study. Going forward replication study research could be done by "changing elements of the study design, for instance, looking at different subject areas, knowledge types, and teaching practices."

Gamification and its effects

The author (Sanchez, 2020) found that "testing effect has a great effect on learning through online quizzes. Gamification did not enhance the testing effect. Student abilities can impact outcomes of gamification." It was hypothesized that students who take and complete gamified quizzes would complete more quizzes and show better learning effects.

"Findings supported the testing effect in that students who completed more quizzes performed better on subsequent tests. Furthermore, students who completed the gamified quizzes had significantly better scores on the first test."

This was not the effect of students completing a greater number of quizzes. Moreover, the beneficial effects of gamification did not persist in later tests taken by the students. This shows that gamification might work due to its novelty, but this influence might not be sustainable. The study also shows that "higher achieving students benefited more from gamification than lower achieving students."

The key results of the study (Sanchez, 2020) are

- "Imply that gamification might be a viable option for short-term assignments"
- "Highlight concerns of a novelty effect and recommend instructors to not to use the same gamification method permanently"
- "Indicate that gamification might not be adequate to target low achieving students."

There is evidence that gamification will not sustainably improve learning. Game features lose their influence, on learning, after the initial period. So, continuous alteration of game features would be required to show improvements/benefits over traditional methods. Also, game features should be introduced with care as higher achieving students benefit more than lower achieving students. Some game features may act more as a distraction than a benefit, especially for lower achieving students. So, instructors should apply gamification with care with as clear understanding that gamification features are best designed basis the assignment and students who will be taking them.

There are limitations to the study, including

1. Study is based on a quasi-experimental design due to having real-world field data
2. Three game elements were used in gamification making it difficult to tell which of these elements had which effects.
3. The aim of the study was to reveal potential psychological effect through which gamification would enhance the testing effect. But the results show that gamification worked through a different mechanism.

The author suggests that "further studies could consider gathering qualitative data from participants which would help to reveal students' thoughts on gamification and provides insights into their learning experience through gamification". In order to understand these effects better, it was suggested to carry out longitudinal studies to investigate the novelty effects as well as individual differences moderating gamification effects.

Instructional quality of Massive Open Online Courses (MOOCs)

"The study provides a critical, systematic analysis and evidence base of the instructional quality of

MOOCs. The analysis was based on a set of first principles of instruction, derived from the main contemporary learning and instructional theories and models. Basis the analysis of the quality of instructional design of 76 Massive Open Online Courses (MOOCs) the study found that most of the MOOCs attained a low score on many of the principles of instructions. There was limited evidence of the first principles of instruction in these MOOCs. Most courses implemented only some of the principles, with most MOOCs scoring low on the extent to which these principles were implemented. None of the courses implemented all the principles. Out of 72 possible total points that each course could score according to the Course Scan instrument, none of these MOOCs scored above 28 points.” (Margaryan et al, 2015)

There were a host of probable causes – “instructors and designers of the MOOCs may lack knowledge of the contemporary instructional design principles or learning theories, or the instructors may be driven predominantly by their institutional marketing considerations rather than by pedagogic concerns.” (Margaryan et al, 2015)

Future researcher could “investigate the rationale for institutions', individual academics' and instructional designers, goals and motivations underpinning their involvement in MOOCs, examining the broader design and quality assurance processes and organizational contexts within which MOOCs are developed.” (Margaryan et al, 2015)

“The ten principles are fundamental criteria of instructional quality and can be applied to evaluate any form of structured instructional courses. However, the Course Scan methodology is devised to enable the application of the ten principles to evaluate primarily online courses. Applying the methodology to classroom-based or blended learning courses would require significant modifications to the procedure, as well as the introduction of additional data collection instruments. For example, if researchers were to apply the methodology to classroom-only or blended learning courses, they would have to make provisions for collecting data about learning activities that occur physically in the classroom and that are not captured online, perhaps by combining classroom observation with the analysis of course materials, resources, and assignments. So, when using the ten principles of instruction to analyze classroom- based or blended learning courses, a different evaluation methodology should be devised.”

Computer-based homework

The results were different for students with low prior knowledge and students with high prior knowledge. “In low prior knowledge students, feedback resulted in better post-test performance than no feedback. But in students with high prior knowledge, they learned just as much whether they received feedback or not”. These results are in line with earlier researches that suggested that the different levels of domain knowledge lead to variation in the effects of feedback.

The study “examined the impact of feedback and prior knowledge, and regression analyses were used for each outcome measure. Each model included condition, pre-test score, and their interaction. Three variables, no-feedback versus the three feedback conditions, correct-answer feedback versus the two feedback conditions with additional information, and explanation feedback versus try-again feedback, were contrasted. So, each model included three condition variables, pre-test score (mean-centered), and three conditions by pre-test score interactions. On mastering the post-test learning items, all three feedback types had positive effects for low- knowledge students, but neutral effects for high knowledge students.” (Fyfe, 2016)

Scope for further research

The study suggests that “there is a need to examine the generalizability of the effects over time and with different tasks and populations. The study tested the impact of feedback on a single algebra homework assignment, more research is needed with more diverse set of students from different grade levels, learning a variety of topics. Assessments over longer time duration would be required to know whether the effects of feedback on student learning are maintained at later time points. More work is also needed to explore ways to enhance the feedback for high-knowledge students.”

Teacher candidates' attitude towards technology use and integration

“There is a significant mean difference in the perception of teacher’s attitudes towards technology after the training program. Also, the influence of paired grouping on teacher’s attitude was positive. Thus, it's clear that proper training should be given to the teachers for excelling in their teaching style using

technology. It can be done as a part of the in-service program too. A teacher has to get updated with the changing pattern in the field of education. A regular career improvement program should be conducted in the school. Once when the teacher is confident, the entire learning becomes more enjoyable.” (Michelle Giles, 2019)

Scope for further research

The research conducted by author could be conducted using a control group. So that the comparative analysis can be studied. A comparative analysis in the academic performance of students can be performed in a student group taught by trained and untrained teachers (Technology Training).

Technological Pedagogical Content Knowledge, Self- Confidence, and Perception Teachers towards Instructional Technologies

“Results show that male pre-service teachers have more self-confidence than female pre-service teachers in terms of using technology in mathematics education. However, it indicates that female students got higher scores than males in terms of the results of the perception survey towards technology. That is, this result might be related to the readiness of pre-service teachers to use instructional technologies rather than the teacher education program, and male pre-service teachers may feel more competent to use technological software than their female colleagues. To increase the self-confidence of both male and female pre-service mathematics teachers, different types of instructional activities might be presented to pre-service teachers using instructional technology software in methods for teaching courses or other elective courses related to technology use in mathematics education. The courses provided for pre-service teachers and in-service teachers might get them confident to use instructional technologies in mathematics education. As it is stated above, the TPACK, TPACK related self-confidence, and perception towards the use of instructional technologies of pre-service mathematics teachers might be improved by getting them to participate in the creation of learning activities which includes instructional technologies. If teachers engage in such activities adequately, they might appreciate the value of the use of instructional technologies in mathematics education. Therefore, their knowledge, self-confidence, and perception might be changed in this way.” (Karatas, 2017)

Scope for further work

“Self-confidence, and perception towards the use of instructional technologies of pre-service mathematics teachers might be improved by getting them to participate in the creation and using the procedure of learning activities which includes instructional technologies. If students engage in such activities adequately, they might appreciate the value of the use of instructional technologies in mathematics education. Therefore, their knowledge, self-confidence, and perception might be changed in this way. The study was limited to 427 pre-service middle school mathematics teachers from three different universities, who were predominantly female. Also, the results of the study were limited with the data obtained from the questions of three surveys. Hence, the generalizability of the conclusions of this study to larger student populations or other contexts might be limited. Also, the results of the study were limited with quantitative analyses of data” (Karatas, 2017).

Qualitative analyses can be used to investigate these more deeply. Also, empirical studies can be conducted by controlling other factors and analyze the results more effectively.

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