



DIGITAL TRANSFORMATION OF SYNCHRONOUS AND ASYNCHRONOUS KNOWLEDGE TRANSFER AND LEARNING WITH EdTech



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Synopsis

Technology formally entered academia around 1450s AD when the printing press started being used for making books available to learners. Long after about seven centuries, gradual adoption of information, communication, and digital technologies brought overwhelming changes for speedier, more effective, and impactful teaching, learning, training, and evaluation. These rendered both synchronous and asynchronous modes much smarter and more exciting particularly for generations Y and Z. The advent and evolution of Web1 to Web3 has made globally accessible distance learning an indispensable part of contemporary education management development systems. Efforts have been made to narrate certain major dimensions and the collective effects of all these technologies culminating in EdTech. It has also delineated the taxonomies behind and the impacts of AI and Generative AI on EdTech.

Image Source: <https://er.educause.edu/articles/2022/9/digital-transformation-in-higher-education-7-areas-for-enhancing-digital-learning>

Introduction - Teaching and Learning Processes

The ancient form of education spread possibly through synchronous mode. The process was through teachers' deliberations, writing on the stone plate, explanations, clarifications, and answers to questions of students. Oxford Dictionary defines the term 'education' using many synonymous words, viz., teaching, schooling, tuition, instruction, indoctrination, enlightenment, inculcation, development, improvement, and so on. Therefore, any technology that can speed up one or more of these processes, and/or obviate the physical presence of a teacher can be called technology-based help, platform, media, and/or tools. All these can collectively be called EdTech.

Imparting and attainment of knowledge, schooling, and learning can take place in three different modes, viz., synchronous, asynchronous, and hybrid. Synchronous mode is a situation when the teacher and the students are physically present in one place while participating in the process of imparting and gathering knowledge. Asynchronous mode is when the student is alone and is learning from books, teaching notes, or any other learning resources. That is why it is popularly said that the pinnacle point of achievement by an author is when a student feels while learning asynchronously that the writer of the book is invisibly present with her/him and helping to learn.

The hybrid model started with the advent of high-speed ICT. It happens when a student learns by watching a video, with or without other students joining in one place. She/he can feel that the teacher is virtually present with her but cannot interact, ask questions, and get answers. At best those can be conveyed by writing in a chat box and the teacher can reply instantly or later. An improved version of this is teaching through video conferencing platforms like Zoom, MS Teams, etc. These facilities provide a virtual classroom and were extensively used during the COVID-19 pandemic. The author, having personally used it during that period is of the view that emotional connection, one of the most important requirements for teaching, remains missing, besides control over students.

Objective

The sole objective of this paper is to develop a simple understanding of EdTech platforms and solutions. It has made efforts to narrate how the efforts of teachers, researchers, knowledge integrators, computer and communication technologists, and digital scientists have culminated into a digital platform that is gradually

becoming an essential part of a learner's life across all ages and academic disciplines. This paper also examines the taxonomies that are followed in building learning and training solutions coupled with facilities for continuous self-evaluation. Multivarious impacts from the adoption and applications of AI tools have also been delineated in the paper.

Genesis, Definition, and Evolution of EdTech

The genesis of education is as old as human civilisation. There was no formal medium for documentation at the beginning. In ancient India, the media of learning and knowledge transfer were *Shruti* (hearing) and *Smriti* (remembering). *Vedic Rishis* used to pass on knowledge through word of mouth to disciples assembled at *Gurukul*, the seat of learning. Writing of scripts for learning started on dried long tree leaves. Moving fast forward, with the introduction of the printing press, being the first technology for spreading knowledge and education, came the written media for mass usage. Computing technology provided the electronic medium for learning and knowledge delivery from around the late 1960s.

EdTech can simply be defined as systems and applications of technology-based education, delivered through the internet or by robots. The process is organised by leveraging computing software, digital, communication, and mechatronic technologies, and hardware to offer platforms/media for learning, self-evaluation, and enhancing effectiveness of learning. It can be asynchronous and virtually synchronous. With the advent of the internet and Web1, riding on wireless communication technology, one-way knowledge transfer in digital form started for mass use. Wikis came in 1989 and Wikipedia was launched on January 15, 2001, as a resource for information and learning. Some schools of digital evangelists call it the first formal version of web based EdTech. E

Readers would, therefore, agree that there is no single source to which one can attribute the credit as the genesis of EdTech. Many technologies culminated in EdTech to evolve and cater to the needs of students from the kindergarten level to those of researchers over the past several decades. The new addition to all these is the Generative AI. Therefore, it would not be right to conclude that the genesis of EdTech lies in ICT and digital technology only. This can further be justified by bringing in the definition of technology as "*The application of scientific knowledge for practical purposes.*" By this definition in the era of 1440 AD

invention of the printing press was also a technology that evolved further to enable the mass production of printed pages bound as a book as a medium for learning and gaining knowledge.

Categories EdTech Solutions and Platforms

Educational Technologies can be classified from the perspective of their usage and circumstantial and environmental positioning. Predominantly those classified groups are for ‘Engagement of Classroom’, Asynchronous Learning, Self-evaluation, Conducting Examination and Evaluation using Digital Platforms, etc.

EdTech Companies and solution designers adopt different approaches and target different groups and

levels of prospective learners and trainees as well as institutional/corporate customers while designing their facilities. Some of them specialise only for academic purposes with target customers being only different levels of academic institutions like schools, colleges, and universities. Many of their platforms can also be simultaneously subscribed to by institutions for bulk deliveries and by individual customers for distance learning and skill enhancement. The best example of this dual customer groups model is Coursera. There are many EdTech startups and Unicorns in India. The following is a logo-centric list of the major twelve Indian EdTechs organisations:

Source of Images: <https://iimskills.com/ed-tech-companies-in-india/>

Readers may please refer to the afore-quoted website to gather details about the above and many more such EdTech Companies in India. Besides the above Indian EdTech entities, several other giant entities are also servicing from overseas locations through the Internet like Coursera, Oda Class, Amazon Academy, Snapsolve, etc. From the perspective of the types of their platforms and delivery EdTech facilities can be divided into the following categories:

EdTech for Synchronous Teaching and Learning

One may believe that EdTech solutions, created by applications of ICT and digital technologies, are not required in synchronous classroom teaching processes and those are meant for distance learning only. The

teaching community and students will agree that even a Smart Board, a ‘many in one’ kind of digitalised large TV screen-based solution, has immensely contributed to and upgraded the method of synchronous teaching. Teachers are equipped with, inter alia, quick access to the internet and repository of knowledge, digital board writing that can be saved and shared, and split board facility for simultaneous presentation of the theory and solving problems among many other such facilities.

EdTech for Asynchronous Teaching and Learning

EdTechs have advanced many more versions/steps ahead, in addition to asynchronous learning. Students can now directly subscribe and access learning materials to read and learn, e.g., the platform offered by Coursera.

Such platforms provide the entire learning management solution (LMS) for an entire course/subject, including self-evaluation of application proficiency.

Students can also evaluate the extent of attaining error-free knowledge and learning, their ability to solve mathematical or accounting problems, etc. by invoking the Test facility. The solution will put questions on the computer screen from MCQ-type quizzes to stiffer and stiffer questions/problems with facilities for students to answer. Post this EdTech solution will promptly reveal the grade/marks of the student or take her/him through another tour of questions from the preliminary level to the hardest level. If need be, students can again go back to learning materials. The system will not permit the learner to take up the next chapter or level of learning until the previous level/chapter is cleared through such a process of evaluation. The globally famous EdTech firm Coursera provides such asynchronous facilities among many others.

EdTech for Virtually Synchronous and Hybrid Learning and Training

With the World Wide Web (www) evolving to Web2 the process of imparting digital technology platform-based education and training facilities became virtually interactive and video enabled. Adoption technologies for AR, VR, and MR, Gamification, and Metaverse upgraded the virtual learning environment manifold. These rendered the platforms virtually synchronous with options for hybrid deliveries. The present Web3 technology further advanced these processes and made visualisation. Web3 enabled the introduction of 'Distance Laboratory Work' for experimentation required for subjects like physics, engineering, etc. This process is called Decentralised Science or DeSci.

The video conferencing service providers joined the bandwagon of EdTech entities in a big way during the COVID-19 pandemic period. They rendered invaluable services to teachers and learners across the world to continue with the process of learning and knowledge transfers. All stakeholders for institutionalised education systems across all academic levels became dependent on such virtual classrooms participating from anywhere through the internet. This mode of EdTech has now become a co-existent medium for teaching, training, learning, and evaluation.

Infusion of AI and ML into EdTech

The infusion of AI and ML into EdTech upgraded the process for evaluation and grading learners with

a step-by-step assessment of the extent and effectiveness of learning. For this purpose, gradually stiffer questions are put forward from the question bank with the student progressively answering harder questions and vice versa. AI helped automate the evaluation of written content by using OCR technology. Adoption of AI, ML, and BDA also helped enhance the assessment of efficacy and purposeful analyses from the perspective of the rightfulness of immersive content, and virtual pedagogy. A combined analysis of results from both evaluations brings out the need to improve those immersive contents.

Various cognitive technologies have also provided system designers, teachers, and learners with many other facilities. AI helped immediate assessment of the extent of absorption and learning by assessing the:

- ⊙ Impacts and pattern of changes reflected on a learner's face and body language,
- ⊙ Pattern of verbal interactions, questions raised by the learners, and/or failure to answer questions when the teacher adopts the Socratic method of teaching,
- ⊙ The nature of notes typed by her/him on the digital notepad for subsequent self-paced study,
- ⊙ Errors committed while answering questions for self-evaluation at the end of a chapter, etc

Based on such assessments the system can prompt the student to relearn certain specified parts of the content to fill of gaps and/or rectify errors. AI can also automatically change the pattern for visual/immersive content for ease of learning.

8allocate.¹ reports that "*Knewton, an adaptive learning company, has helped increase student test scores by 62% in participating institutions with the help of AI-driven personalized learning. AI models can take over multiple mundane admin tasks such as student orientation, transcript reviews, and prospect outreach.*" AI thus augments the effectiveness and efficiency of the EdTech platforms by the following:


- ⊙ Automated KYC and registration of learners,
- ⊙ Profiling of Learners through initial questions and answers,
- ⊙ Intelligent Tutoring System,
- ⊙ Self-paced Learning Facilities,
- ⊙ Adaptive Classroom Teaching,
- ⊙ Automated Testing and Assessment,
- ⊙ Performance Analytics of Learners, including the impacts of demographic attributes,

- Listing Requirements for Modification, Upgradation, etc. for the EdTech solution designers based on analyses of feedback from learners and emerging pattern of their performance.

Howard Gardner’s Theory of Multiple Intelligence and EdTech

The popular belief is that a person can learn in three ways, by seeing and observing or visual learning, by listening or auditory learning, and by manipulating,

touching, and feeling objects or kinaesthetic learning. However many other theories have proved that human beings learn and acquire knowledge by applying other kinds of intelligence and making other objects the medium of learning. The most popular of them is the ‘Theory of Multiple Intelligence’² ideated by Prof. Howard Gardner³ and his co-researchers at Harvard University School of Education. They have established that a human being has the following nine different intelligences which help them to learn.

	<ol style="list-style-type: none"> 1. Verbal-linguistic, 2. Logical-mathematical, 3. Spatial-visual, 4. Bodily-kinaesthetic, 5. Musical, 6. Interpersonal, 7. Intrapersonal, 8. Natural (by observing nature) and 9. Existential or from day to day living of self
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Source of the graphic: <https://www.simplypsychology.org/multiple-intelligences.html>

Gardner has defined Intelligence as a “Biopsychological potential to process information that can be activated in a cultural setting to solve problems or create products that are of value in a culture” (Gardner, 2000, p.28).”

Teachers, researchers, and knowledge integrators in collaboration with innovative solution designers have made the best use of the above nine intelligence with the help of digital technologies and robotic process automation (RPA). Their innovative graphical and immersive presentations, visualisation of knowledge, and smart and digitally enabled pedagogical expositions made EdTech an attractive platform for learning. The learner or trainee has to follow simple processes in a computing device or smart phone. They have affirmatively aroused and exploited all these nine different intelligences of mankind. Many times, conventional asynchronous classroom teaching methods may not be able to achieve such beneficial exploitation of the said nine different intelligences of human beings.

Nature and Taxonomy of EdTech

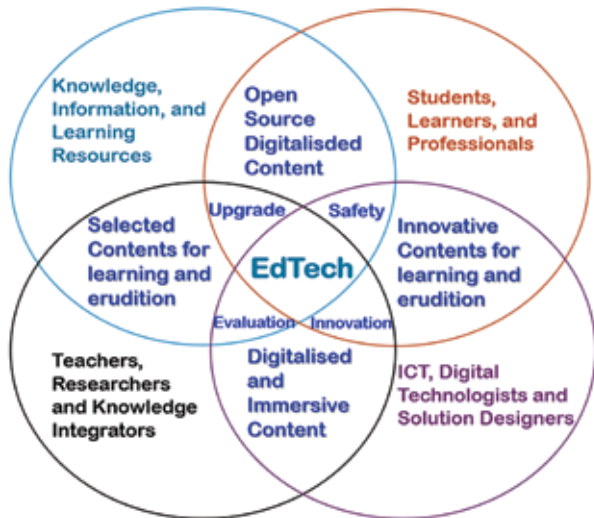
Adoption, application, and integration of digital technologies for creating digital platforms or Apps for academic education, training and application-oriented skillset development purposes, using any type of computing devices, or large smart board type devices,

is a learner-centric product. It should aim at virtually holding hands of users and taking them forward in their journey to learning and attaining skills. The learner can be a student of any specified academic level, or a professional from any industry. It should advance and/or diversify her/his knowledge and help attain new skill sets. The user can even be a teacher who prefers to refresh and complete the journey through an EdTech platform before suggesting to his target learners.

EdTech is essentially an ‘Instructional Technology’. The Association of Educational and Communication Technology (AECT)³ has defined it as “The theory and practice of design, development, utilization, management, and evaluation of processes and resources for learning”..... instructional technology involves the application of theory from different fields, developing learning materials and using it, and evaluating the outcome from the point of learner and professional teachers. Here the focus of technology is to enhance or facilitate learning”.

Therefore, any EdTech product must be purposeful for its target users and comprehensive for the segment of knowledge and learning, or any specific academic course it aims to impart and then assess the learning impact. It is, therefore, important for readers to understand and appreciate the Taxonomy of EdTech.

A Schematic View of Taxonomy for EdTech



Source: Created by the author

Taxonomy is a biological term. According to the World Taxonomy Initiative, It is defined as “... *the science of naming, describing and classifying organisms and includes all plants, animals, and microorganisms of the world.*” In that light, the above graphic depicts the four major components of EdTech Universe. The first level intersections of those four major circles generate another four components and the second level intersections four more. Thus, twelve major and common components have been included in the above graphic, albeit there can be more specific to any EdTech solution. Due to the limitation of space, those are not being explained.

There can be several more sub-components and drivers underlying each one of the above 12 elements. For example, for ‘Upgrade’ the EdTech solution will provide facilities for generating feedback from learners and

retain performance-related statistical data on the efficacy of application-oriented learning reflected through each learner’s score in evaluation. Through the application of AI-based tools the ‘Teachers and Knowledge Integrators’ must provide insights by data analyses and suggest more inputs to the solution designer to modify/upgrade the content and questions for evaluation. This would help subsequent developments and upgrade the system to in turn improve the overall performance of learners and thus the EdTech App itself. Hence the new taxonomical component is the AI-based ‘Feedback’, ‘Evaluation Score Sheet’, and the AI-based ‘Cognitive Tools’ for drawing insights.

Bloom’s Taxonomy for Pedagogy and Post-learning Evaluation

In addition to Howard Gardner’s ‘Theory of Multiple Intelligence’ the knowledge integrators and solution designers for EdTech should adopt the six levels of ‘Bloom’s Taxonomy’. The objective should be to make the process of learning multilateral/multimodal and enable users to gradually scale the higher levels of knowledge and creative skills. Those also help design systems and processes to assess the efficacy of learning and application skills of the learners.

Therefore, while designing the back-end EdTech platform, the front-end APP, the ‘Digitalised Immersive Content’ and ‘Virtualised Pedagogy’ knowledge integrators and solution designers should keep in mind those six levels. This is because through the EdTech solution, they must facilitate the users to gather knowledge, visualise the entire content for learning at ease, and attain application-oriented skills to ensure that a learner also achieves the following six levels of capabilities as suggested by Bloom’s Taxonomy:

Create	Use Existing Information to make something new Invent, Develop, Design, Compose, Generate, Construct
Evaluate	Make judgments based on sound analysis Assess, Judge, Defend, Prioritize, Critique, Recommend
Analyze	Explore relationships, causes, and connections Compare, Contrast, Categorize, Organize, Distinguish
Apply	Use existing knowledge in new contexts Practice, Calculate, Implement, Operate, Use, Illustrate
Understand	Grasp the meaning of something Explain, Paraphrase, Report, Describe, Summarize
Remember	Retain and recall information Reiterate, Memorize, Duplicate, Repeat, Identify

Source: https://courses.dcs.wisc.edu/design-teaching/PlanDesign_Fall2016/2-Online-Course-Design/2_Learning-Objectives-Alignment/6_objectives_blooms-taxonomy.html

Bloom’s Taxonomy, therefore, in one sense represents the aspirations of the learners. It prompts the solution designers that a learner will use the EdTech product only if it provides the right kind of knowledge and skills by holding the hands of learners. It must help users to be equipped with the right capabilities from the bottom level of learning and understanding to scale up for creating something new. In the process, the EdTech platform must help them assimilate, apply, and analyze the immersive knowledge and learning content in the repository of the platform, i.e. the levels as revealed by the above pyramid of Bloom’s Taxonomy. In the ultimate analyses thus the EdTech will help the learner to upgrade to creative category at the pinnacle.

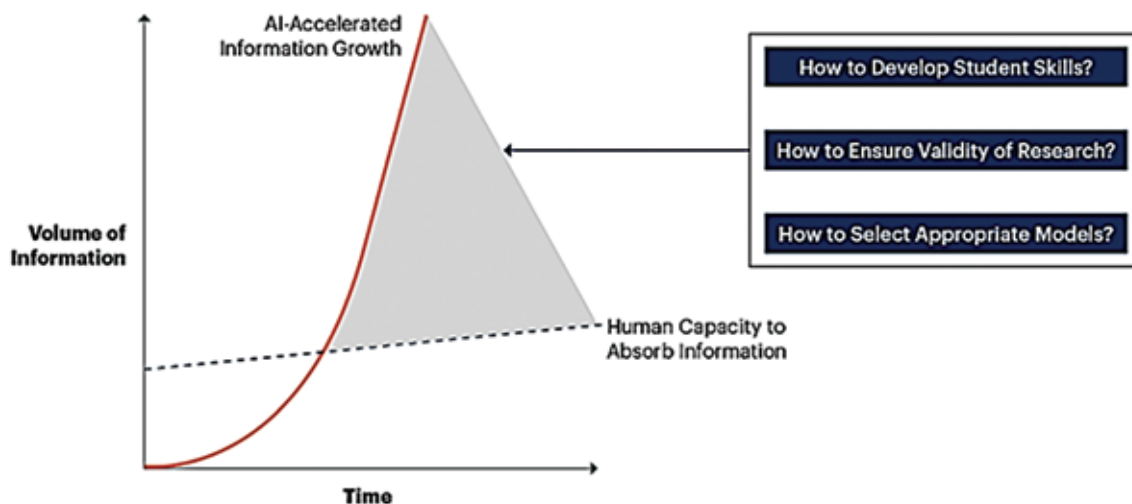
It is worth noting here that during the early 1990s Chip Bruce, an information scientist of the USA, created a taxonomy for the use of information technology from the perspective of impulsive actions of children on matters of advancement of knowledge and evaluation thereof. Those four taxonomical elements were coined considering the American Philosopher John Dewey’s⁴, ‘four impulses of the child’: *inquiry, construction, communication, and expression.*” According to James a Levin³ these four have guided teachers, knowledge integrators, and EdTech solution designers “.... in the uses of technologies for education to better understand

the range of uses and it has also helped spur the development of new uses”. These are equally worth adopting while designing EdTech solutions.

Surge of Academic Contents

The latest development in the field of AI in the form of Generative AI has unfolded and heightened the expectations from EdTech. According to a publication of Gartner containing EdTech related predictions for 2024, “Education CIOs are evaluating generative AI’s potential and managing its risks. This challenge, along with the continued need for operational efficiency, student experience and competitiveness, creates a complex landscape that education CIOs must plan to navigate. GenAI-created content – Teaching, Research, offers potential for both students and faculty to accelerate the production of engaging content, and enable assets to flex to different global contexts and be delivered in multiple languages.” Without quoting any number Gartner has included the following graphic for all stakeholders of EdTech to appreciate the order of magnitude in terms of rate of growth over a given time frame in Generative AI driven contents for EdTech vis-à-vis mankind’s ability to absorb those. Gartner has also raised three questions to be pondered over for if humanity has to find answers to match the speed.

AI-Driven Rush in Growth of Contents Vs. Human Absorption Capacity



Source: Please see at serial number 5 of Webliography

With extensive use of Generative AI enabled Large Language Models (LLMS) and high speed cognitive tools for language conversion, EdTech solution designers will be able include in their platforms application based wide range of case studies as learning contents. All these

will most certainly improve effectiveness and popularity and of EdTech platforms. However, everyone in the EdTecch solution builder community must be cautious about and protect from all the evils of Generative AI that have been experienced so far including plagiarism

and stale/ misinformation.

Benefits of EdTech

From the above discourse, the readers by now must have observed and realised the benefits of EdTech platforms. Given the shortage of space those are not being re-articulated. Readers might have understood that EdTech platforms are set to render commendable services to the learner, teaching, and re-learner community, including for management development. By many counts the EdTech systems provide flexibility and convenience of learning at an affordable cost. As the number of users increases year over year costs also will decrease. EdTech solutions are dynamic and first adopters of knowledge rather than books.

EdTech service providers are gradually developing a global academic economy. According to a publication of the World Economic Forum⁶, *"The next 10 years will see 800 million K-12 graduates and 350 million*

post-secondary-school graduates globally, and expenditure on education around the world is set to hit \$10 trillion by 2030. In that growing global education ecosystem, Edtech is set to play a critical role."

Conclusion

The author feels that he should write its second volume to make it more comprehensive from the several other perspectives not covered in this paper. Leaving those aside, orthodox group of people can say that there is no substitute of classroom teaching. EdTech platforms deprive students from experiencing the love, affection, strict discipline, and emotional bonding with the teacher. It also deprives students of the benefits of body language, anecdotes, emotional intelligence, and pearls of wisdom of the teacher. But despite all these, given at its present state of affairs, EdTech has shown all promises and potentials to co-exist with classroom teaching and grow.

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