

# Understanding Technological Evolution in Teaching: A Qualitative Data Analysis

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**Abstract**—Every evolution, rooted in its principles, presents a time-relevant paradigm shift. In the regards, technological evolution has been a significant milestone in the journey of educational contributions. It has today become an integral part of the education eco-system. While generation-z students are characteristically tech-savvy, at the same time it questions the caliber of the faculty to address the needs of these students. To understand the evolution of teaching pedagogies of the classroom, a qualitative study was conducted with Connectivism as the underlying theoretical framework. Through the semi-structured interviews, twenty seven faculty were interviewed with five questions. The first round of coding was carried out using the descriptive and vivo methods and second was carried out using the focused coding. Five themes have been discussed from the round one coding and summarized using the round two. The paper presents the results and discussion of this qualitative study and opens the potential space for future technology-related research questions. Writing learning outcomes, evolving classrooms and selecting technology have been discussed with respect to technological implications. The study concludes that the research groups need to develop philosophies by integrating the technology into the learning styles.

**Keywords**—Connectivism; Education; Evolution; Teacher; Technology.

**JEET Category**—Research

## I. INTRODUCTION

**B**E it scientific principles or philosophy, evolution is an interconnected historical process. With time, there has been a fundamental shift in every domain, altered and affected by a time-relevant paradigm. Though the principles are usually rooted in the theories of the purview, the practicality has changed with respect to the state-of-art necessities. In due course of time, evolution has witnessed some of the elemental changes in the application layer boiling down to the

foundational layer as a compulsory necessity. To name one such is the role of technology. From being once an additional-benefit to now being a platform-for-everything, technology has observed a radical change impacting human endeavors. Technology has brought in revolution, making the platform of usage more accessible and also adding personalization (Walkington, 2013).

Like many other domains, even education has seen a drastic change with respect to teaching and learning methodologies, which are mainly influenced by technology. Machines and tools that were once restricted to undergraduate programs are now often habitually used, even in primary schools and lower. Technology has had a significant role in the anatomy of education, from planning a classroom session to delivery, assignment, and assessments. The rapid infusion of technology in education was perceived during the pandemic, which otherwise would have taken a longer time phase. From an expert-generated resource across the globe to giving a proctored test, technology has brought everything to one's lap. In the regards, global perspective of technology in education has been discussed and deliberated (Selwyn, 2012).

Dramatics, storytelling, arts, etc. are some of the forms employed in teaching and learning. Technology has opened new facades by supporting rhizomatic learning. Based on the student learning styles and the complexity of the concepts to be covered, a teacher can now choose amongst the various available means supported by the multimedia delivery. Technology has created a new age for learning by integrating different tools and platform into the teaching learning process (Fulton, 1993). With simulations, online coding platforms, software as a service, and virtual laboratories, multifaceted complex concepts have been broken down into simple manageable components of lesson delivery. Along with the university designed program, a student can now also access resources from around the globe, take at their own pace, and master additional skills as demanded by the job market.

While the generation-z kids have been tech savvy and inherently part of digital learning eco-systems (Turner, 2015), the same might not be the case at the other end. Most faculty even today are from the generation where the only classroom means of delivery was chalk and talk. Though there were

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pedagogical innovations through activities, there was minimal scaffolding from the technical end. There was minimal intervention in delivery or assessments with respect to technology. Though most have now adapted to the modern needs of digitally influenced classrooms, the change has not been an easy transformation. While most faculty still are in the middle grounds of technology usage, there sure is a digital divide with respect to students and faculty. Literature has discussed the consequences that technology could bring by correlating it with the Gresham's law and warning that it could lead to unwanted and unpleasant consequences (McCluskey, 1994).

This work aims to understand the evolution of technology into the classrooms from a faculty perspective. While educators are working hard to bring a balance between traditional teaching methods and digital solutions, technology can only enhance the experience but not replace the human element in entirety. Educators understand that adapting to this changing landscape is inevitable and it has to be thoughtfully incorporated to bring out the best benefits to the students.

The paper is further divided into following sections: section II presents the literature survey, section III presents the research design, Section IV presents the methodology, section V presents the results and data analysis, section VI presents the discussion followed by conclusion in section VII.

## II. LITERATURE SURVEY

This section presents the evolution of technology in education from last two decades along with the classic literature support. Google scholar was used as to list the year-wise papers starting from the year 2020. One top paper based on the relevance was selected for the study from year, criteria for relevance as decided by the Google scholar. This study was carried out during the period of July 2023. The keyword used for the search was 'technology in education'.

At the start of the year 2000, the community was already conversing about surveys of the past works, with technology in education and discussing the problems and obstacles of using it in academics. Barriers to adapting technology in education have been discussed at the start of 2000's era (Rogers, 2000). In order to have a significant and meaningful advancement in learning process and to have impact on global scale, research findings state that the education system must integrally link with technology and theory (Spector, 2001). Educational policy, approach, infrastructure, content-ware, committed and trained personnel, financial resources and integration have been the major parameters identified to incorporate technology in education (Haddad & Draxler, 2002). In a critical review of research findings on information technology in education states that the specific design features of the software designed can make a major impact too (Markauskaite, 2003). Teacher training has been identified as one of the potential issues (Greer & Keohane, 2004). Gender and technology in education have been discussed (Sanders, 2005).

Learning theories like constructivist, behaviorist, etc. have been used with technology support making the learning faster,

cheaper and easier (Romeo, 2006). Calls have been made to develop the new philosophies with technology and education (Brogden & Couros, 2007). Impact of faculty attitude, distance education and innovation has been premeditated (2008). The race between technology and education has been reflected upon (Goldin & Katz, 2009).

While technology can assist with several means, studies have been made with respect to student focus and issues with instructional coherence have been discussed (Means, 2010). The various dimensions of using technology in education have been surveyed and discussed (Hamidi et al., 2011). A meta-ethnography study of nineteen web-of-science articles indicates one of the identified key themes as teachers must align theory and practice and understand the reasons behind using a particular technology (Tondeur et al., 2012). Handbooks have been written on information technologies for education and training (Adelsberger et al., 2013). Deliberations have been made to assimilate the new technologies by selecting the right tool to align with research based instructional practices to enhance the engaged learning opportunities (Holland & Holland, 2014). In the regards, discussions have been made on why it's crucial to be critical when we integrate technology and education (Selwyn, 2015).

A list has been made on what teachers should know about technology and education (De Bruyckere et al., 2016). Studies have been made on how technology is intertwined with social developments and is part of the society (Cloete, 2017). From digital footprints to online degrees, and leading to globalization, the modern technologies in the field of education have been studied (Raja & Nagasubraman, 2018). Systematic reviews have been conducted evaluating the use of technology in education (Lai & Bower, 2019). Learning opportunities for teachers and students have been identified where teacher has an opportunity to create different learning materials for different learning styles (Reddy & Bubonia, 2020).

Artificial Intelligence technologies for education have been talked about (Zhang & Aslan, 2021). Information technologies in education have been discussed (Hawkrige, 2022). Hermeneutic literature review has been carried out to understand the theories and models employed to comprehend the benefits of technology (Sackstein et al., 2023). This timeline literature survey presents the evolution of technology in various dimensions. With the fast paced progress, it is essential to understand how a teacher has been adapting to the changes that are happening on the global scale.

## III. RESEARCH DESIGN

This section presents the research design that was followed for the proposed work.

### A. *Philosophical Assumptions*

The proposed work follows the pragmatic philosophical assumptions (Creswell & Poth, 2013), where the goal is to understand the teachers perspective on technology in education. We construct the reality by understanding how do teachers perceive the technology for the class preparation and its further

usages and it has multiple perspectives. Each teacher might construct their own reality constituting the ontology. The knowledge is constructed by being an insider and understanding the subjective evidences from participants which constitutes the epistemology. The axiological beliefs are that the considering the limit of the study, there could be biases and the study reflects both participants and researchers perspectives. The methodology followed is the qualitative research.

### B. Connectivism: Theoretical Framework

The study is grounded on the theoretical framework of Connectivism. Connectivism is social learning that is networked; meaning that there is technology that plays role in the learning (Duke et al., 2013). The theory combines learning content, learning context, learning technologies and learning subjects. The learning is technologically enhanced (Utecht & Keller, 2019). The motivation for this study is derived from the characteristics of the Connectivism. It has been questioned and deliberated if it is a learning theory for the digital age (Goldie, 2016). With the networked information landscapes, the theory throws light on how the modern era learning styles has changed for the better good (Kathleen, 2011).

### C. Research Question

The study aims to understand the teacher involvement of the technology usage for the course content delivery, preparation, assessments, feedback and any other components that are related to teaching and learning. The research question for the study was formulated accordingly.

RQ: What is the holistic impact of technology in a teacher's timeline of the semester tenure?

### D. Model

Figure 1 below presents the model employed for the study.

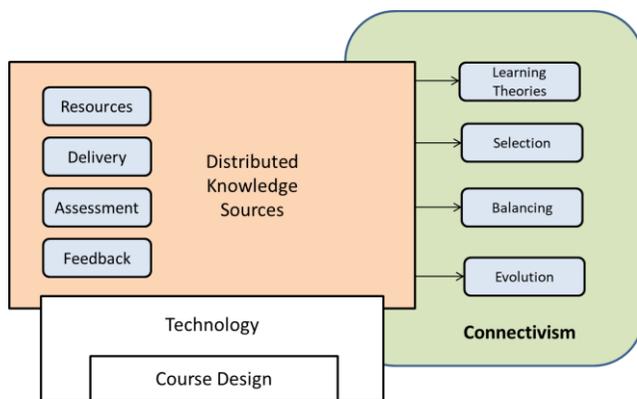


Fig. 1: Model of technology in education

The model is designed combining the elements of technology evolution as identified in the literature survey and the Connectivism framework. Technology is in-evidently part of the entire course design and the knowledge of each component is distributed. Based on the research question formulated the model explores the learning theories, technology selection, balancing the classroom and evolution of technology in classroom.

### E. Sampling

A semi-structured interview was conducted for the data collection process to understand the technology implications in teaching process. Self-selection was used for the interview process (Sharma, 2017). A call-for was made in three institutions to participate in the interview during July-August of 2023. Everyone who agreed to give the interview during the timeframe was interviewed. Snowballing process was further followed asking participants to enroll if anyone else from their contact would be interested in the interview (Goodman, 1961). In snowball sampling participants assist in identifying the potential participants. With the followed process, a total of twenty seven faculty were interviewed from eight institutions across India. The department of the faculty they belong to varied across the engineering disciplines. The years of teaching experience of these 27 faculty can be seen in Table 1 populated below.

TABLE I  
YEARS OF EXPERIENCE

SI. No.	Years of Experience	Number of Faculty
1	Less than 6	6
2	6 to 10	7
3	11 to 20	12
4	More than 20	2

## IV. METHOD

As a part of methods used, this section presents the objectives and the question design for the semi-structured interviews. The questions were influenced by the model designed and the research question that was formulated.

### A. Objectives

The objectives of the work are as listed below in Table 2.

TABLE II  
OBJECTIVES

ID.	Objective
OBJ_1	To understand the evolution of technology in the classroom
OBJ_2	To comprehend on how a faculty selects technology for the classroom
OBJ_3	To understand the influence of technology in classroom practices

Three objectives were used as a guide to formulate the five interview questions.

### B. Question Design

A semi-structured interview was conducted for the data collection process. There were five questions asked during the interview which connected technology and course delivery, usage of technology, selection of technology, balancing between traditional methods and technology and evolution of classroom practices. A University approved consent form was shared with the faculty seeking their approval to use the data

for research purpose. Five questions designed accordingly are listed below.

Question 1: What are your thoughts on technology and the course delivery in the current era? Question 2: Can you provide an overview of the types of technology tools you regularly use in your class delivery? And how do these tools enhance the learning experience for your students? Question 3: How do you determine which specific technology tools to incorporate into your teaching? Question 4: How do you balance traditional teaching methods with the integration of technology? And Question 5: How have your teaching practices evolved as a result of incorporating technology?

## V. RESULTS AND DATA ANALYSIS

Two rounds of coding was carried out on the transcribed data. In the first round a mixture of descriptive and vivo coding was used. In descriptive coding, we code the passages according to the topic (Gibbs, 2007). In vivo coding we use the exact phrases and words collected from their lived experiences and perspectives (Manning, 2017). Focused coding was employed for the second round where we categorize the related and merge (Stuckey, 2015). The paper presents the summary and analysis of the coding methods and keyword assignment of each phase is not included in the description.

### A. Round One Coding

The summarized themes are presented in the Table 3 below. Followed by the themes identified in the round one coding is described further in detail. Under each theme described are the major supporting points for the arrived themes.

TABLE III  
LIST OF ROUND ONE THEMES

Theme No.	Theme
1	Shapes the landscape of classroom
2	Tools are unlimited
3	Learning outcomes decide the technology
4	Classroom is about enriching learning experience
5	Evolution is multi-faceted

#### 1) Theme 1: Technology shapes the landscape of the classroom

Technology presents plethora of options to the learners. It has had a significant impact on the quality of delivery as students can always look for better resources elsewhere. What we had once does not work anymore. Traditional teaching can always be integrated with appropriate technology methods. This change will constantly persist in the future as well. It helps in explicit content delivery. It keeps one competitive. Teachers must collaborate with technology like a partner. It's a mode to keep the generation-z engaged even for math oriented courses. Technology helps one to go beyond classroom and connect with all the essential life skills. It is integral part of us now and cannot be viewed in isolation. It makes classroom fun. Technology has assistance for any

concept that we want to bring into the classroom. The barriers that existed once are not anymore.

#### 2) Theme 2: Tools are unlimited

Be it multimedia content or simple power point presentations, technology can assist in every form of content design and delivery. From programming to an English class, there is support for every subject. These provide flexibility in the process and keep one engaged. They facilitate interaction. From Google classrooms to virtual reality, every experience is now a reality. From quizzes to feedback, there are tool that can be customized as per need. From understanding pronunciations to taking a discussion online to a global scale, technology can enrich the experience. Faculty can record and host videos that students can re-watch later. One can make posters for a class event or even have a virtual classroom running along physical.

#### 3) Theme 3: Learning outcomes decide the technology

It is mostly the features of technology that one uses as an evaluation parameter to decide the kind of technology to use. Gaps and student feedback can help in deciding the right technology. Ease of use and accessibility naturally becomes an important criterion. The course nature decides the technology type as well. Pedagogical goals and requirement from students need to be considered as well. Writing well-defined learning outcomes can help in this regard. They must enhance the learning experience. It must benefit all the stakeholders involved. It must compliment the teaching style.

#### 4) Theme 4: A classroom is about enriching learning experience

Technology must not replace the traditional teaching but it must complement the process. A combination of various learning methods can be merged for the classroom delivery. A teacher must use the best of both worlds to make the class session impactful. An appropriate human interaction is necessary while technology enriches the learning experience. A class can always begin with chalk and talk followed by technology supplementations.

#### 5) Theme 5: Evolution is multi-faceted

Theory finds its platform for the practical experience. Interaction and collaboration has increased. New philosophies have evolved. Real life examples have made into classroom walls. The learning methods have shifted from passive to active. Classrooms have found practical relevance. Subjects core knowledge and depth has been enhanced. It has increased the confidence level. It provides an environment to go beyond the classrooms. There has been an increased use of collaborative learning breaking the physical barriers. The learning journey is elevated in all the aspects.

### B. Round Two Coding

With focused coding the themes were merged to arrive at the following as described further. The landscapes and evolution are connected. The tools that we use and the

selection process might not always be based on objectives set for the class. There is a need for proper planning to have an effective integration of traditional classrooms and technology. Learning experiences must be supported with feedback for improvement.

## VI. DISCUSSION

This section presents the insights and inferences from the study conducted. We divide the discussion into three parts. Of the three parts are: a part of writing learning outcomes, a part for evolution and the last part for deciding technology. Each part also provides a scope to define research questions to carry future research work.

### A. Writing Learning Outcomes

We usually consider the course content to write the course learning outcomes. If theories like constructive alignment are used, then we also design based on the assessment (Biggs, 1996). Considering the evolution and the role of technology, it's high time we start writing outcomes based on the usage of digital sources as well. A MOOC if used as a part of course delivery, there has to be a separately designed learning outcome. A teacher must list all the technologies to be used and then decided its impact on learning outcomes. This can also help in designing assessments and indirectly realizing outcomes. Research questions can be formulated with such learning outcomes to measure the effectiveness and impact.

### B. Evolving Classrooms

A faculty must also take feedback for the technology used. There is hardly a component that measure a classroom delivery for the tools used. There is no direct question that measures the impact of ICT in a classroom. In order to develop philosophies that integrate with learning styles, there must be explicit feedback to evaluate the technology used for the classroom delivery. Different tools can be used on groups to identify the effective one and research questions for the study can be formulated accordingly. Tools also drive the evolution. New tools cover the gaps of existing. A possible research direction is that, can the tools be designed guided by the learning styles.

### C. Selecting Technology

Most of the times a technology is selected because university mandated it or it were a recommendation. This ad-hoc approach must evolve. A faculty must first list all the requirements to make the classroom delivery effective. Based on the need a right tool needs to be selected for the classroom delivery. A checklist can be made and brainstormed before making a decision. The feedback from students and alumni can also help in this regard. As much as we understand evolution, we might be contemporaneous in adapting it. If there is no tool that meets our requirement, there lies an opportunity to build one for a better good society. There is ample research scope in this area to evaluate and select a technology meeting the modern needs of digitized classrooms.

## VII. CONCLUSION

The proposed qualitative study has led to several research directions on how to improve the classroom session by making technology an inherent part of teaching. Based on the qualitative analysis, the objectives of the work can be concluded as: to understand the evolution of technology in the classroom, it is necessary to understand the past and have a vision for future through learning outcomes. These outcomes must be derived by technology parameter as well. A faculty must select the right technology for the classroom based on research directed by content, tool and students. To understand the influence of technology in classroom practices, the technology must be viewed through the lens of adapted learning style.

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