An Analysis of Technology Adoption of E-Learning Tools in School Education: Using System Dynamics

Sunita Kumari Malhotra
Associate Professor
Dayalbagh Educational Institute (DEI)
Agra, Uttar Pradesh, India.

Akansha Verma
Research Scholar
Dayalbagh Educational Institute (DEI)
Agra, Uttar Pradesh, India.

Abstract

In the era of digital technology, learning in schools has been observed as a means of improving quality of delivery, approachability, and learning among the students and teachers in the educational stages of primary, secondary and tertiary education in India. Thus e-learning is an innovative standard change in the education sector for the quality enhancement of learning and concentrated knowledge within the students and it is also a medium for convenient teaching for the teachers. The analytical study focuses on the enablers and barriers in the adoption of electronic-learning tools in school's education with the help of system dynamics. The analysis is carried out using systems analysis using causal loops, stock-flow diagram and simulation is done on the basis of available information which represents that how potential schools for technological adoption will convert into actual adopters irrespective of the various challenges faced by them. Both types of data primary and secondary will be employing in study. This study is also relevant to the performance assessment of schools that are using e-learning tools in the perspective of the teachers and students.

Keywords

Technology integration, E-learning tools, Education, System analysis, System thinking, Enablers, and Barriers.

1. Introduction

For the quality education concern teaching and learning has been certainly important factors. Since emerging of this century, the education system has faced a variety of challenges in terms of social, cultural, economic, and technical. As the research and practice of accelerating learning and advancing performance (Januszewski & Molenda, (2008), technology trying to attempt and overcome challenges by developing new approaches and frameworks in the domain of education. In this

situation, (ICTs) information and communication technologies signify a new approach for strengthening the transmission of information and serving to meet these challenges. According to Lever-Duffy, McDonald, & Mizell, 2003; USDE, 2000; ISTE, 1999 ICTs consist of the use as a minimum of a computer and the Internet as well as computer software and hardware, networks, and a host of devices that adapt information (text, images, sounds, and motion) into extensive digital formats.

For the effective integration of ICTs in the schoolroom, curriculum, school administration, library, and any educational setting a prearranged process is important. With the implementation of ICTs the value of education enhances by serving educators to do their job and by helping learners to acquire more effectually. In these situations, teachers' shifting role in the 21st era includes an essential mission, which is towards the borderline for applying technological innovations to the learning and teaching process. At this time, the necessary skills and the level of future teachers' willingness are key factors in implementing new ICTs. Therefore, school's teachers play a critical role in developing future teachers to turn out to be effective in ICTs integration into the curriculum.

In this article, the practice of system dynamic modeling helps to know, envisage, and explore the use of technology integration in schools. In the social system of education, technology integration is a dynamic social practice which facilitates the teaching-learning process.

Therefore, with the help of a systems approach, we will be able to find out the frequency of adoption of e-learning tools in education and how much they are impacting the teachers and students and the factors like enablers and barriers affecting the rate of adoption along with the overall performance of the schools. The model introduced in this study draws out together identified components of integration and conclusions from a large-scale technology plan to create an initial casual-loop diagram of technology integration in school teaching. Apparently, in this paper, model presented feedback and multiple effects in the system of education. Consequently, the use of the systems approach can possibly support a shift from focusing on teachers' technology use to student outcomes, and the feedback loop of students' technology use on teachers' practice. Implications for technology integration, teacher change, and learning are discussed.

With the purpose to provide a more realistic view of technology integration and possible teacher and student change, particularly in relation to the impact of barriers to integration, student learning, and input of support and training with the help of the system approach model.

2. Objectives of the Study

- To identify the enablers and barriers to the adoption of e-learning tools in education.
- To find out the impact of enablers & barriers for technology adoption of e-learning tools in education.
- To aware of the importance of e-learning tools in school's education for the enhancement of quality using the SD model-based simulation scenario Research Methodology.

3. Need of the Study

The study implies advances the acknowledgement of academic staff to the value of using the interactive characteristics of e-learning as an important asset in teaching students. The present study is based on a non-linear complex system, consists of the enabling and disabling variables related to an with adoption rate of technology in education leading to performance and growth of the education sector. To explore this problem, we present a system dynamics based exploratory model of technology integration that builds upon the existing body of research analyzing factors of teachers' technology integration.

4. Enablers & Barriers

In the words of following (Baylor and Ritchie 2002; Ertmer and Ottenbreit-Leftwich 2010; Hew and Brush 2007; Inan and Lowther 2010) there is not a set group of agreed factors limiting or promoting teachers' use of Information Technology in the classroom. But from the literature, there are several commonly identified factors, such as resources, curriculum, teachers' attitudes, and beliefs, knowledge, and skills, assessment, and the institution, and subject culture. Researchers have tended to discuss these factors in relation to how much they would affect the adoption of ICT's in schools and act as an enabler or barrier to teachers' use of Information Technology in the classroom.

According to Ertmer 1999, 2005 enabling factors supported and motivated integration whereas barriers were identified as limiting factors in teachers' technology integration.

Table 1: List of Enablers and Barriers

Enablers	Barriers
Having technology plans	Access to technology
Offering in-service training	Technical support or time limitations
Allocation of more financial resources	Lack of in-service training
Teacher readiness	Lack of basic knowledge/skills for ICTs
Quality of teaching and learning	Lack of appropriate software/materials
Technical support in the school	Adoption Delay
Proper knowledge/skills for ICT integration	Lack of knowledge/skills for ICT integration
Decreasing course load of teacher educators	Lack of appropriate administrative support

5. Conceptual Framework

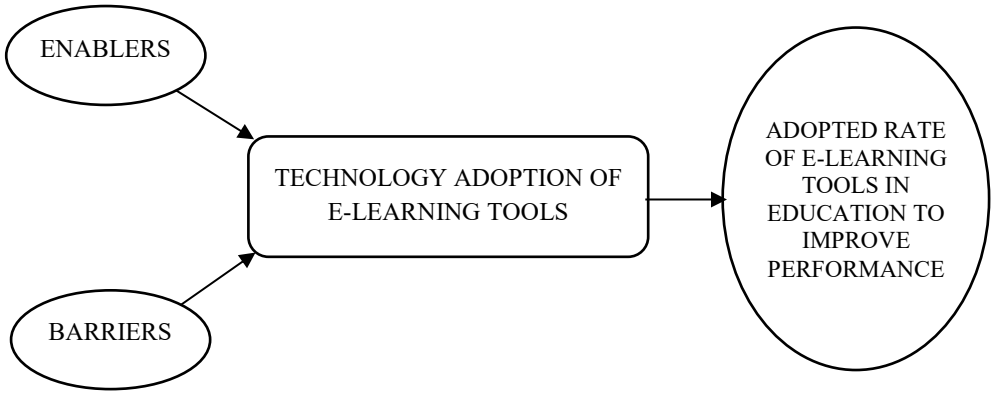

Figure 1: Conceptual Model

6. Review of Literature

According to (Zhao et al. 2002, p. 482); said with the diversification of technology integration in teaching and learning in the ground of educational e-learning tools, research remains be struggling. Whereas (Ertmer et al. 2012 p. 423) said that in the past years, research work has identified the complicated and disordered process of classroom technology integration and, that there are thousands of research articles examining, exploring, and investigating, essentially trying to unpack, technology integration in schools. So far, the interplay and complication of technology incorporation continue to be illusory.

(Borko 2009 and Thompson 2013) identified the technology specifically refers to information and communication technologies (ICTs). What can be an ICT? This could be a smartphone, educational games, laptop, social networking website, etc. that facilitating a teacher and a student in the teaching and learning process in a classroom. We are talking about the use of digital technologies. This could be as part of direct teaching, classroom task, work in a computer lab. Technology does not include the teaching of computing skills. It is known that teachers' integration of ICTs in teaching and learning is a wicked problem.

Rittel and Webber 1973 stated that Wicked problems which are vigorous, contextually hold, and autonomous explained by having a big number of compound variables.

Borko 2009, also defined the problems related to technology integration. Technology integration, as a problem, has been defined by a number of dynamic factors, such as technological aspects of new tools, effective practices, potential to transform learning, new forms of teaching and learning spaces.

According to Law 2008 and Ertmer 2012, technology integration is a more effective factor for the enhancement of quality in school's education and has the largest potential impact when used in problem and project based tasks, and underpinned with constructivist pedagogy. Ertmer and Ottenbreit-Leftwich 2010 states that many studies have shown that students' use of technology is related to learning gains digital information skills are an essential part of the practice of most professions, for 21stcentury use of ICTs is considered to be an essential skill learning in schools and throughout life.

Yet, young people are unlikely to independently use technology in ways resulting in positive learning gains, these skills and practices must be integrated into learning by the teacher (Ng 2012). Over the last decades, pedagogy research has tried to understand how to bring about these changes in teachers' practice and better results in student's learning with effective use of technology in the classroom, but we still have very mixed results in the area. What is known about technology integration has caused complexity.

7. Research Methodology

Understanding the attributes of technological changes becomes a critical domain of technological innovation. Thus far, research on technological innovation was conducted in the framework of defining its characteristics, appearance, and pattern. Recently, there was a remarkable increase in studies in which the "system approach" concept was introduced to technological change in order to create an understanding of this subject.

This paper analyzes the changing pattern of technological innovation by using System Dynamic Simulation. SD is a framework that can substitute the existing manner of static and linear thinking with holistic and dynamic thinking. Dynamic thinking is supposed to describe the deviations in behavioral design of problems as an interval of time instead of, to detect the cause of the problem for an exact time. Since technological changes take place continuously, from the point of view of a long-term view, it is not possible to assess the technological change at a particular point. Thus, the analysis examines behavioral structure as time strategies instead of focusing on a particular event at a certain point in time.

The Casual Loop Diagram (CLD) has been used for mapping the feedback loop structures of the system. The causal relationship between Teacher ICT integration and Learning Outcomes related variables has been evolved. Significant feedback factors have been detailed through five reinforcing and four balancing loops. The Stock Flow Diagram (SFD) has been developed using the Stella software (V9.1.3) of SD to holistically understand the system behaviors by studying various relevant simulation scenarios.

Researchers have collected data from the secondary sources comprising various reports, magazines, periodicals, articles, blogs, newspapers, research papers published in esteemed national and international journals, and web references.

The CLD Model was prepared using VENSIM software, explaining the dynamic of the relationship between technology adoption in the education.

Table 1: Key Variables used in the Model

Variables	Type of data	Sources of data
Complexity in adopting tools & technology	Secondary	Progress report of school
Rate of adoption	Primary	Questionnaire
Professional development	Primary	Interviews: Deans/Prospective teacher
Learning outcomes	Primary	Surveys from teachers & students
The Output quality of the tool	Primary	Surveys from teacher & students
Teacher readiness in adopting e-learning tools	Primary	A Questionnaire using 5 point likert scale
Teaching productivity	Secondary	Annual report of schools
Knowledge about integration	Primary	Through workshops
Awareness of tools/technology	Primary	Questionnaire
Adoption delay	Primary	Educational surveys
Potential adopters of technology used in education	Primary	Educational surveys
Adopters of technology in education	Primary	Educational surveys
Learning time	Primary	Educational surveys

8. Causal Loop Diagram (CLD)

To map the impact of teacher ICT integration on the growth of professional development and learning outcomes, a CLD has been developed which represents causal relationships and interdependencies as well as feedback processes of the model. Figure 2 shows four feedback loops that consist of two balancing and two rein forcing loops.

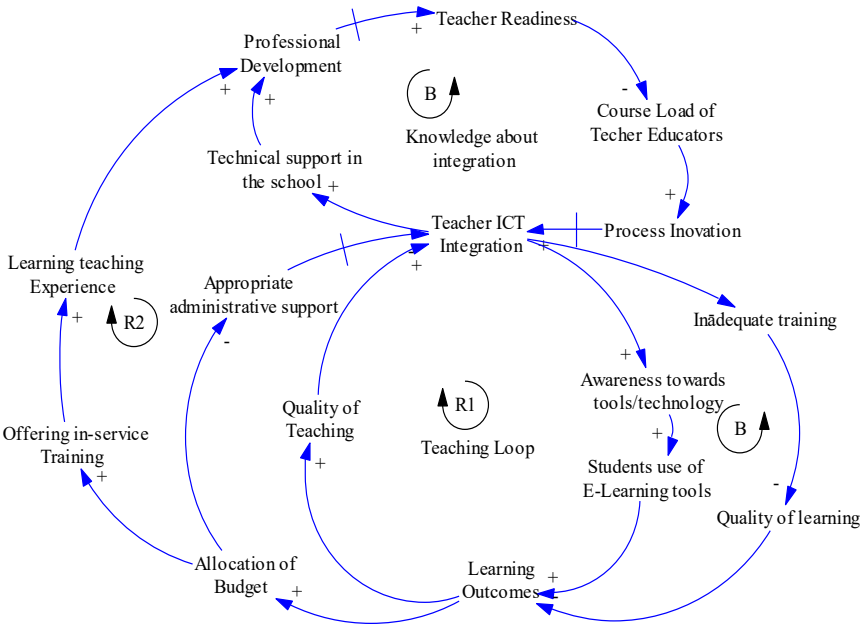

Figure 2: CLD Causality between Variables of Teacher ICT Integration, Learning Outcomes

Table 3: Showing the Name of the Different Loop and their Effects with other Variables

Causal Loop	Factors/ variables	Description	Known Effect Loops
Teaching loop (R1)	ICT integration	Teachers' use of technology in education.	People do not certainly think or know about educational technology adoption unless they are exposed to it.
	Student Use of ICTs	How students are expected and asked to engage with ICT in learning? Teachers' will perceive an effect on learning outcomes.	Students using technology result in higher grade points than those not using technology.

	Learning outcomes	Outcomes from students' engagement with ICT (e.g., engagement, higher-order thinking skills).	Teachers experiencing positive outcomes from students are more likely to integrate technology.
	ICTs support learning	Views about the effect of ICT on students' learning outcomes.	Predicted teachers' value of technology is that ICT is important. Positive experiences with, integrating technology build assurance as an instructional tool.
	Teacher readiness	Teachers' perceptions of confidence and capability to use technology in teaching.	Direct relationship to technology integration .The best predictor of ICT adoption.
	Professional development	Formal or informal training under taken by teachers to improve their practice or technology use.	In general, today's teachers may be more familiar with technology, still, they may not be fully prepared or able to integrate computer technology in their class rooms. The direct relationship to teacher readiness to use technology.
	Offering in service training	Teachers' requirement, and want, to learn about technology integration.	Teachers' experience about technology adoption facilitated their 'inner drive' to improve practice teachers more competent using ICT were more likely to attend ICT-related professional development.

	Inadequate training	Teachers are not getting proper training to operate the e-learning tools and other technologies.	Less will be training provided to teachers will result in low teaching standards and this will lead to less learning outcomes by teachers and students.

9. Stock and Flow Diagram (SFD)

The CLDs provide the causal relationships amongst factors and are not able to capture the stock and flow structure of systems; the need for SFDs becomes necessary.

There are two significant stocks identified in the linkage between potential adopters of technology in education and adopters in technology in education as shown in the SFD of Figure 3.

The SFD also indicates the accumulations and flow-related relationships between different variables—adoption delay, learning time, and teaching productivity effect on the rate of adoption indicated in the SFD in Figure 3.

The inputs for creating the SFD were obtained from the academic experts who provided the relations between variables as well as behavior trends and values of variables. The model was initiated for carrying out a number of SD-based simulations with the application of the software, Stella V 9.1.3.

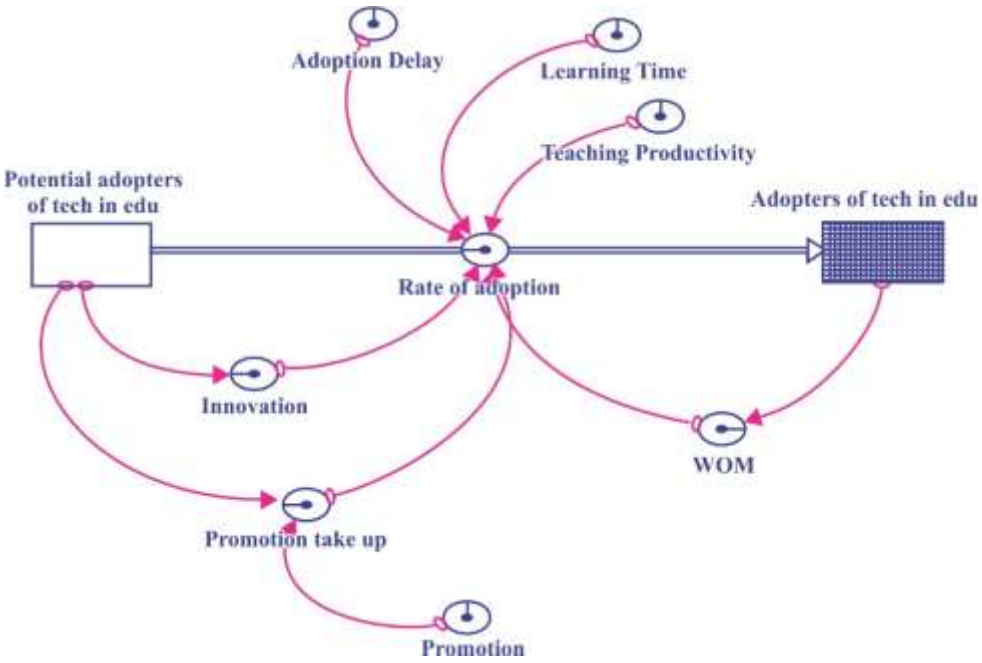

Figure 3: SFD Linking Potential Adopters of Technology in Education with Actual Adopters of Technology in Education

10.Simulation of Model

- GraphPad

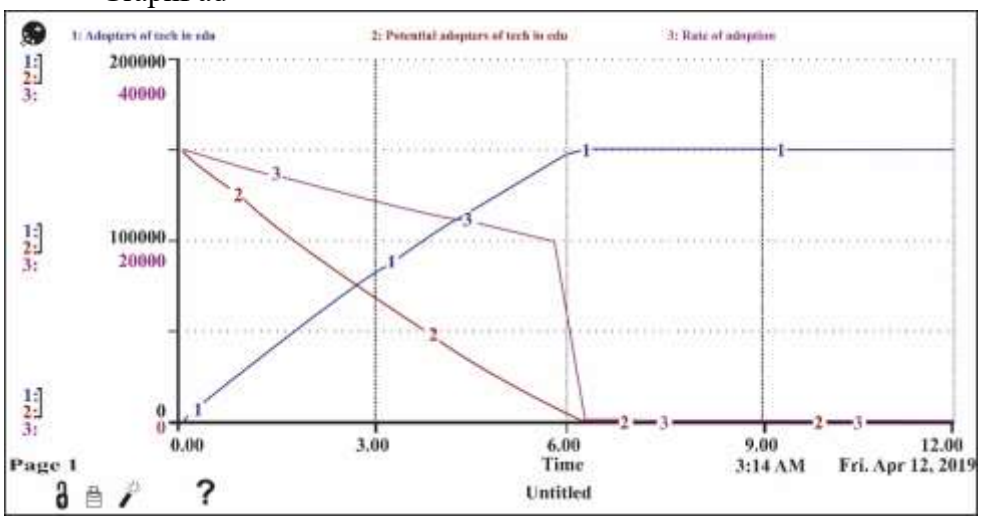

Figure 4: The Result of SD Simulation with regard to the Technology Adopters

11.Results and Interpretation

The scenario stimulated from the SD model developed were studied and summarized as-

The SD model presented in the study is based on the bass model, as it is showing how potential adopters are converting into actual adopters of technology in school's education.

The trend graph of actual adopters is increasing due to the high adoption rate and then it is constant. It resulted from the study that technology adoption has been taken place at a high rate of adoption irrespective of various barriers faced by them.

Result from the study shows that technology integration has been particularly beneficial for the quality enhancement of the school's education.

The included factors for the rate of adoption are the following: Innovation, Promotion takes up, Word of Mouth, Teaching, Productivity, Learning Time, and Adoption Delay.

As it is shown in the graph that as rate of adoption declines shows the potential adopters are converted into adopters.

This means the system dynamics model helps this study to find out the importance of e-learning tools in the education sector.

Table 3: Simulation through Table Pad

9.54 PM 4/14/2019	Table 1 (Untitled Table)		
Time	**Potential adapters of tech**	**Adopters of tech in edu**	**Rate of adoption**
.00	150.000.00	0.00	30.008.44
.25	142.497.89	7.502.11	29.482.92
.50	135.127.16	14.872.84	28.966.60
.75	127.885.51	22.114.49	28.459.32
1.00	120.770.68	29.229.32	27.960.93
1.25	113.780.45	36.219.55	27.471.28
1.50	106.912.63	43.087.37	26.990.17
1.75	100.165.09	49.834.91	26.517.50
2.00	93.535.72	56.464.28	26.053.12
2.25	87.022.44	62.977.56	25.596.86
2.50	80.823.22	69.378.78	25.148.60
2.75	74.336.07	75.663.93	24.708.18
3.00	68.159.03	81.840.97	24.275.48

12.Conclusion

This study is based on the implication of system dynamics modeling to examine the factors affected by technology integration in an education field.

As this method helps to better understand the complexities and dynamics of possible changes in the factors such as in this study, the researcher used the model on possible changes in the nature of learners and teachers for the technology adoption in their pedagogy.

It is also concluded from this study that technology integration is considered to be more effective for the learners as well as teachers from the perspective of the education sector.

Researchers have presented a system model of technology integration and demonstrated how it could be used to employ systems thinking to understand some of the complexity and dynamic of technology integration, possibly make new patterns and influencing factors visible and refocus technology integration on learning.

It is important to note that the system approach builds on exiting research and simply provides a method to examine factors as components of a system and observe their multiple effects.

However, using various variables in the CLD diagram of teacher integration and learning outcomes is able to suggest important interactions in terms of reinforcing loops and balancing loops in the fig. 2 and feedback in the system.

This has provided a key step in beginning to incorporate systems thinking and methods in educational technology research.

13.References

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