The Effective Use of Digital Storytelling and Flipped Classroom Instructional Approach to Improve Science Subjects

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 The current study explores the theoretical and practical knowledge and skills acquisition in teaching physics subject. The proposed approach combined the effects of the flipped-classroom approach and the Digital Storytelling (DST) method on student's to help them understand the concepts of K-12 Physics subject at the Govt College of Gujrat, Pakistan. For this purpose, the topic content was developed with the Seven critical elements of digital storytelling mapped with TPACK framework-based lectures implemented using the Flipped classroom-based model. A Quasi-experimental research design was employed to assess multiple data sources, comprising pre-and post-tests on results. The experiment was performed with 15-18 years old K-12 Pre-engineering science students of the academic year of 2020-2021 (n=77) to discover any disparities in their learning of science subjects. The observations and post-testing results suggested that the individuals boosted their academic achievement in terms of marks and transformed their attitude toward Flipped-Model Learning backed by digital Storytelling based lectures. The findings further revealed that DST-based instruction facilitated the conducive leaning environment of flipped classroom as student academic performance was enhanced. Based on the empirical evidence, it has been recommended for future studies to be considered the collaboration of digital story telling pedagogies and flipped classroom learning environment to overcome the learning difficulties in the subject of physics.

Keywords: flipped classroom, digital storytelling, science subject, TPACK, K-12, physics, students

INTRODUCTION

Natural Science subjects are considered challenging subjects for understanding and teaching, especially in third-world countries like Pakistan, where the technology adoption curve at the grass-roots level is critically low. In the traditional teaching method, students face retention and engagement issues with the lectures, which might cause low grades and understanding of the concepts particularly considering physics subject. Even though physics is the core subject among the entire science disciplines. Physics disciplines are tough to learn, and people struggle with abstract notions. For instance, learning-content and related-material on the laws of natural physics, general relativity, blackbody radiation, and Compton scattering are exceedingly puzzling to learners since they deal with generally intangible concepts. It is essential to construct and deploy instructional activities that aid learners in forming visual images that express their conceptual perceptions (Tas, Kose, and Cepni, 2006). Therefore, grasping the concepts and understanding the fundamental themes with rational thinking is imperative. Moreover, contribution of technological involvement in facilitating the understanding of underpinning concept of physics cannot be ignored. Therefore, much emphasis is placed on determining the effectiveness of digital storytelling-based lectures of natural science subjects in the flipped-classroom model. This study follows a K-12 grade class and their teacher in a Govt school in Gujrat. The study combines digital storytelling with flipped classroom model to teach Physics using lesson plans that were made with the help of the TPACK framework. It is expected that the finding of the current study will provide guidelines for educational policy and practice makers. Further, it also brings attention towards catering the domain-specific needs of 21st-century learners.

Even though a significant amount of work has been done in digital storytelling in every field of education, nevertheless, it is hard to develop science subjects' material. To develop the proposed approach working framework; dual process was taken into consideration. First, we developed a digital storytelling-based physics lecture on "Types of forces," that was delivered to students in a flipped-classroom model via available online lecture delivery platforms including YouTube and Zoom. According to flipped classroom procedure, prior to conduct actual classroom, instructor provided students with learning materials where students were required to read the topic on their own one week prior to post-test data collection. The instructor gathered pre-test data to measure the student's knowledge on the subject matter. Secondly, after lessons were delivered, the researcher assessed student's retention of the topic discussed in the lecture. This approach was used keeping the Meadows suggestion that focused on use of technology-focused description, focusing on digital storytelling and digital cameras, software, digital tools, tablets, laptops, and computers. Since, teachers can leverage from user-contributed content and employ instructional technology when implementing this integrated technology application (Meadows, 2003). This method enables students to learn on their own, whereas, the facilitator's role is comprehensively done in the form of preparing the DST – based lecture.

Literature Review

Flipped Classroom Learning (FCL)

"Flipped classroom" is a teaching method first popularized in the United States and invented by Baker (2000) wherethey use the two classroom practices (inside and outdoors) together to accomplish actual teaching tasks and treat teaching as an essential component of a flipped classroom's effect on communication. They reinvigorate student enthusiasm in self-directed learning and enhance their capacity (Punch, 2006). As opposed to just listening to lectures, using a flipped classroom format that enabled students to participate in class activities and discussions in a collaborative manner (Baker, 2000); taking charge of one's learning enables the student to have more time for interacting with their teacher, which increases in overall learning time (Bergmann & Sams, 2012; Subramaniam, 2016; Shehzad et al., 2020)). In addition, the flipped Classroom empowers children by providing an opportunity for all students to engage in their learning fully. At the same time, the instructor remains an additional guide to help them along the way. Because students may watch the recordings anytime and anywhere, it is undoubtedly an effective technique to enhance autonomous learning (Subramaniam, 2016). Teachers can spend more time in class if they provide lecture recordings for learners to view at home. Whenever instructors notice that learners do not comprehend anything, they can jump in and assist one-on-one (Doman & Webb, 2017).

Digital Storytelling (DST)

The study of Digital Storytelling has become widespread worldwide, with research being done in numerous locations in the United States, Europe, and Asian and Middle Eastern countries. "Twenty-first-century learning mode" refers to DST, described by Jenkins, Purushotma, Clinton, and Robison (2009). Except writing about it for academia, most of the present research on DST is concerned with helping students achieving personal or societal goals (Hull & Katz, 2006; Hull, Zacher, & Hibbert, 2009; Stewart & Ivala, 2017). Hence, scarcity of research is found in school subjects. As in the past literature it has been widely proven significant as students can learn about easy and complex subjects and gain competence in presenting, writing, and technical abilities can be developed through DST.

In addition to enhancing students' lower-order thinking, DST fosters higher-order thinking, such as preparing for a long-term research project and creating innovative learning environments. Past research has demonstrated that ICT must be an integral component in learning environments. The study used tablet computers and smartphones for digital storytelling and mobile devices like smartphones and laptops for multimodal digital knowledge production The integration of DST with subject-matter learning proved ICT as an important aspect in student learning (e.g., Lee & Tan, 2018; OECD, 2013).

In this current study, students in Gujrat, Pakistan, learned through digital storytelling and apply it to physics concepts to be more engaged in their studies which in turn, improves retention. Similarly, Pakistan (a country with a vast population of young

generation) recognizes that learners need new skills and competencies to deal with the rapidly changing global world and 21st challenges. Digital storytelling is implemented to enable students to study course content via online or offline media, allowing them to become active learners and interact with their peers and communities (Yapici, Ümit & Karakoyun, Ferit, 2016; Karakoyun, 2016).

Social, cultural, and linguistic themes are prevalent in digital stories used in the teaching-instruction environment (Banaszewski, 2005; Yang & Wu, 2012; Demirer, 2013). There is very little research on use of digital storytelling specially in physics subject training. Apart from a few research, digital storytelling has yet to be widely utilized in physics training in Pakistan. Digital storytelling enables people to engage in physics in Pakistan. Mobile phones, the internet, and computers would allow individuals to use multimedia resources more efficiently and effectively and take advantage of these tools even when not in the classroom. With internet sharing, digital stories relevant to physics themes can be provided to individuals in any location and at any time. Thus, story viewers would gain information about the subject they were interested in. As a result, digital stories, because of their ability to be accessed remotely, can serve as a distance education tool taught using the internet.

Track Framework

The TPACK framework identifies three different knowledge sets: Primary, factual, and experiential knowledge, and describes how they interact with each other and with one another (3 sets of knowledge: primary, factual, and experiential; see each of them interact with each other and with one another) (Mishra & Koehler, 2006; Barbour, Rieber, Thomas, & Rauscher, 2009). See Figure 1 to illustrate how all sorts of knowledge in the framework interconnect. The concept of digital storytelling can serve as a means of engaging pre-service teachers before they begin their service. Teaching and learning projects that place technology as a valuable tool. Robin (2008) Digital storytelling is not a new idea; in fact, it has been for quite some time. However, the expanding affordability and accessibility of multimedia have furthered the use of Digital storytelling. Ensuring that you have resources (such as cameras, computers, microphones, editing software, Apps, tech gadgets, and scanners) is the first step towards growing stories passed on by word of mouth which has demonstrated to be a practical and straightforward approach to spread among students and instructors, authorship practices of storytelling with digital media." utilizing several computing applications and media to tell stories is considered "craft." Employing digital media in numerous compelling ways. To cultivate multi-literacies, such as multilingualism, dealing with digital images, text, and videos in the media-rich environment that we find ourselves in today requires media literacy, digital literacy, and visual literacy. It allows them to build stories before entering the teaching profession—individuals or groups who create educational product content.
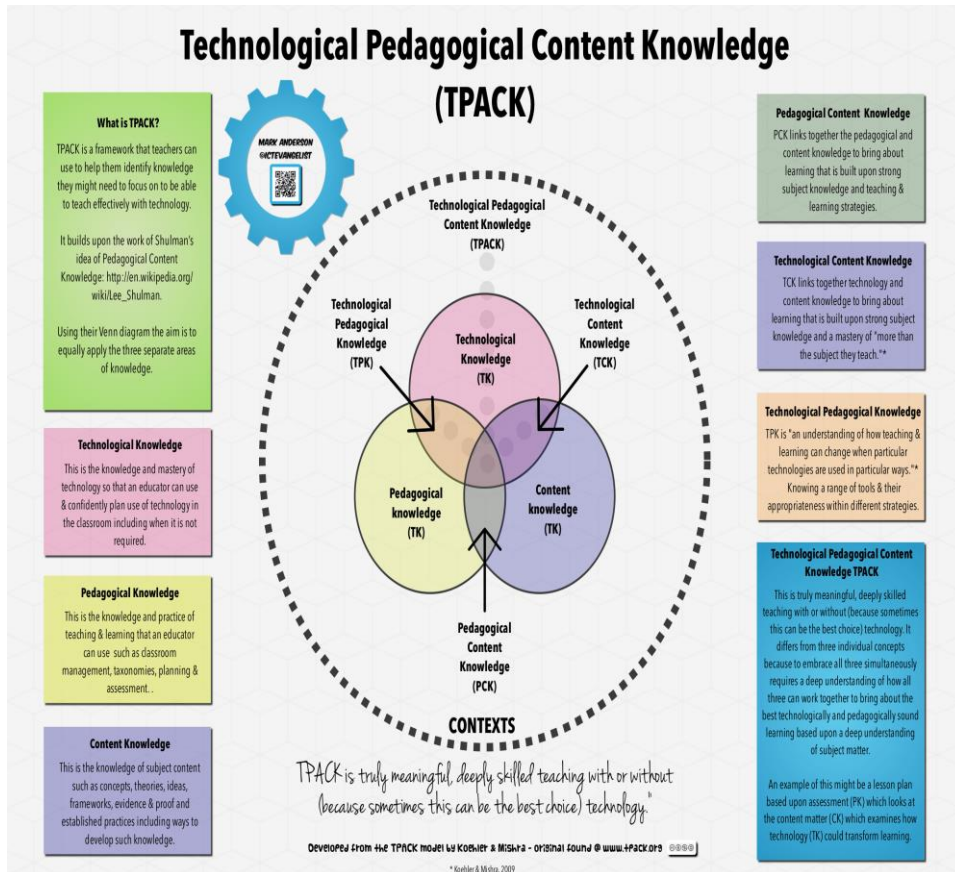
Figure 1
TPACK Framework

METHOD

This section consists of two parts; the first part reports the research objective, while the second part provide details of the research design that comprises of the subject, the research instruments, data collection, and data analysis.

Research objective

This research is carried out to investigate the effect of a flipped-classroom approach backed with TPACK based digital storytelling approach to measuring the academic achievement of students at Gujrat College, Pakistan

Research Design

This research was carried out; using a quasi-experimental design which aims to establish causal relationship between variables of the study. Before conducting the research permission from the said school was obtained. Afterwards, teachers were trained to prepare and use the intervention material. A consent letter was designed that was attached to the questionnaire which consist of study purpose and assured participants anonymity. The subjects were assigned to two groups i.e., experimental group (exposed to proposed approach which digital story telling method mapped on TPACK framework) and control group (exposed with convention method of teaching and learning physics). Data was collected with the sequential procedure of quasi-experimental design such as pre-test, intervention, and post-test. Intervention was made on the physics topic of "Forces of natures" having seven questions. Student's academic performance was measured via final scores graded at the end of the subject completion on the questions that were designed on the topic of "Forces of natures". A comparison on pre-test and post-test was made along with the questionnairewhich was conducted to know the student's opinion about DST based flipped approach instructional method. The self-reported questionnaire was administered in English language that took approximately 15-20 minutes to complete.

Instrumentation

Lesson Plan: In this research study, the lesson plan was the primary instrumentation that was developed using the TPACK framework, which is targeted to obtain the research objective. A Video lesson was designed for 6 minutes covering the basic concepts of "Forces of Nature" and relatable real-life examples mapped on the TPACK framework. Expert opinion and guidance was used to design the lesson that precisely describes the core concept of the topic, after the creation of the lesson plan it was again verified by knowledge expert. Researcher in this study worked as an instructional designer to ensure the content quality and delivery.

Video clips: Video clips were selected from YouTube, and a few clips were combined to make lessons for the experimental group. For this purpose, Video Scribe and Filmora software's were used. Video Scribe is basically used for white-board animation. It is limited used for mathematics-related subjects' animations which has been used in the study in a distinctive way. Filmora on the other hand is general video editor which was used for audio editing. The video that was made on the TPACK framework, ensured these points in depth.

1. Point of view: Delivering the main concept idea first to students from the instructor's perspective.

2. Dramatic Question: A key question to grab attention will be answered at the end.

3. Emotional Quotient: To create relatability, adjusting the real-life examples & scenarios so that students can connect with the story.

4. The gift of your voice: A great way to personalize the story to help the audience understand.

5. The power of soundtrack: Uses SFX and sound/music to make the story compelling.

6. Economy: Using Images/graphics/icons/reference images/ animation to avoid overloading the viewer with information.

7. Pacing: The Rhythm of the lecture starts at high and quickly ends with slow progress.

Flipped Classroom Environment

Students were given the link of YouTube video and Google drive link in flipped setting, access was provided so that they can watch the video wherever they are comfortable and available to watch.

Achievement test

The post-test was designed to check the knowledge gained after the intervention of DST-based lectures in Flipped classroom model.

Then after Providing study material in the Flipped model, the post-test in Multiple Choice Questions with three/four possible answer options were developed to check the knowledge gained in the Flipped Classroom by students on their own the total number of students who participated in the study and their attendance is provided below inTable 1)

Table 1
The number of students attending.

	Total no of students	Attendance percentage
Control group	36	100 %
Experimental group	41	100 %

Data Analysis

After the complete fulfilment of research objectives instrumentations, the data were collected as follows.

Testing: One-time pre-test and post-test were prepared and administered respectively to the control and experimental group. Then Pre-test and post-test scores from achievement tests were analyzed using SPSS- Statistical Package for the Social Sciences; it was used to conduct a fundamental analysis of means, Standard deviations, and independent t-tests for the data collected before and after the intervention.

FINDINGS

After the data collection and analysis of means, standard deviations, and independent *t*-tests. The results are presented following the research questions.

RQ: To what extent can a flipped classroom backed with digital storytelling-based lectures enhance academic achievement in the form of results?

Descriptive statistics comparing the Pre and post-test of students in Flipped classroom approach backed by digital storytelling-based lectures that indicated that the mean scores of experimental groups in the post-test (M=6.71) were higher than the pre-test (M= 2.61). Similarly, the results from the pre and post-test results of the Control group were given, respectively, Pre-test (M= 2.22) and post-test (3.47). (See Table 2)

Table 2
Experimental group & control group (Pre-test & Post-test Data)

	Pre-test (Mean)	Post-test (Mean)
Control group	2.22	2.28
Experimental group	3.47	6.41

The data were subjected to the *t*-test for paired samples, with the results showing a statistically significant gain (n=41, M=6.41, p=0.00) for the physics test. See table 3.

Table 3
Descriptive statistics of pair samples

Pair sample statistics	Mean	N	Std. Deviation	Std. Error
Control group: Post-Test	3.47	36	1.183	0.197
Pre-Test	2.22	36	0.832	0.139
Experimental group: Post-Test	6.41	41	0.706	0.110
Pre-Test	2.28	41	1.457	0.227

The paired-samples *t*-Test shown in table 4 indicates that with flipped Classroom backed with a digital storytelling-based approach, the students performed significantly better on the post-test (p<0.05) compared to the pre-test (See table 4).

Table 4
Descriptive statistics of pair samples

Pair sample statistics	Mean	N	Std. Deviation	t	P-Value
Control group: Post-Test	3.47	36	1.183	13.438	0.00
Experimental group: Post-Test	6.41	41	0.706	13.025	0.00

The quantitative finding indicates that the Flipped classroom model backed with DST-based lessons significantly affected students' understanding and performance and academic achievement with enhanced learning outcomes. These findings also narrate that we can improve science subjects teaching by blending digital story telling based lectures with Flipped classroom model, which can lead students to grasp concepts with less time and yield high results. This finding also signifies that quantitative and qualitative data support each other.

DISCUSSION

Higher secondary school students benefitted greatly from DST-based lectures implemented in flipped classrooms approach, and they enhanced their knowledge of physics concepts of "Forces of nature". The post-test scores were more significant than the pre-test scores. Before and after the test, the physics lesson exam results demonstrated a substantial variation of scores between pre-and post-tests. In other words, participants' understanding abilities improved, which was determined by the flipped model and DST-based content. Finally, the intervention lasted for only a few hours, and as a result, substantial improvements in understanding core concepts with good real-life relatable examples. Students that took part in the study might have had more significant consequences if the study continued for a whole academic year.

The findings showed that students found flipping the Classroom and DST technique difficult due to the non-availability of tech gadgets and less understanding of tech at the Intermediate level. Furthermore, group work proved difficult for many of them since they did not know how to work. This is possible, as it has been hypothesized that the kids had not learned to cooperate cooperatively and were apathetic.

Ultimately, considering the critical necessity of physics in day-to-day life, physics is one of the premier academic fields that individuals must pursue. However, physics subjects should be straightforward, attractive, and easily understandable. To accomplish this, understanding science subjects should engage numerous senses and be accessible to everybody at any time and in any location. Creative storytelling, which involves audio, visual, music, and animation, is a way to fulfil this desire. The greater significance of digital storytelling in physics education comes to light when it is noted that people from all over the world will get online access to digital stories regardless of location and time.

CONCLUSIONS AND RECOMMENDATIONS

Research findings at the outset indicated that both teachers and students had implemented the DST project in the Flipped Classroom paradigm. A primary benefit to the pupils was their capacity to learn to work alone and with others, and these students claimed this. Teachers who had previously taught concepts likewise saw that the most significant benefit of cooperation was readily apparent. Also, DST Project learning has added a new set of abilities, such as ICT, communication, creativity, and technology, to the talents we teach. Adding the DST to the Flipped classroom approach was a well-intentioned option as it fosters 21st-century skills. On the other hand, teachers in the Classroom must be prepared to apply ways of the 21st century to help students utilize the latest technological innovation. According to current educational studies, optimally using computers and technical instruments is a significant factor in effective learning (Beatty, 2010).

Therefore, teachers should understand that technological innovations can become a learning culture and start with the teaching staff and the pedagogical processes (Yelland, Cope & Kalantzis, 2008). It is as important as what we say how we communicate to our students. In today's culture, the information noise can be loud, and it can be a matter of diffusing the frequencies to which students listen in competition. With the help of

educational technologies, purposeful pedagogies can be implemented to teach science subjects to cater to the problems faced by students in the 21st-century era. One of today's most potent educational instruments is the digital story, which focuses upon and connects digital natives with the curriculum.

Digital storytelling is the process of generating ideas, researching, exploring, and learning about them. The student creates a script that details their findings and turns the concept into an actual story. Students work with photographs, audio, and graphics and finally develop their storyline that integrates multimedia. Build a video that will be seen on the web or a computer. Indeed, this course of action involves Tasks that challenge and inspire kids to learn can strengthen their self-efficacy, attitude, and academic achievement. Accomplishment. To promote active learning, it is good to include digital stories in lessons about physics. As well as practical knowledge. This idea has been suggested to be used with pupils at least for the duration of a school year. Term. Furthermore, students and teachers can become active participants in the learning process using digitally authored stories. Further investigations on the relationship between digital storytelling and physics are needed. Instruction. The usage of cooperative learning was assessed in a comparison group in this research. Contemporary learning approaches, as well as up-to-date educational practices, can be likened to digital storytelling. A more comprehensive range of participants Additionally, the researcher may resort to similar research.

Additionally, a similar study might be utilized to pupils before their duty in an educational setting—teachers of different academic levels. Throughout the trial, the period was six weeks (In addition, the modern physics unit was the only theme behind digital storytelling.), considering the wide-ranging implications of digital storytelling. The notion is that emotive traits may only change over a substantial period. It is recommended that in later studies, the application process should be scheduled for a longer timeframe. Reach more cherished goals about digital storytelling's impact on expressive traits.

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