

Time for Attitudinal Change and Critical Thinking: Implementing Blended Learning in an Indian Elementary Classroom

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ABSTRACT

The main purpose of this empirical study was to investigate the effects of blended learning on students' learning attitude and critical thinking. Secondly to probe into teachers' perceptions on blending potentials in an underprivileged elementary classroom, a design study was conducted among 50 children from a fifth standard class of a government-run Indian elementary school. Findings revealed a significant difference in students' learning attitude towards the designed courses between the two cycles, in favour of the post blended implantation stage. This difference, which emerged during 10 weeks, was found gender-neutral. The blended model was more effective for inspiring students' critical thinking compared to the traditional learning model. Further, this study exclusively reports a positive correlation between students' learning attitude and critical thinking faculties. The study concludes that blending was more effective for students' learning attitudes and critical thinking even in a school with poor technological infrastructure and underprepared yet willing teachers.

KEYWORDS

Attitudinal Change, Blended Learning, Critical Thinking, Elementary Education, India, Learning Attitude

INTRODUCTION

Time changes leaving behind reasons to change our thoughts and approaches. The earlier behaviouristic or cognitivist learning thoughts have been facing severe hurdles that made us think towards constructivism with new hopes. Fast-changing technologies have forced educational institutions globally to rethink the way they deliver lessons, cater to rising student numbers respecting their individuality, and flame their inborn potentials (Bates, 2015). Based on this constructivist approach e-learning, hybrid learning, and blended learning methods have evolved and gained traction. The limitations and inabilities of traditional teaching strategies and methods to keep pace with these changes, given the changing role of both teacher and student (Kundu, 2018). Besides their global obligations that every nation has pledged like SDG-4 (UNESCO) to implement to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. Pushed by these sentiments of change India has expressed a dramatic motif to change through its National Education Policy (NEP-2020) leaving behind its earlier hesitations on technology adoption and changing roles of teachers (Kundu & Bej, 2021). The authors also noted this country has emotionally moved to embrace

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educational technology at all levels starting from elementary to the universities through a pre-planned to be transformed physically and psychologically. Recently the country has experienced a skeletal picture of online learning during the COVID-19 pandemic and prolonged school closures (Kundu & Bej, 2020). Insufficiencies were evident throughout. Insufficiencies of device, skills, and attitudes-the three major pillars of technology adoption (Mukhopadhyay, 2020). But we can't stop or lose ourselves in desperations rather we need to question ourselves. How far our grass-root level establishments are ready for the incremental change? How technological adoption has been effective to our majority yet marginal schools? This research has been a calculative move towards this direction that went to find out answers to these development questions whether BL is effective for Indian classrooms putting an incremental effect on students learning attitude and critical thinking (henceforth CT).

BLENDING CONVEYS PROGRESSIVE CONVERGENCE

Dissatisfaction is the root of any human invention. Blended Learning (BL) is a natural outcome of this dissatisfaction with the two archetypal learning environments - the traditional face-to-face (F2F) learning environment, and the computer-mediated distributed learning environment. Both these environments had their inherent strengths and weaknesses (Kundu, 2018). While humane and spontaneity are strongholds with the first one, the second one came up with a new vision of flexibility and depth of reflection where the first environments cut a sorry figure. Garrison & Vaughan (2008, p.5) defined blended learning as "the thoughtful fusion of face-to-face and online learning experiences". The simplest definition of BL as asserted in Cleveland-Innes & Wilton (2018) is the use of traditional classroom teaching methods together with the use of online learning for the same students studying the same content in the same course.

Graham (2006) found its appearance not accidental rather a clear line of progressive convergence is clear. In the past, both environments operated separately as the authors presented here in Fig.1. But as time passed by technological miracles started taking human attentions over the past half-centuries especially with the proliferation of computers, the internet, www, and ICT, computer-mediated distributed learning started intruding into whole instructional terrain over all four dimensions- time, space, human, and fidelity. Today online learning or e-learning has taken up a considerable portion of classroom instruction especially after the COVID-19 pandemic (Kundu & Bej, 2021).

Blending Rationales

The blending of two environments as Kundu, Bej, & Dey (2021) sum up ensures increased access, autonomy, knowledge creation, added flexibility, increased cost-effectiveness, greater reflection, greater attention to learners' individuality, greater human connection, and improved pedagogy. The theoretical lineage of BL could be found in the Community of Inquiry (CoI) Model introduced by Garrison, Anderson & Archer (1999) grounded in John Dewey's (1938) view of practical inquiry to address a shared issue, to support critical thinking, critical inquiry, and discourse among students and teachers. The CoI framework (see Fig. 2) highlights social presence, teaching presence, and cognitive presence as essential elements to facilitate successful educational experiences (Shea & Bidjerano, 2012). It can help teachers blending online and offline work to cultivate a blended classroom characterized by respect, dialogue, inquiry, self-directedness, and exploration (Pool, Reitsma, & van den Berg, 2017). Osguthorpe & Graham (2003) identified six rationales that one might choose to design or use a blended learning system: pedagogical richness, access to knowledge, social interaction, personal agency, cost-effectiveness, and ease of revision. For Graham (2006, p.6), the most common reason for adopting blended learning is that "BL combines the best of both worlds". Graham, Allen, & Ure (2005) stated that people choose blended learning for improved pedagogy, increased access and flexibility, and cost-effectiveness. Kundu, Bej, & Dey (2021) have found BL effective in enhancing students' engagement and achievement. But does BL affect students' attitude and creativity in an unfamiliar setting?

Figure 1 Progressive convergence of F2F and distributed learning

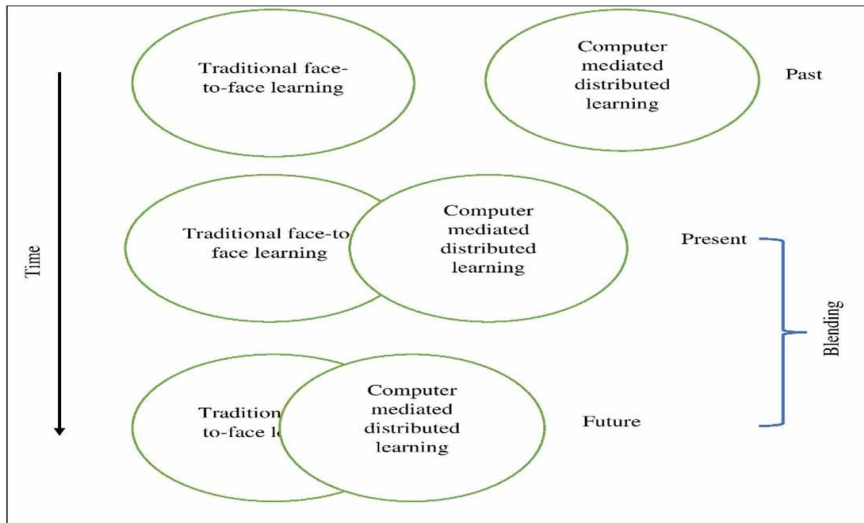
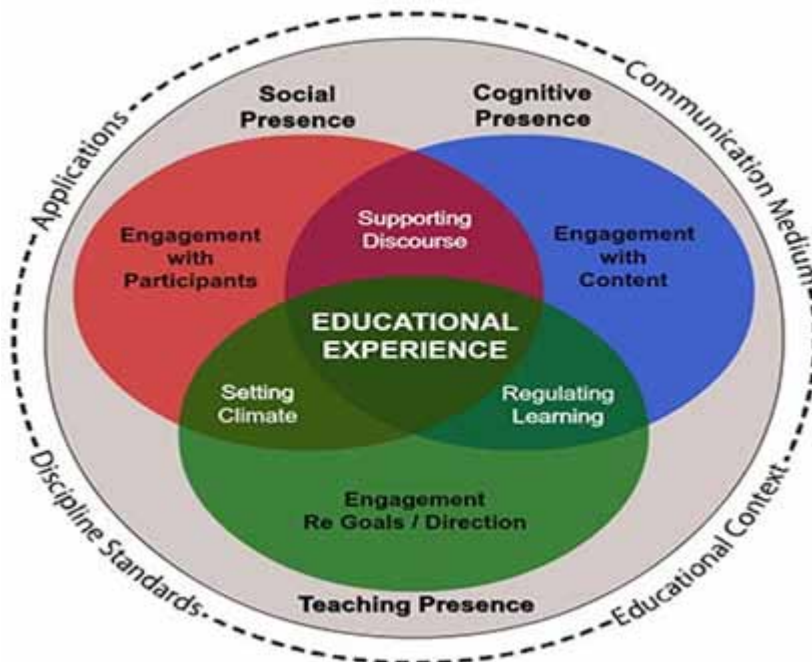


Figure 2 Community of Inquiry Model (Garrison, Anderson, & Archer, 1999)



Critical Thinking and Learning

Descartes argued that thinking is reasoning, and that reason is a chain of simple ideas linked by applying strict rules of logic (McGregor, 2007). Both learning and thinking are the concepts that support and complement one another. Richard W. Paul said, “critical thinking (CT) is thinking about your thinking while you’re thinking in order to make your thinking better” (Elder & Paul, 2009). According to

American Philosophical Association (1990), CT is an ability that is beyond rote and memorization. When students think critically, they are encouraged to think for themselves, to question hypotheses, to analyze and synthesize the events, to go one step further by developing new hypotheses, and test them against the facts. Questioning is the cornerstone of CT which in turn is the source of knowledge formation according to the constructivist paradigm (Dewey, 1922) and as such should be taught as a framework for all learning. Students are frequently conditioned in their approach to learning by experiences in teacher-cantered, textbook-driven classrooms (Sharma & Elbow 2000). This situation is a disturbing case for contemporary educators, and for this reason, they would rather choose the latest models and methods which are more effective in directing students to think (Kundu & Bej, 2022). Critical thinking involves logic as well as creativity. It may involve inductive and deductive reasoning, analysis, and problem-solving as well as creative, innovative, and complex approaches to the resolution of issues and challenges. CT involved two dimensions like the ability to reason well and disposition to do so (Emir, 2009). This is nurtured when students are analyzing, evaluating, interpreting, or synthesizing information and applying their creative thought to form an argument, solve a problem, or reach a conclusion (Bowell & Kemp, 2002). The aim of Critical Thinking is to promote independent thinking, personal autonomy, and reasoned judgment in thought and action (Iyer, 2019). Hence, Kundu & Bej (2022) placed CT as one of the most vital 21st-century skills for the students that need to be developed and strengthened through proper designs. It shows the immense importance of CT in learning that speaks for its strength as a variable taken up in this study.

Students' Attitude and Learning

Attitude is a psychological construct, a mental and emotional entity that inheres (exist essentially) in or characterizes a person (Perloff, 2016). They are complex and are an acquired state through experiences from past and present (Minton & Kahle, 2014). Prominent psychologist Gordon Allport described this latent psychological construct as “the most distinctive and indispensable concept in contemporary social psychology” (Allport, 1935). Simply attitudes are the feelings individuals have about themselves and the world. Students' attitude towards school and learning is the focus of this study. Lewy (1986) first defined the construct ‘attitude toward school’ as students' behaviours, the expression of their feelings regarding affection and judgments, favourable or unfavourable, for the school and school experiences. The affective characteristics of it may be an important explanatory element of students' learning, quality-education, and investment of individual actors in the different dimensions that make up the school (Candeias, Rebelo, Franco, & Mendes, 2010). Santiago, 1994). Kundu, Bej, & Dey (2020) asserted this construct is intrinsically related to other constructs, such as students' perceptions and interest in learning, their competence, motivation, and academic achievement. How pupils behave in school, how they relate to peers and teachers, the investment they make in academic and extracurricular activities are aspects largely influenced by the attitudes they have toward school and learning. This immensely individual construct is influenced by several factors like gender, their cultural background, the kind and quality of family relationships, family and peers support, previous school performance, that means, pupils' positive attitudes and behaviours play an important role in their academic success (Akey, 2006). This study investigates students' attitudes towards BL and exclusively explored the relationship between attitude and critical thinking.

Blending for Indian Schools

The above literature review revealed BL as a progressive convergence with rationales that uphold its adoption for academic effectiveness. But how this innovative convergence effect for schools that didn't have minimum technology penetration? Is its adoption equally potent for multitudes of schools in the Developing Countries already struggling in several shortcomings? If yes, then which modality would be more effective? How does it affect other vital learning parameters like students' attitude or critical thinking?

India, one of the rapidly evolving economies on this globe wishes to evolve as a global superpower (Kumar & Rustagi, 2016). This appears impossible without a super education system. School education has long been suffering from stigmas of huge inefficiencies that encourage teacher-dominated rote learning having little space for students to culture their creativity (Kundu & Bej, 2020). Mukhopadhyay (2020) said unwanted remnants of the colonial system have been perpetuated in the elementary classrooms resulting in teacher-directed classroom instruction, the pedagogical approach focussing on the memorization of notes, unrestrained rote learning, poor interaction, poor social inclusion, poor attitude, and CT level along with no opportunities for critical inquiry, active participation in the learning process. It has left a little space for technology adoption and resulting in a complete shutdown of institutional operations during the COVID-19 calamities (Sharma & Bozkurt, 2020). Kundu (2018, p-203) has found it unsurprising that ‘children in government-run elementary schools here spend most of their time memorizing a series of disconnected concepts from textbooks that hamper their learning attitude and CT level.’

In this context, could BL be that secret to have substantial influence over students’ learning psyche. That is the basic question in this study. Could BL adoption enhance students’ attitude and critical thinking potentials? Then it would be a growth-oriented step for several developing economies like India suffering from similar learning limitations. Indian context may serve as an experimental ground for BL implementation and its effectiveness in all the 152 developing nations comprising 85.20% of the global population that equally struggling to enhance learning attainments of their school students (WorldData). Here understanding how to work with teachers to use technologies pertaining BL classrooms is important (Batra & Reio, 2016). This study targets this research gap as well.

METHODOLOGY

Research Objectives

The present study aimed to determine the impact of BL model on student attitudes towards Maths and Literacy course and on their CT faculties. The two courses are of utmost importance for elementary students across globe since literacy skills allow students to seek out information, explore subjects in-depth, and gain a deeper understanding of the world around them. Studying mathematics stimulates curiosity, fosters creativity to equip children with the skills they need in life beyond school (Kundu, Bej, & Adhikari, 2021). Thus, it sought to answer the following research questions (RQ):

RQ1. Does blending change students’ attitudes towards maths and literacy?

RQ2. Does blending enhance students’ critical thinking?

RQ3. What is the relationship between attitude and critical thinking?

RQ4. How do teachers perceive this instructional shift?

Sites and Participants

This DBR was implemented in a rural inclusive government run co-educational elementary school in the state of West Bengal in the Eastern part of India, ideally representing the country in several facets. Having huge population density, low educational penetration in rural areas, low women education rate, poor quality of education, schools with meagre pool of educational infrastructures, and overcrowded classrooms with teacher dominated age-old pedagogies. The selected school hosted 125 students total in grades five to eight most of them (85%) belong to BPL (Below Poverty Line) families under control of three teachers (maths, literacy, and social science each). A total of 50 children (30 boys and 20 girls) in the fifth-grade class (10-11 years age) and three teachers participated in this study.

As per research design the participants were divided into two groups: the experimental group consisting of 25 students (15 boys and 10 girls) who were taught through BL and the control group, consisting of 25 students (15 boys and 10 girls) who were taught in the traditional method. In

accordance with DBR, the teachers collaborated, made suggestions, and offered opinions on initial design and further adjustments during implementation while the researchers arranged everything, trained, convinced, encouraged, and supported teachers since the school had neither a single computer nor internet nor having a teacher who could turn on a computer. Participant names were kept hidden to honour ethical agreements.

Research Background

As already discussed in literature, BL is exceedingly complex, and it becomes more challenging when there has been an acute shortage of attitude, skills, and device. Since the school has been a poor performer in all these domains it appeared very challenging for the researchers to introduce BL model here. The researchers made this possible with the genial co-operations from the teachers without whom this study would not have realized. They provided necessary help and guidance to all the stakeholders including teachers, students, guardians, local government, and arranging the blended set up providing contents, computers, and internet connectivity.

For this context, Design-based Research (DBR) methods were deliberately used to gather and analyse data. Traditional quasi-experimental case study approach might be suitable for this study but researchers preferred to call it DBR since researchers believed in the collaboration and advocated to act as agents of change by working hand-in-hand with the teachers in real situation, pioneered a change in the traditional classroom practice by setting an example, and an iterative process of design, and evaluation to develop knowledge which is the strongest advocacy for being this study a DBR.

Proponents of DBR claimed that educational research is often too abstract or sterilized to be useful in real contexts, detached from practice, failed to improve classroom practices, and hence practitioners are not able to benefit from the research when they cannot see how the research make things possible to inform and improve their designs and practices (The Design-Based Research Collective, 2002). Armstrong, Dopp, & Welsh (2020) said in an educational setting, DBR is a research approach that engages in iterative designs to develop knowledge that improves educational practices that originated because some researchers believed that traditional research methods failed to improve classroom practices, welcomed researchers' as agents of change and research subjects as collaborators, produced both new designs and theories, and consisted of an iterative process of design and evaluation to develop knowledge. Simply, DBR helps researchers address design problems (Wang & Hannifin, 2005).

In this classroom, DBR occurred in real settings with the co-operation between teachers and researchers, employs mixed methods, operates in periods of designing, implementing, and adjustment, and relies on team reflection and decision-making (Anderson & Shattuck, 2012). The designed problem was how to promote attitude and CT level, effort, attitude, and time on task. DBR also occurred as researchers and teachers cordially collaborated to observe, describe, and understand BL routines, including what differences in student attitude and CT might emerge.

Procedures

The classes were conducted at the close vigil of the two researchers every day for ten weeks during 11 am. to 1 pm. (11 am to 12 am for literacy and 12 am. to 1 pm for maths) in all official school days and the rest of the days the classes were to run in traditional modes. This ten-week time-frame was stipulated by the School Management Body for this study as they didn't want longer alien intrusion in their normal school operations.

The quantitative data was collected through an attitude and CT test to investigate the changes in students' learning attitude and CT level. The qualitative data was collected from the face-to-face interviews with three teachers on several occasions. In the control group, the students were taught a specific content of the grade fifth maths and literacy textbook using traditional teacher-centred teaching. The experimental group were taught the same content on the same day by the same teacher using BL Station Rotation Model (SRM) where students in a course rotate between various modalities,

one of which is online learning. There are various sub-models: station rotation, lab rotation, and individual rotation. Station rotation sub-model is better suited to K–12 education that requires students to rotate between stations in the classroom at an instructor's discretion (Cleveland-Innes & Wilton, 2018). If some day the control group was taught with maths in the first half by the maths teacher during that time the experimental group were taught with literacy by the literacy teacher. One researcher used to present with the control group as well to observe their class running with usual pace and form. Rest one used to present with the experimental group.

The researchers prepared computerized educational program for the selected content units and its activities to use BL in teaching the experimental group. They trained the teachers on how to use BL in teaching maths and literacy. They also taught the students on how to deal with the relevant technological items required for the blended mode of learning. Rotation models for both maths and literacy were selected and modified for ten weeks alongside teachers. In these rotation models, children moved in small groups between centres. Some centres had teachers, some were offline group activities, and some were online computer activities. Each day, there were eight activity choices (four maths/ four literacy). The children were able to choose the activities that they wanted until the activity had five children at the centre. When the next rotation came, the children chose again. A student, who missed an activity in one rotation because it was full, could go to another and then return to the desired activity in the next round.

The researchers did not want children to use computer time to do rote or drill activities, but teachers liked the idea of having children practice certain skills through repetitive practice. As a compromise, one of the computer literacy activities consisted of programmed word recognition and one computer maths activity consisted of drilling mathematics facts. The rest of the computer-based activities included activities such as story writing, Minecraft® (helped the children to get a better understanding of maths concepts, including: even numbers, odd numbers, prime numbers, and square roots), audio-supported reading, drawing, computer-assisted maths problem generation, and computer animated modelling for solving maths problems from selected topics. The teachers also insisted children must attend a teacher-led group during the rotation time. Non-computer activities outside of the teacher-led groups consisted mostly of guided reading and maths problem solving. Sometimes, children played games or used flash cards. Additional structural routines in the classroom consisted of using chimes to signal movement between activities, descriptions of what children were to do at each activity before the blended session began, and clean up time at the end.

The experiment and control groups were randomly assigned. Class size was taken into consideration in selecting the groups, while student success rates for the previous years and individual differences were neglected. Obtaining the consent of, and coordinating with the administration of the school to conduct study and implementation of the experimental group lessons through BL and implementation of the control group in the traditional method. Both groups were administered the CT and attitude pre-tests in order to determine whether the experiment and control groups were equivalent in terms of research variables and preliminary information. The tests were implementation for both the experimental group and the control group in two stages at the beginning before the blended model implanted at the pre-blended stage on 10th January 2020 and at the post-blended stage in the end of tenth week on 22nd March 2020 just before the lock down was announced owing to pandemic outbreak of COVID-19 (Kundu & Bej, 2020). Besides, interviews with the teachers were conducted at the end of the study to record their perception of teaching in a blended set up.

Research Tools

Maths and Literacy Attitude scale. Quantitative data concerning learners' attitude towards maths and literacy were obtained by administering this scale developed the researchers following the Comprehensive Model of Scale Development (CMSD) (Kundu, Bej, & Dey, 2022) and taking help of similar scales like Yağar, Çermik & Guner (2011). It was a 30 items tool each attached with a five-point Likert type scale ranging from strongly agree (5) to strongly disagree (1). Reverse score

was used for negative items. Following the CMSD the Construct Validity was found 0.87 (good as per rule of thumb) and the Internal Consistency Measure (Cronbach's α) was .91 (of excellent degree).

Critical Thinking Disposition Inventory. To measure the CT disposition, researchers used the California Critical Thinking Disposition Inventory (CCTDI), a widely used and standardised instrument. The CCTDI measures the "willing" dimension in the expression "willing and able" to think critically. High scores on CCTDI are positively correlated with a strong desire to apply one's critical thinking skills in decision making and problem solving, with leadership, with ego resilience, and with the capacity to benefit from educational training and psychological counselling. Since the originally scale was translated into local (Bengali) language the validity and reliability were reaffirmed following the said CMSD model with Construct Validity 0.88 and the Internal Consistency Measure (Cronbach's α) was .89 for whole 30 items scale each attached with a five-point Likert scale with high scores indicating high CT.

Interview. To recognize teacher perceptions and evolving teacher understandings, open ended individual interviews were conducted with participating teachers. Face-to-face interviews with three teachers were arranged at different occasions. Each interview lasted 30 minutes at times and language convenient for teachers. While researchers asked scheduled questions about student learning and the experience of BL implementation, teachers were free to share whatever they wanted to with regard to the project. This was in line with the desired attitude of trust and collaboration between participants and researcher desired in this project (Brinkmann & Kvale, 2015). To obtain qualitative data, teacher's decision-making strategies and solicited their perceptions of the implementation process were recorded. The questions included in the set interview protocol were as follows:

- a) Did you find improvement in students' thinking level at post-BL stage?
- b) Did you find this blended model exciting for your teaching?
- c) What changes did you find among students during these ten weeks?
- d) What do you want a permanent blended set up in your school?

Data Analysis

Quantitative data analysis focused on comparing students' attitude and CT level after and before blended environment implanted by applying the selected tests. Qualitative data analysis focused on teachers' perceptions on implementing blended learning. In accordance with the DBR protocol, adjustments were made in response to data analysis (Anderson & Shattuck, 2012). The researchers used the Statistical Package for the Social Sciences (SPSS) program to calculate mean, standard deviation, t-tests, variance tests, necessary to reach the answer of the research questions.

FINDINGS

Outcomes Relating to RQ1

In order to compare the two groups in the study in terms of attitude towards maths and literacy, the researchers used an independent sample *t-test* to compare the two groups' results in the pre-BL stage on the specific topics of their textbook units, before applying the blended learning. Results are shown in Tables 1 and 2 below.

Table 1 shows there is a clear increase in attitude level in the post-BL stage in both groups. Table 2 shows the obtained *p* (2.01) is greater than the level of significance 0.05, the test is not significant at the 0.05 level, which indicates that there is no significant difference between the two groups of the study regarding attitude towards the subject at pre-BL stage.

Table 1. Description of attitude test scores at two stages

Group	N	Pre-BL		Post-BL	
		Mean	Std.	Mean	Std.
Control	25	15.6	1.53	18.24	1.95
Experimental	25	14.9	1.17	19.64	2.01

Table 2. t-test results of attitude scores between experimental and control groups at pre-BL

Variables	N	Mean	Std. deviation	t	df	Sig. (2- tailed)
Control	25	15.6	1.53	1.52	46	2.01
Experimental	25	14.9	1.17			

Note. * Statistically significant at (p £0.05)

Answering the first research question, the variance between the attitude tests mean scores of students in the experimental group and the control group in the post-BL implantation stage was calculated through an analysis of variance (Levene's test) and the results are presented in Table 3 that shows the obtained p-value (0.001) is smaller than 0.05, this means there are significant differences at the significance level of 0.05, which indicates that there is significant difference between the two groups of learners with regard to their attitude towards the learning topics covered in maths and literacy after ten weeks. Based on the test results, it can be inferred that teaching the students through BL had a positive effect on their attitude towards the subjects studied. The finding is consistent with several earlier studies that also confirmed blended learning has positive effect on the learning attitude of students (compared to traditional learning) (Leo & Puzio, 2016).

The Levene's test results in Table 4 further shows this difference was gender neutral since no significant difference was found between the attitude levels of boys and girls which means BL effects learning attitude levels of boys and girls equally.

Table 3. Variance of attitude scores between experimental and control groups at post-BL

	Levene's test for equality of variances		t-test			
	F	Sig.	t	df	p (2- tailed)	Mean difference
Equal variances assumed	0.747	0.557	3.54	46	0.001	1.4
Equal variances not assumed			4.02	45	0.000	1.4

Note. * Statistically significant at (p £0.05)

Outcomes Relating RQ2

Table 5 shows the CCTDI scores at pre- and post-BL implementation stages. A positive growth in the test scores is obvious but the growth is much higher among the students of experimental group.

At the beginning a t-test (see Table 6) was conducted to be assured of the difference in CT level between control and experience groups and calculated ($p=0.671>.05$) outcomes shows having no significant difference in CT level at this stage.

Table 4. Variance of attitude scores between boys and girls at two stages

	Levene's test for equality of variances		t-test			
	F	Sig.	t	df	p (2- tailed)	Mean difference
Equal variances assumed	1.113	0.742	2.52	21	0.022	1.4
Equal variances not assumed			2.08	20	0.000	1.4

Note. * Statistically significant at (p £0.05)

Table 5 Description of CT scores of two groups at pre and post BL

Group	N	Pre-BL		Post-BL	
		Mean	Std.	Mean	Std.
Control	25	51.5	3.4	53.9	2.6
Experimental	25	57.8	3.2	72.01	2.5

Table 6. t-test of CT scores between experimental and control groups at pre-BL

Variables	N	Mean	Std. deviation	t	df	Sig. (2- tailed)
Control	25	51.5	3.4	3.9	46	0.671
Experimental	25	57.8	3.2			

Note. * Statistically significant at (P £0.05)

In order to answer the second research question, the variance between the CT tests mean scores of students in the experimental group and the control group in the post-BL implantation stage was calculated for an analysis of variance (Levene's test) and the results are presented in Table 7.

The results exhibit a statistically significant variance in CT level ($p=.001 < .05$) between the experimental and the control groups. Thus, the growth in the CT level at the post-BL stage is significant and this outcome again found gender neutral since the variance in CT level between boys and girls was statistically not significant as per the Levene's test in Table 8. This indicates to the fact that boys and girls equally react BL atmosphere and their CT level upsurges.

Table 7. Variance of CT scores between experimental and control groups at post-BL

	Levene's test for equality of variances		t-test			
	F	Sig.	t	df	p (2- tailed)	Mean difference
Equal variances assumed	0.747	0.557	3.54	46	0.001	1.4
Equal variances not assumed			4.02	45	0.001	1.4

Note. * Statistically significant at (p £0.05)

Table 8. Variance of CT scores at two stages between boys and girls

	Levene's test for equality of variances		t-test			
	F	Sig.	t	df	Sig. (2- tailed)	Mean difference
Equal variances assumed	5.774	1.742	5.61	21	0.021	6.1
Equal variances not assumed			3.32	20	0.013	6.1

Note. * Statistically significant at ($p \leq 0.05$)

Outcomes Related to RQ3

Table 9 summarizes the Pearson's correlation analysis between attitudes and CT levels of the Experimental group at Pre- and Post-BL stages. In both stages the results shows a positive and statistically significant correlation between the two variables ($r=0.47$, $p=.002<.05$).

Table 9. Correlation results showing relationship between attitude and CT

Stage	Pre-BL		Post-BL	
Experimental Group	Attitude	CT	Attitude	CT
Attitude	-	.47*	-	.47*
Critical Thinking	.47*	-	.47*	-

Note. * Correlation is significant at the .05 level (two tailed)

Outcomes Related to RQ4

The third research question regarding teachers' perception on the implementation of BL in classroom, the teachers reported that BL brought excitement at learning to use new teaching strategies, hopefulness to their teaching context, and anticipation for more positive interactions with children in the future.

Learning new strategies for teaching. All three teachers described their preparation for teaching as centred on routines in elementary schools where children were taught in a traditional setting with almost no teaching aids. Teachers also painted a dismal advocacy picture where they were advised not to implement digital pedagogies, despite clear policy intents from the government (Kundu & Bej, 2021). This is evident when a teacher said:

[Utilizing] a blended model has been interesting but we never saw this in our pre-service training nor during the in-service trainings [we have received].

The teachers reported enjoying the process of reviewing the data and making decisions which is a success story of any DBR ground study. They agreed that when they heard they were going to be studied, they felt intimidated. However, at the end of the process when they realized that it helped them decked with a latest trend of school pedagogy, they gained confidence. Gathering and analysing data aside, teachers initially lacked confidence in the computer-assisted, online portions of blended learning. For example, one teacher said:

[O]ur teachers lack technology skill; of four, only one of us knows how to turn on a computer.

These feelings of inadequacy when it came to computer use were often at the forefront of the BL design. For example, as the study proceeded, researchers learned that this was one reason why teachers wanted rote activities on the computer—they perceived them to be easier to set up for children and there would be fewer technical problems with them.

DISCUSSION

The outcomes of this project revealed that BL model contributes more to student attitudes towards maths and literacy courses when compared to the traditional learning model and this finding is not new as it is compatible with the previous literature Korkmaz & Karakuş (2009) and Akgunduz & Akinoglu (2016) already discussed. But the novelty of this study lies in the fact that it is the first ever attempt to implement BL model in an elementary level in any underprivileged background where socio-economic ambience was not befitting for such complex technology integration. Besides, the study focussed on the insight for practice and close collaboration between the teachers and researchers which made the changes possible within ten weeks. The changes were found gender neutral that is also a new direction in this regard and the time frame to attain such a change is also a new notion.

Compared to the traditional instruction method, the BL model contributes more to the critical thinking level of the participant students which support the available literature like Korkmaz & Karakuş (2009), Kazua & Demirkolb (2014), and Tajvidi, Ghiyasvandian, & Salsali (2014). Thus, BL method could be effective in reducing memorization and rote learning, the biggest problem in Indian education (Kundu, 2018) since students who learn with understanding are able to transfer their knowledge to tasks requiring problem-solving with greater success than those who learn only by rote.

Besides a positive correlation between student attitude towards maths and literacy course and their CT levels is found that is pedagogy neutral, in other words, the more positive the student attitudes towards the maths and literacy the higher their CT level, and this been the same at traditional learning and BL learning.

Besides this DBR was novel in diagnosing teachers' perceptions on this shift and putting an example of collaboration between teachers and researchers. At first, researchers were an important resource for keeping the computers operating. Over time, children actually became quite adept at diagnosing and addressing technical issues and so did the teachers. In addition, the teachers were proud of themselves for implementing BL without extensive preparation and in schools with poor infrastructure. The lack of basic infrastructure, irrespective of technology hurt these teachers' morale. Even so, they reported feelings of excitement about being able to use BL even in less-than-ideal instructional circumstances. One teacher beautifully summarized the experience as:

It was a big learning experience for us through these nine weeks on how to operate a blended learning model in our poor elementary classrooms.

As much as teachers appreciated the experience and as much as they gained confidence, they still felt that the implementation was a "long" ten of weeks of work. It is likely they will need additional support from their schools and outside groups to maintain the BL environment. These signs the success side of DBR in the real setting which adds effectiveness of an education research by bringing improvement in the practical application. Anticipation of more positive interactions with children. Teachers learned to ignore or re-direct children in BL rather than punish them. Before BL implementation, teachers reported that they often used corporal punishment with children, even children with special needs, and even though they felt it was wrong. One teacher said:

I know corporal punishment is against all pedagogic principles, but if we are to maintain peace and discipline in our classrooms, it is the last resort we used to adopt, otherwise the whole school will go to waste.

While Indian government has attempted to dislodge corporal punishment in schools, these efforts have been largely unsuccessful. Fortunately, these teachers saw less need to corporally punish children because more children were engaged and because they were not always trying to get 50 active children to be silent and listen to one speaker. However, the BL experience also offered the teachers opportunities to see children try new things, learn academic skills, increase technological literacy, and achieve their own. When teachers saw children in this new light, they reported that corporal punishment was less appealing to them.

Insights for Practice

In this study, researchers rotated children through a series of stations. Findings revealed that implementing BL among a small group of learners did increase their learning attitude and CT level and this time ‘time for attitudinal change and CT’ was ten weeks only. Using knowledge from research and professional learning, BL can be effectively implemented in more classrooms (Kundu, Bej, & Rice, 2020). One area of interest for practice is how the children and teachers worked to acquire the types of basic technological literacies necessary to perform technical support. Organizing BL to share responsibility for technical support and maintenance might further encourage the development of positive teacher-student relationships as well as keep the technology running in classrooms (Kundu, Bej, & Dey, 2021).

We emphasize that our implementation of BL was DBR guided by strategies where we made informed judgments about what might work and then gathered data, analysed it, and made additional adjustments. Thus, inquiry and practice were tightly linked. Teachers learned through this process that data was not as intimidating as they thought, but surely there was room for additional on-going data collection and analysis as they gain more experience during future blended teaching. Such data includes attitude and CT level or other documentation of learning during the blended experiences. It also might include discipline records and other measures of classroom climate. Eventually, it might even include data practices more tightly tethered to the online portion of the learning, such as clicks on websites, page visits, and more.

As a team, we engaged in DBR focused on collaborative strategies to support children using mixed methods and multiple iterations (Anderson & Shattuck, 2012). Such practices for supporting inquiry should be enshrined in public education policy in India and potentially other places to provide opportunities for more teachers to embrace BL practices.

The fact that there was no significant difference between boys and girls adds to growing understandings in India and potentially in other countries about the need to educate all students and even to avoid having sex or gender of focal interest in the educational experience (Kundu & Bej, 2020). While there are persistent educational disparities in India, boys and girls alike seem to have adjusted well to BL in this classroom. According to researchers’ notes and teacher observations, both boys and girls were also equally interested in overseeing technical support as well.

Modern education in India from the elementary school to university levels is often severely criticized for encouraging rote learning, rather than comprehension, critical thinking, and problem-solving (Kundu, 2018). Additionally, teachers may be less inclined to use methods of classroom instruction and management for which they have been criticised. Introducing BL to elementary children in such countries may increase students’ attitude, thinking, engagement, and eventually achievement. That will make teachers regain their lost reputations by the grace of technology and a unique progressive convergence through BL.

CONCLUSION

The huge gap between policy intent and policy impact has been the hallmark of education among developing countries including India that has been witnessing throughout this current decade rapid positive changes and developments in all areas, in a way that reflects broader life for holistic development of the child. A dramatic shift from the traditional teacher dominated pedagogy to foster students’ creativity and critical thinking is the prime focus of the India’s New Education Policy (NEP, 2020). The outcome of this DBR may prove helpful in discovering the effectiveness of BL at the elementary level, in schools suffering from several shortcomings and limitations by making positive changes in students learning attitudes towards maths and literacy, the two life-making core subjects at this level and in the level of their creative thinking. Boys and girls were found equally affected by this change. Besides, this empirically study exclusively established the positive relation between students’ attitude and critical thinking faculties.

These outcomes also represent what might be expected from DBR—that as teachers and researchers attended to design problems in the classroom, they were able to meet the needs. Although it cannot be determined or too early to claim with conviction whether attitude and CT level increased because of the technical support, expert support, management support, curriculum support, emotional support, or some combination, still these findings are as much a reflection of teachers' gradual increase in skill at selecting activities for children as they are a reflection of children responding to activities and routines. Thus, when partnerships happen, the partnership between teachers and professionals, between teachers and students, circumstances have some success, and the expected outcome may be possible even within a short ten weeks' time.

LIMITATIONS

This is basically a case study conducted within a single classroom of only 50 students of an elementary school and hence the results may vary in another study with larger samples or in the different context of other culture or state. The study used DBR in a specific classroom chosen because of teacher interest in improving the current pandemonium situation of the multitudes of Indian primary schools who were desperately searching for ways to up bring quality education and hence these findings are not generalizable to all blended classrooms. Another limitation is the fact that researchers were there in the overall monitoring and guidance of this study because without their involvement this study was not possible since the school had neither a single computer nor a single teacher who could simply turn on a computer.

FUTURE RESEARCH

The study has a big space ahead where future research could be conducted with a large sample covering multiple schools to find if BL is equally potent in yielding the same results. 'Time for attitudinal change and critical thinking' for this study was ten weeks, future research may be conducted if it is possible within the less time. Here various local factors like regional disparities could be considered as in a vast country like India regional disparity is a big concern because development here has is not universal and reached to the far cornered areas. Research could also be directed in providing the schools an ideal framework for the establishment of blended environment where teacher-students can work, interact and improve. The digitalisation of course contents or curriculum development, keeping the blended pattern in view, is also a major concern to offer teachers with readymade course contents where more research is essential.

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