Research Article

Effectiveness of Digital Pedagogy on Teaching Competency in Physical Science among B.Ed. Students with Special Reference to Constructivism

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Abstract

Digital technology has changed many aspects of our life. The impact of digital technology in India across the past four decades has been enormous. Even in this digital era, there is a huge demand for skilled and competent teachers all over the country. A quality teacher education programme requires changes in pedagogical studies. Digital pedagogy can be used to develop the teaching competency among students in the teacher education programme. Digital pedagogy is the study and use of contemporary digital technologies in teaching and learning. It can be effectively implemented with constructivist teaching. Student teachers can be trained to facilitate the learner to construct knowledge rather than just passively receiving information. The science teacher is expected to be a facilitator of scientific knowledge. Pedagogy of physical science is dynamic and ever new domain of knowledge. Keeping in view the above concerns of pedagogy of physical science and to bring quality and excellence in the teaching of physical science, the authors have attempted to study the effectiveness of digital pedagogy in the teaching of physical science with a constructivist approach.

Keywords: Constructivism, Constructivist approach, Digital Pedagogy, Physical Science, Teacher Education

Introduction

Teacher education has grown exponentially in the past ten years to meet the demands of quality teachers in both private and government institutions. After the implementation of the Teacher Education Curriculum Framework, 2014, the attention is focused on the quality pedagogical practices at the B.Ed. level. Student teachers should be properly trained to meet the challenges in the contemporary digital-oriented society (Craig Blewett., 2020). Teachers are expected to handle e-resources. The present teacher education curriculum of physical science includes aims and objectives of teaching physical science, teaching methods and strategies and curriculum reform projects. Adequate practices are given to the student teachers before they go for 80 days' internship in schools. When the digital pedagogy is applied, the teaching competency of the student teachers will be enhanced (Salin SN. & Noor Aida Mahmor, 2018). Student teachers who use a constructivist approach in the teaching of physical science can develop their teaching competency with the support of digital pedagogy. The researcher used the experimental method to study its effectiveness among the students and teachers of physical science.

Meaning and Concept of Digital Pedagogy

Digital pedagogy emphasizes the use of contemporary digital technologies, using digital tools thoughtfully, and paying attention to the impact of digital tools on learning. Digital pedagogy

can be applied to any concept. A teacher should plan, prepare, and execute the digital pedagogy for the selected content. It can be applied to the online environment, face to face environment, and hybrid environment. Teachers encourage students and also themselves to think critically about new things (Wadmany, Rivka, Kliachko, Sarah, 2014).

According to Paulo Freire (2018), the term pedagogy is not ideologically neutral. There is no such thing as a neutral educational process. There are different forms of digital technologies such as Communication technology, Web technology, Data mining, Data Warehousing, Database technology, and Cyber technology. Digital pedagogy will be effective only when the teacher uses the desired technology appropriate to the content. Teachers and also learners can use the appropriate digital technology in a better way when they are thinking critically about the nature and effects of that technology (Valerie Anderson, 2020). The use of digital technology will enhance the teaching-learning process and will change the teaching-learning experience. The digital pedagogy varies from the use of presentation software like PowerPoint to flipped classrooms.

Constructivism

Constructivism emphasizes the construction of knowledge rather than just taking in information. Twomey Fosnot (1989) defines constructivism by reference to four principles viz., learning, in an important way, depends on what we already know, new ideas occur as we adapt and change our old ideas; Constructivism requires meaningful learning through rethinking old ideas and bringing new conclusions about new ideas.

The curriculum in a constructivist classroom begins with the whole and expands to include the parts. Students work primarily in a group. Students' inquiry, hypotheses, and interests are highly valued. Learning is constructed on the ideas that the students already have. Thus, the learning is interactive and not repetitive.

Teachers have an interaction with students to construct their knowledge. Knowledge is seen as dynamic with experience. Finally, the student's knowledge and the acquisition of higher-order skills can be assessed through observations and points of view.

Constructivist Teaching

Constructivist teaching is based on the idea that learning occurs as learners are actively involved in a process of meaning and knowledge construction as opposed to passively receiving information (Audrey Gray, 1996).

Knowledge is not a thing simply shared by the teacher in the classroom, but it should be constructed through the active participation of learners in the teaching-learning process and the mental process of development. Learners are the builders of the knowledge and the creators of the knowledge. A teacher should facilitate a learning environment that is conducive and suitable for such learners. Piaget (1975) viewed that learners encounter an experience or conflict with the way of thinking that gives rise to a State of imbalance. Now, negotiation connects teachers and students in a common purpose. It is the customs building teaching to fit the individuals who attend the class. Constructivist teaching offers options and choices for the students.

There are several components to be included in constructivist teaching. A teacher can incorporate the main components in planning the lesson. The following are from the 5E model encompassing the phases Engage,

Explain, Explore, Extend, and Evaluate; steps which educators have traditionally taught students to move through in phases.

Engage: Students are acquainted with the concept through connecting to prior knowledge or linking with earlier lessons discussed, contextual situations, experiments followed by questions to think or analyze.

Explain: This phase is meant for the treatment of the concepts or the procedures with various strategies and methodologies. Explanations given to the concepts, providing illustrations with analogies, asking questions to scaffold are the main activities during this phase of teaching.

Explore: The teacher will allow students to do some activities or experiments, discussions, and student explanations. The use of appropriate learning resources will support learners to gain knowledge. A teacher can provide a task for collaborative learning. Concept maps and graph organizers can be used as scaffolding devices to explain the links and concepts assess the attainment of concepts, check for anticipated and unforeseen misconceptions, etc.

Extend: This phase includes providing new situations, problems or questions wherein the students can apply the concepts to identify principles learnt in the situations provided or solve the given problem or be able to work in the given situation by applying what is learnt.

Evaluate: The teacher will review the lesson by asking questions on the subject matter covered in the class by keeping the learning objectives in mind. Students' attainability is evaluated in this phase. The teacher's role is to clarify misconceptions if any.

At the end of the unit, a teacher should relate the application of what is learnt with real life.

Constructivist Teacher and Digital Pedagogy

Teachers play multiple roles in facilitating learning, such as connecting to prior knowledge, demonstrating, explaining, reinforcing, giving examples with analogies, giving tasks to perform, scaffolding, forming groups and assigning tasks, assisting and guiding learners and evaluating the learning outcomes. (Barber Wendy, King & Sylvia Buchamn, 2015).

In all the phases various kinds of technologies can be used to enrich the teaching-learning process effectively. The teacher provides students with experiences that allow them to hypothesize, infer, observe, predict, classify, and invent. The constructivist teacher fosters critical thinking and creates active and motivated learners.
Constructivist teachers must acquire competencies in various skills including selection, collection, production, reflection, and presentation of digital content.

Selection: Student teachers are instructed to navigate the content in technology-mediated contexts, and evaluate the quality and validity of the sources

Collection: Student teachers are trained to compile exciting and accessible materials for learners. They have to provide a wide range of problem-solving and practical skills to facilitate children's learning.

Production: Student teachers can create their e–materials, which can help enhance their creativity and digital literacy. Digital demonstration will encourage the student teacher to explain any content thoroughly.

Reflection: It is important that when creating materials for physical science learners it is important to conduct a needs analysis to present materials that are motivating and age-appropriate and work closely with software developers to create sound pedagogical resources.

Presentation: An effective presentation is possible with a suitable lesson plan and practices of teaching skills. Student-teachers should develop their potential with suitable communication skills and technological skills.

Statement of the Problem

The problem selected for the study is "Effectiveness of Digital Pedagogy on Teaching Competency in Physical Science among B.Ed. students with special reference to Constructivism". The investigator attempts to study the effective use of digital pedagogy by the teacher trainees in physical science.

Objectives of the study

- To study the effectiveness of digital pedagogy among the student teachers in their teaching competency in physical science in the constructivist style of teaching.
- To compare the teaching competency in the teaching of physical science with skill-based ICT approaches and through the conventional approach.
- To find out the achievement of student teachers with digital pedagogy using emerging technologies and the internet to meet the needs of the individual learners.
- To find out the achievement of students for the various stages of development of lessons such as Engage, Explain, Explore, Extend, and Evaluate with the use of digital pedagogy.

Hypothesis

- Student teachers who have practised in digital pedagogy will be competent in the teaching of physical science in the constructivist style of teaching.
- There is no significant difference between the mean scores of the pretests of experimental and control group students.
- Student teachers who have practised digital pedagogy differ significantly in their teaching competency.
- There is a significant difference between the student teachers using the digital pedagogy and the student teachers using the conventional method in various stages of development of lessons such as Engage, Explain, Explore, Extend, and Evaluate.

Need for the study

To bring effective improvement in the quality of teacher education, it is necessary to focus attention on emerging technologies. Now, many teachers are thinking of using recent technological advancements to enrich their teaching competency. Physical science teachers are not exceptional. The use of digital pedagogy at the B.Ed. level will support them to enrich their teaching competency. Hence, it is important to study the effectiveness of digital pedagogy in physical science at the B.Ed. level.

Scope of the study

The investigator attempted to know the effectiveness of digital pedagogy on teaching competency. The study will be of great help for the student teachers and teacher educators since the concept of teaching has been changing from time to time. One can teach well only when he has a better teaching competency. In

this context, the investigator attempted to study the effectiveness of digital pedagogy on teaching competency at the B.Ed. level.

Review of Related Literature

Dominik PetKo (2012) examines teacher affiliation for the constructivist style of teaching which is often considered to facilitate the pedagogical use of digital media. The study's survey of 357 Swiss secondary school teachers revealed a significant positive correlation between will, skill and tool variables and the combined frequency and diversity of technology used in teaching.

M Ally (2014) used the competency profile for the digital teacher to train and orient the digital teacher of the future and the research revealed that emerging technologies, artificial intelligence and the internet will make the student-teacher meet the needs of the individual learners.

Salin S.N and Noor Aida Mohammad (2018) conducted a survey to examine the attributes of meaningful learning that student teachers perceived as enabling them to improve their digital pedagogy. The findings reveal that the attributes of meaningful learning activities contribute to the improvement of teachers' knowledge of and skills in using Web 2.0.

Sarah Prestridge (2008) suggested that skill-based ICT practices could be considered for those teachers who are operating in a traditional teacher-centred approach where developing skills are in focus. Interestingly, these teachers agree with beliefs that align with digital pedagogies.

Methodology

The present study is experimental research. The method used for the study was the experimental method. The nature of the experiment is pre-posttest equivalent group design. The independent variables in the study were the teaching of physical science. The dependent variable in the study was the teaching competency using Digital Pedagogy concerning constructivism.

The population of the study was those students studying B.Ed. and Integrated B.Ed. programme with a pedagogy of physical science as one of the courses in the Karnataka State. A Random sampling technique was used to select the sample. The sample selected for the study consisted of 77 student teachers studying B.Ed. and Integrated B.Ed. programmes at the colleges in Mysuru district with the pedagogy of physical science as one of the course papers. Among them, 39 belong to the experimental group and 38 belong to the control group based on their preference between digital pedagogy and conventional one.

The investigator developed a tool and named it 'Digite(a)ch' that comprises various digital technology tools to facilitate the student teacher to select, collect, produce, and reflect the content cum methodology. This tool was made available to the student-teacher in the cloud platform so that they could operate at any time. The researcher validated it for the present study. The researcher also developed a tool called evaluation Proforma which contains criteria for evaluating the teaching competency with special reference to constructivism.

Student teachers in both the experimental group and control group prepared the unit plan and lesson plans for chapter 8, 'MOTION' in the 9th standard Science book of NCERT publication. Student teachers prepared a suitable lesson plan for teaching the content in the constructivist approach. The experimental group prepared PowerPoint, blogs, and stored them in the database. They have downloaded

the suitable simulations and animations from the websites and stored them in the database. The experimental group prepared questions for continuous assessment to conduct online testing. In this study, the t-Test to analyze the differential hypotheses is the statistical technique used.

Analysis of Data

The data collected through the experimentation were processed and the results are presented in the tabular form. The mean and standard deviation were calculated for the variables. All the data were analyzed with a level of significance established at 0.05 levels.

Table-1: 't'- test for the mean of the Pre-test scores of control and experimental group student teachers with respect to the different phases in the teaching-learning process

Phases	Group	Number	Mean	S.D.	Calculated 't' value	Remarks
Engage	Experimental	39	1.2256	1.1799	0.0030	N.S
	Control	38	1.2271	1.1563		
Explain	Experimental	39	0.7524	0.7456	0.0833	N.S
	Control	38	0.7612	0.8795		
Explore	Experimental	39	0.5612	0.6854	0.1312	N.S
	Control	38	0.5647	0.6956		
Extend	Experimental	39	0.2145	0.5544	0.2141	N.S
	Control	38	0.2204	0.5124		
Evaluate	Experimental	39	0.2714	0.8454	0.0385	N.S
	Control	38	0.2965	0.8714		

The 't' values from table 1 show that there is no significant difference between the experimental and control groups concerning different phases of the teaching-learning process. The mean scores of the experimental group and control group reveal that both the groups are equal in different phases of the teaching-learning process. Hence, the framed null hypothesis is accepted.

Table-2: 't'-test for the Mean of Differences of Pre and Post-test scores of control group students concerning phases of the teaching-learning process

Phases	Number	Mean of differences	Standard error	t value	Remarks at 5% level
Engage	38	7.7895	2.8102	17.0835	Significant
Explain	38	8.0756	2.7584	18.0124	Significant
Explore	38	8.3125	2.0654	23.2130	Significant
Extend	38	8.5124	2.0456	25.2452	Significant
Evaluate	38	8.6235	1.9968	27.2564	Significant

Table 2 shows that 't' values of the control group are significant at 0.05 level. This reveals that there is a significant difference between the mean scores of pre and post-test of the control group in the different phases

of the teaching-learning process. It is therefore concluded that the conventional method of teaching has made a significant achievement to the control group students in all the phases.

Table-3: 't'-test for the Mean of Differences of Pre and Post-test scores of experimental group students concerning the phases of the teaching-learning process

Phases	Number	Mean of differences	Standard error	t value	Remarks at 5% level
Engage	39	11.1254	3.1514	23.5645	Significant
Explain	39	11.8565	3.7545	24.1425	Significant
Explore	39	13.5241	2.5625	26.8456	Significant
Extend	39	14.2151	2.2541	28.3256	Significant
Evaluate	39	14.9656	1.3365	31.256	Significant

It is found from Table 3 that the calculated t values are significant at 0.05 level. This suggests that there is a significant difference between the mean scores of the pre and post-test of the experimental group concerning different phases of the teaching-learning process. It may be Stated in other words that the experimental group students practised through digital pedagogy performed significantly in the phases of the teaching-learning process such as Engage, Explain, Explore, Extend, and Evaluate.

Table-4: 't'-test for the mean of post-test scores of experimental and control groups of students concerning the phases of the teaching-learning process

Phases	Group	Number	Mean	S.D.	Calculated 't' value	Remarks
Engage	Experimental	39	14.2356	3.2345	8.7584	Significant
	Control	38	8.2565	2.8795		
Explain	Experimental	39	13.9656	3.4154	7.5142	Significant
	Control	38	8.2356	2.4578		
Explore	Experimental	39	14.2536	3.1854	7.3564	Significant
	Control	38	7.9656	2.5465		
Extend	Experimental	39	14.1547	3.0025	10.4174	Significant
	Control	38	8.1235	2.1454		
Evaluate	Experimental	39	14.2535	3.2464	8.5648	Significant
	Control	38	8.4547	2.1014		

Table 4 shows that the observed 't' value is significant at 0.05 level. It is inferred that the Experimental and Control group students are not similar in the post-test concerning the different phases of the teaching-learning process. The higher mean scores achieved by the experimental group may be due to the effect of digital pedagogy. The framed hypothesis is accepted.

Table-5: 't'-test for the Mean gain scores of control and experimental groups of students concerning the phases of the teaching-learning process

Phases	Group	Number	Mean	SD	't' value	Remarks at 5% level
Engage	Experimental	39	11.1254	3.1965	6.1325	Significant
	Control	38	7.7895	2.7896		
Explain	Experimental	39	11.8565	3.1254	7.6545	Significant
	Control	38	8.0756	2.4758		
Explore	Experimental	39	13.5241	2.6595	7.9965	Significant
	Control	38	8.3125	2.2125		
Extend	Experimental	39	14.2151	2.5142	8.0145	Significant
	Control	38	8.5124	2.1125		
Evaluate	Experimental	39	14.9656	2.0123	8.2534	Significant
	Control	38	8.6235	2.0656		

Table 5 shows that the observed 't' values are significant at 0.05 level. It is inferred that the control and experimental group students are not similar in the post-test concerning the phases of the teaching-learning process. The higher mean scores achieved by the experimental group may be due to the effect of the experimental treatment given through digital pedagogy. Hence, the framed hypothesis is accepted.

Findings of the Present Study

Based on the pre-test scores, it is observed that both control and experimental group students are having similar mean scores. There is no significant difference in the mean scores of experimental and control groups concerning different phases of the teaching-learning process. Based on the analysis of pretest and post-test scores of the control group, it is observed that there is a significant difference of 0.05 level in all the phases of the teaching-learning process which shows that the control group students have performed equally in the pre-test and post-test. The conventional method influenced the control group better. From the analysis of pre and post scores of experimental group students, it is observed that the impact of digital pedagogy was significant among the experimental group. The experimental group of students achieved significantly higher gain scores than the control group students. The experimental group students exposed to digital pedagogy achieved more score gains in the different phases of the teaching-learning process such as Engage, Explain, Explore, Extend, and Evaluate.

Discussion and Conclusion

Pre-test scores analysis shows that there was no significant difference in the previous teaching competency of both experimental and control groups in all five phases. This shows that both the groups are equal before the treatment. When the pretest and post-test scores were compared, it was found that the traditional method of teaching and teaching through digital pedagogy was significantly effective. Achievement of both groups was found significant. As the gain scores analysis is more suitable and appropriate, it showed that the teaching competency of the students in the experimental group was significantly higher than the students in

the control group. The digital pedagogy might have helped the students to teach effectively and efficiently as well as it helped to exhibit all constructive teaching skills. It is to be noted that the previous studies as well as the present study have found that significant effects like digital pedagogy in the teaching-learning process led to the effective teaching competency of the B.Ed. students in physical science.

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