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Effectiveness of joyful game-based blended learning method in learning chemistry during COVID-19

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ABSTRACT

The recent introduction of joyful learning in National Education Policy (NEP) 2020 created great interest among students and is predicted to be the most suitable learning method for 21st-century learners. Game-based learning enhances education making all educational games increasingly popular. Learning efficiency can be enhanced through educational games. This article purposes to examine the efficiency of the game-based joyful blended learning method in learning chemistry, periodic table elements (1 to 30) among tenth standard students. The main purpose of the current study was to assist secondary school students to learn science-related ideas via participating in educational card games and using digital media for learning concepts. The educational advantages of the game in terms of learning performance, as well as students' views of its integration into scientific learning, were studied. A quasi-experimental technique was used to obtain the study's goal. The sample comprises 240 students studying the tenth standard in 4 different private CBSE schools in Palakkad district, Kerala, India. The pretest, posttest, gain scores, and retention scores were compared. The study's results indicated that there is a substantial mean score variation in learning chemistry (elements) between pretest, posttest, and retention tests of students in the experimental and control group. The students developed positive attitudes towards the usage of educational cards in learning Chemistry. The developed game-based joyful blended learning method develops reflective thinking and self-regulated learning among students.

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1. INTRODUCTION

National Education Policy (NEP), 2020 focuses on the need for the shift towards digital teaching and the increased demand for interactive teaching-learning methods. Game-based Learning combines teaching content with an intrinsic motivation to learn joyfully. Student-student interactions and teacher-student interactions have a vital role in the teaching-learning process and have a great influence on learning by understanding concepts in an easy way. Unlike interactions within digital games by computers, face-to-face engagement connects students to human reactions, physical activity, as well as conversational tones.

Computer-aided instruction; a form of virtual reality helps students visualize abstract concepts. In terms of game-based learning, a seamless experience linking learning and gaming attributes must be present. Online learning can be characterized as a technique for making the process of teaching-learning more student-centered, creative, and adaptive via the use of technology. Online learning signifies learning that takes place in a synchronous or asynchronous setting that used a variety of devices (laptops, mobile phones,

and so on) with internet connection. Students may study from anywhere in these environments and communicate with professors and other students [1]. Teachers have challenges in moving from offline to online mode, altering instructional methods, and managing time. It's challenging to generate curriculum-based content that also engages students [2].

Game-based joyful learning is a teaching approach in which students study key aspects of games in a classroom setting developed by instructors. Students develop a correct perspective towards joyful learning of the displayed content and experience the richness of playing the game. Joyful learning implies a series of pleasant, enjoyable learning experiences where learning is active, personally fulfilling, and successful. There are a variety of instructional media available to fulfill the needs of various learners. The goal of instructional audio and visual media is to promote important understanding and learning. There are several benefits and drawbacks that must be addressed to guarantee optimal selection and usage of instructional material [3].

The game-based joyful learning method is technologically-innovative and makes the teaching-learning process highly enjoyable. Curricular concepts can be introduced by connecting games with topics [4]. Learners can be motivated to use their discipline knowledge to solve a difficulty in the game. To enhance game-based learning, game visuals, as well as interactive components, may be incorporated into the procedure of teaching-learning. In the academic literature on educational gaming, it is often claimed that positive use of game-based learning experiences enhanced learning effects.

A joyful classroom removes stress and anxiety, meaningless repetition, and boredom rote memory study habits. It also eliminates uncertainty and confusion, intolerance, intimidation, and inflexibility. Teacher-student interactions, as well as student-student interactions, have an important effect on learning in the classroom. A joyful teacher will be relaxed, personable and reassuring, surprising and creative, ordered and confident, reasonable, open-minded, and accepting responses from students in a positive manner. The game-based learning aroused students to learn with interest [5].

Blended learning is more powerful and transformative compared to other forms of learning. It is a new instructional concept and is getting developed. With the advancement of blended learning in the field of education, researchers in India have hardly explored this area of research. Many games' unique educational potential comes from their ability to provide learners with motivating, engaging, and enjoyable learning experiences. We concentrate on two aspects of game-based learning experiences, flow and joy, and their relationship to learning in the present research.

Scientific information and learning ideas were promoted via the use of digital games [6]. Some teachers have begun to employ online platforms to aid in education, allowing students to participate in online learning activities and interact with one another [7]. The findings of the experiment revealed that including game aspects into operating system courses could raise the level of interest in the courses among students who may be ready to invest time in courses with an idea to win, thereby achieving the objective of raising learning motivation.

In this moment of crisis, teachers may employ a mix of text, video, and audio to connect their students and make their lectures personable [8]. This can aid to establish a collaborative as well as dynamic learning atmosphere in which students could offer immediate ask questions, feedback, and learn interactively. The element of e-learning is useful in times of crisis including natural disasters, man-made catastrophes, or pandemics like COVID-19. The popularity of video podcasts (vodcasts) on sites such as YouTube shows the potential inclination for users to utilize vodcasts as an instructional medium [9]. The usage of video podcasts as an efficient pedagogy has grown in educational contexts as instructors were motivated to become more fluent in authoring "Web 2.0" technologies.

Blended learning strategy is partially technology-dependent and provides opportunities for joyful learning in classrooms. In this 21st century, integration of technology in education for joyful learning refers to the incorporation of technological tools into the instructional process. Visual aspects are crucial in classes since they help make learning more permanent. It was suggested by teachers that game activity will enhance the student's motivation and it can be utilized as an assessment activity as students enjoyed game-based learning. Digital games may be utilized for different types of learning, such as skill-and-drill, creating deeper conceptual understandings, and problem-solving. Most researchers agree to the fact that game-based learning technologies have the potential to interact with new types of learning, understanding, awareness, as well as communication [10]. E-learning supports online learning and the factors governing e-learning have to be checked to make the education system more effective. E-learning tools have a vital role in the setting of learning during the epidemic situation [11].

A study performed in Admiraal *et al*. [12] shows the potential of the idea of flow in game-based learning research and provides new opportunities for future study with emphasis on flow with gameplay as an essential explanatory factor of student learning. Students may attempt to reproduce flow experiences, invoking a growth principle developing a lot of experiences leading to long-term learning effects. Hwang and Wu [13] in their survey aimed to examine the study status and trends in digital "game-based learning" between 2001-2010 and examined the number of articles, sample groups selected and learning domains

adopted in game-based learning in this period. Chiang *et al*. [14] studied the impact of several computer games on the students' flow experiences & positive emotions and found out that games may induce flow as well as positive emotions. Digital games have been found in research to increase learning motivation and generate positive emotions among students.

During monotonous traditional teaching, students may face difficulties in understanding some concepts in chemistry. The usage of android-based games and blended learning as media in chemistry instruction may help students improve their self-efficacy and accomplishment [15]. Yien *et al.* [16] revealed students' positive attitudes regarding the usage of game-based learning. Students particularly during online classes feel restless in understanding topics like periodic classification of elements which form the basis of learning chemistry. When interesting innovative methods are adopted, students can understand easily and gets motivated to learn elements in chemistry. Technology in chemistry teaching will make the teaching-learning process interesting.

When the elements of joyful learning are incorporated along with teaching, students will find great interest and easiness to learn chemistry. In this COVID pandemic, desired learning outcomes can be achieved using a game-based blended learning method while teaching. The result of this joyful game-based learning method will be reflected as a change in the behavior of students that can be found in the process of learning leading to the formation of competencies and skills in students. Hence the investigators selected this joyful game-based blended method to teach elements for tenth-standard students.

The investigators aimed to prepare a technology-based learning package in chemistry on the topic periodic table to learn elements (1 to 30) for tenth-standard students. The instructional material prepared with a game-based learning concept is delivered online to the students, where the retention and attention levels can be enhanced. A periodic table consists of an arrangement of elements according to atomic numbers in groups and periods in the form of a table. Though it seems to look attractive and easy, a student may feel difficulty understanding the complete table in the regular classes. It will be useful for teachers to formulate the technology-based instructional design and to develop innovative methods of teaching elements using technological tools and create innovative joyful learning methods instead of traditional methods to meet the needs of learners which make learning interesting and joyful. The study by Nair, Yusof, and Arumugam [17] helps youngsters to learn via experience, improves self-esteem and confidence, and also creates interest. On the basis of important research, this study is directed to study the efficiency of joyful game-based blended learning method to learn elements among tenth standard students during the pandemic of COVID-19.

2. RESEARCH METHOD

This study is quasi-experimental which involves 240 students from tenth standard studying in four different CBSE schools in Palakkad, Kerala, of which 120 students were considered as a control group and 120 were considered as the experimental group. Before the formal learning activity, a criterion-referenced test has been managed for both control and experimental group students to assess the previous knowledge of the students. Proper instructions were given by the investigator before conducting the test. The doubts raised by the students were cleared by the investigator. The responses from the students were collected. The investigator organized an interaction with the students involved in the study and with the chemistry teachers handling class for the tenth standard. These pretest scores were analyzed and it was found that two groups were equivalent.

Following the pre-test, the participants were allocated into control and experimental groups. Control group students were given conventional teaching whereas experimental group students were taught through joyful game-based blended learning method. Students of both groups were instructed not to discuss until the posttest and retention test is completed. Since the game can be played only online, students were under complete observation while learning the content. The experimental students were divided into a cluster of small groups of five students. The way of playing the games with activities and use of blended learning joyful game-based learning package was explained in a 10 minutes presentation. The formal learning session involving educational games and online game-based learning continued for 60 minutes. Following the learning activity, a post test was carried out and after 15 days of the gap, a retention test was adopted.

For this research, the researcher developed a technology-based learning package in chemistry (elements 1 to 30) for tenth-standard students using the game-based learning method. Educational cards were designed with symbols of elements and their names written on the cards on sides and matching cards were designed. The group number and period number were hidden in the matching cards and decorated with attractive matching colors. These cards were used by the researcher to create an online game to arrange elements via the play way method. This game can be played only online and the link to play this game was provided to the students. The investigator developed and validated a criterion-referenced test for pre, post, and retention testing.

2.1 Data analysis

Data were examined with SPSS 23 Software. The pretest and posttest scores were examined by descriptive statistics. A t-test of the independent sample was utilized to assess variations of the results of the pretest and posttest and retention tests. Pre-test are used to assess students' starting ability before they begin learning, while posttests are used to assess students' ability to utilize game-based blended learning. The retention test is used to measure the retained knowledge in the selected content. These pretest, posttest, and retention tests are provided to the experimental and control group to determine the efficiency of the joyful game-based blended learning method in learning chemistry. The investigators applied the test of significant difference (t-test) using SPSS 23.00 software with a significance level of 0.05.

According to Table 1, a significant p-value signifies that there exists a substantial variation between the pre-test & post-test of control group students. So, it is concluded that the classroom conventional method of teaching has helped the students to learn chemistry. It is evident from the Table 2, the measured t-value is statistically significant and therefore hypothesis number 2 is accepted. It is also observed that the mean score of the posttest is greater than the pretest phase. Hence game-based learning method helped students to learn the selected content under study.

Table 1. Hypothesis testing with t-test of pretest and posttest scores of control group students

Variable name	Hypothesis	Test phases	N	Mean	SD	t-value	Criteria	p-value	Results
Control group	H1	Pre-test Post-test	120	19.33 25.53	3.40 2.94	33.04	p-value<0.05 then hypothesis is accepted and vice-versa	.000	Accepted

Table 2. Hypothesis testing with t-test of pretest and posttest scores of experimental group students

Variable name	Hypothesis	Test phases	N	Mean	SD	t-value	Criteria	p-value	Results
Experimental group	H2	Pretest Posttest	120	19.40 29.16	2.89 3.06	49.45	p-value<0.05 then hypothesis is accepted and vice-versa	.000*	Accepted

It is seen from Table 3, there is a mean gain score variation in learning chemistry among students in the experimental & control group. The measured t-value is statistically substantial and so hypothesis number 3 is accepted. It is noted that the game-based joyful learning method of teaching is more effective to learn elements in chemistry. Table 4 shows that there is a substantial variation in the retention of learning chemistry in the experimental and control groups of students. The measured t-value is statistically substantial and hypothesis number 4 is accepted. It may be found that the game-based joyful learning method of teaching is more efficient for retention of learning.

Table 3. Hypothesis testing of paired-sample statistics of gain scores of control and experimental groups

Variable name	Hypothesis	Groups	N	Mean	SD	t-value	Criteria	p-value	Results
Gain score	H3	Control group Experimental group	120	6.12 9.72	2.03 1.99	14.11	p-value<0.05 then hypothesis is accepted and vice-versa	.000*	Accepted

Table 4. Hypothesis testing of paired-sample statistics of retention scores of control and experimental groups

Variable name	Hypothesis	Groups	N	Mean	SD	t-value	Criteria	p-value	Results
Retention score	H4	Control group Experimental group	120	27.71 35.17	2.56 2.58	23.53	p-value<0.05 then hypothesis is accepted and vice-versa	.000*	Accepted

The result of data analysis indicated that the game-based learning approach was more efficient in learning elements than other normal teaching methods. In addition, the game-based blended learning method had also proven to be effective for teaching elements in a self-pacing manner. There is a significant gain score and retention score difference between the control and experimental group.

3. RESULTS AND DISCUSSION

When the COVID-19 pandemic became a global pandemic, instructional activities turned to online teaching. It was the government's choice to close schools, colleges, and universities. As a result, creating online teaching is the most effective option to continue education [18], [19]. The goal of the current work was to examine whether game-based blended learning using educational cards and criterion-referenced tests can help the students in knowledge acquisition to learn elements (1 to 30) in chemistry. The retention, pretest, and posttest test scores of experimental groups show that the computerized game-based activities significantly increased the knowledge of students related to the study of elements.

A test of significant differences was performed to determine whether the participants enhanced in evaluation after playing the educational cards game and online computerized test. The retention test and posttest scores of students in the experimental group were considerably greater than the students in the control group. The findings of the research revealed that: i) In terms of learning chemistry (elements), there is a considerable mean score variation between pre and posttests of control and experimental groups of chosen students; ii) Experimental group students retain more of their learning than control group students as shown by their retention scores. Student retention is higher in the experimental group than in the control group; and iii) Students in the experimental group had better learning outcomes than the control group. This is demonstrated by the experimental group students gaining scores over control group students.

The participants showed positive views towards the usage of the card game and thought that the game-based learning method was very interesting and enjoyable. This finding is aligned with previous research [20] reported that gamification may enhance the learning setting to be exciting and enjoyable. Most of the students agreed on this learning technique and expected more joyful learning methods in all subjects in the future. The pupils also stated that joyful learning aided them in achieving scientific information and that the game-based learning approach boosted their attention in studying. Gamification in the learning system is a powerful tool for addressing issues like time restrictions and student pressure [21].

In this study, the statistical values of retention score (Table 4) and gain score (Table 3) of the experimental group shown are high compared to the control group students' scores. This distinction between the control and experimental group shows that online game-based activities significantly increased the knowledge of students related to the study of elements. Meanwhile, the research conducted by Ali [22] shows that the advantages of play-based learning exceed the conventional techniques of teaching. Lin *et al*. [23] found that playing educational card games boosted self-efficacy considerably. Teachers and students might benefit from more face-to-face contact if educational card games were used as a platform for game-based learning as a medium. Traditional teaching was generally used and is still one of the favorable teaching approaches of instruction [16]. At the same time, there was a lot of buzz about the advantages of adding game-based learning activities into classroom educated. Results of a study carried out by Fitriyana *et al*. [15] mentioned that the usage of game-based blended learning is better in promoting the achievement of students. The implementation of technology-based media as interactive learning media provides significant effects on learning. Further, Eric *et al*. [5] pointed out that the pupils developed a favorable perception of game-based learning activities. Thus, future studies and further analysis could be conducted on game-based learning methods and student-student interaction while playing educational card games. Games were capable of generating positive emotions and flow experiences [14].

The investigators of this study suggested that the teachers of the school education shall be trained to use game-based materials in the classroom. Likewise, Jamuna and Pankajam [3] concluded that based on the finding, teachers should be motivated to utilize instructional media in the learning and teaching process to improve the student's academic performance in the current environment. Yien *et al*. [16] stated that the game-based method was more efficient in improving the learning efficiency and attitude of pupils than conventional teaching. The results of previous research [24] show the improvement in academic achievement while using game-based curriculum learning. Subedi *et al*. [11] suggested that the teachers are stepping up their preparedness by bringing in pedagogical strategies for innovative learning.

The importance of play-based classroom learning is growing, and students will work hard to attain a goal engagingly and difficultly that will spark their interest in the activity. Play-based learning may entirely revolutionize memorization skills and the way of learning. This platform was created not just for educational objectives, but also for the development of language abilities, self-reflection, and sociable connections. According to Dewi [25], the research proves blended learning with Edmodo is a smart solution in learning in the pandemic of COVID-19. Previous research [6] found that professional learning is more important by collaborating technological innovations and enriches teaching at the time of the global education crisis. Dhawan [8] concluded that educational institutions should develop resilience into their processes to assure and emphasize the existence of these qualities in their students.

In the new framework created by COVID-19, technology is no longer a choice but a need. As a result, instructors and students must be integrated into the digital world to generate a pedagogical

reconfiguration [26]. This study was focused on chemistry to learn elements (1 to 30) and in the future, researchers can create educational card games and game-based activities for various topics in chemistry and also for other subjects such as language, social science, and mathematics and creates joyful learning methods to enable learners to experience happy and joyful learning in education in this COVID pandemic. The COVID-19 outbreak necessitates an institutionally integrated quality guaranteed-to-learn education system to e-learning, which is more critical in order for students to receive a high-quality online experience aided by organizations with competent procedures and resources [27]. The findings of this research suggested that educational organizations modify virtual channels and platforms to fulfill the interests and requirements of pupils, with an engaging and pleasant method for both students and teachers concluded in his study that intelligence quotient (IQ) may be improved via game-based training, and the influence was persistent [28].

Teachers have become used to conventional instructional approaches such as face-to-face lectures, and adapting to the dynamic condition and accepting the alteration is the need of the hour. The research carried out by [29] shows that a serious gaming environment encourage learners to actively process the educational information that increases learning and motivation. It would be useful for the education sector if a lot of technology-supported creative innovative teaching methodologies are planned and implemented. According to the findings in Aghlara and Tamjid [30], digital games have a good impact on the learning process. The usage of these games in the classroom improves motivation and promotes children's learning and cognitive development. Children's stress levels may be significantly lowered while they learn more fun and engaging activities with the use of such games.

4. CONCLUSION

This learning method was followed by students with real enjoyment and this approach can be followed in the future in all areas of academics, arts, and sports as envisaged in National Education Policy. The students also stated that studying using educational cards helped to develop scientific knowledge as well as game-based learning approach raised attention in learning and level of achievement. The findings of the pretest & posttest show that the card game enhanced scientific knowledge considerably. Furthermore, the use of educational cards to promote game-based learning enhances learning efficiency and motivation. On the basis of findings and results of the current research, it is observed that the established game-based blended learning package for learning chemistry (Elements 1 to 30) for tenth-standard students is highly effective. In addition, it is shown that there is high retention of learning elements in chemistry using the play-way technique.

Therefore, it may be strongly found that the students revealed efficient learning outcomes in chemistry by adopting game-based joyful learning method for learning periodic table (Elements 1 to 30) and proves to be a highly effective tool for the students in this COVID situation. Using this technology-oriented package, the learner can learn elements (1 to 30) at self-pace, develop interest, practice in leisure time, understand easily, and apply to all concepts in science as elements form the basis of matter in the universe. Game-based joyful blended learning is proved to be multi-disciplinary as it focuses on enhancing multiple intelligences of learners and finds its universal importance for learners in this COVID pandemic.

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