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A GAME BASED APPROACH FOR LEARNING SINDHI ALPHABETS: A COMPARATIVE STUDY

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Abstract
Game-Based Learning (GBL) is a subset of serious games that utilizes digital games or software applications with educational purposes, aiming to achieve specific learning goals through interactive gameplay. In the Sindh province of Pakistan, learning the Sindhi language is mandatory, as it serves as the medium of instruction for most subjects. However, Sindhi is considered one of the more challenging languages to learn, primarily due to its complex grammatical structures and extensive set of characters. This study focuses on enhancing the learning of the Sindhi alphabet among lower-grade students. A survey was conducted in various public and private schools to identify the specific difficulties students face when learning the Sindhi alphabet. The results revealed that most students struggled with three main issues: the number of dots on characters, the placement of dots, and distinguishing between characters with similar pronunciations. Additionally, the study observed that traditional teaching methods were insufficient to engage students and motivate them to learn effectively. To address these challenges, a Game-Based Learning (GBL) approach was implemented by developing a prototype using Android Studio. The prototype incorporated four interactive educational activities designed to improve students' understanding of the Sindhi alphabet. A comparative performance analysis was conducted between a control group, which used conventional teaching methods, and an experimental group, which engaged with the developed game. The results of the evaluation indicated that the experimental group performed significantly better across all activities compared to the control group, demonstrating the effectiveness of the GBL approach in enhancing the learning experience for students.

INTRODUCTION

In today's technological era, learners and individuals alike are increasingly engaged in digital content. They acquire knowledge through multimedia, simulated models, learning management systems, virtual classrooms, and collaborative learning environments. Among these, games are recognized as some of the most effective and practical teaching tools, offering an interactive and engaging way for students to learn. According to Oyelere et al. (2016), the integration of handheld devices such as mobile phones, tablets, PDAs, MP3 players, and smart PCs has significantly facilitated the teaching and learning process. Online and digital games, in particular, have become increasingly effective learning tools due to their engaging features.

Game-Based Learning (GBL) is a pedagogical approach where students develop skills and knowledge through gameplay. GBL is widely used in education to foster creativity, critical thinking, and problem-solving abilities. DeKanter (2005) found that educational games effectively link fundamental components of creative learning, providing an integrated learning experience. Various types of games can offer practical learning environments, enabling students to gain knowledge in a fun and interactive way. These games have proven to be particularly useful in classrooms, where they can be applied to improve language skills (Lamrani & Abdelwahed, 2020).

Game-Based Learning (GBL) is a branch of serious games that focuses on the educational outcomes by embedding learning principles into game environments. The primary goal of GBL is to enhance students' confidence and improve their problem-solving abilities (Liang et al., 2010). To foster greater student engagement and improve learning outcomes, it is essential to integrate games into the teaching and learning process (Niamboue Bado, 2022). Many researchers refer to the use of games in education as **serious games**, which address both the cognitive and affective aspects of the learning process (O'Neil et al., 2005). These games allow learners to tailor the learning experience to their cognitive needs while also providing motivation for continued learning (Malone, 1981).

Empirical research indicates that learning processes incorporating digital games yield positive results, significantly enhancing intrinsic motivation, game features, and the overall learning experience. Chowdhury et al. (2024) conducted a thematic review of Digital Game-Based Learning (DGBL) to examine the development and factors influencing children's learning performance. The effective use of GBL can encourage students and foster positive motivation for learning (Othman Ali et al., 2021). When lessons are presented in the form of games, students become more engaged and motivated to participate in the learning process. Therefore, GBL has proven to be an effective tool for language learning, especially for children who prefer a fun and interactive approach. For a more detailed study on GBL, readers may refer to the following articles: [(Alzubi, 2023), (Akour, M. et al., 2020), (Hartt, et al., 2020), (Kim, et al., 2023), (Setiawati, et al., 2024), (Tapay & Walag, 2024)].

The Sindhi language, an Indo-Aryan language, holds significant historical importance and is the primary language of Sindh. However, learning the Sindhi alphabet poses a challenge for children. Hakro et al. (2014) noted that the Sindhi script is derived from the Arabic script, and both languages are cursive in nature, meaning that characters are joined together to form words. Both Sindhi and Arabic use the Naskh writing style, with the same Semitic Abjad writing system (Shaikh et al., 2009). For more detailed studies on the Sindhi language, readers can consult the following articles: [(Ali & David, 2021), (Mukherjee, 2020)].

The Sindhi alphabet consists of 52 characters, while its parent language, Arabic, has 28 characters. Sindhi is also closely related to Persian, Urdu, and Pashto, with 32, 39, and 44 characters, respectively. In Sindhi, 17 characters are dotless and referred to as **base shape characters**. Other characters are formed by adding dots, with variations in both the number and orientation of the dots. Due to the large number of characters and the complexity of dot placement, children often become confused and find it challenging to memorize the Sindhi script.

Given that we live in a digital age, children increasingly prefer digital learning tools. As mentioned earlier, GBL offers an effective approach for learning, and there are many games available to help children learn languages. For example, games like “Fun English” teach English, “Learn Urdu Free” teaches Urdu, and “Langlandia” helps learners acquire Spanish. However, there remains a scarcity of GBL applications for learning the Sindhi language, particularly for children.

METHODOLOGY

The primary objective of this research study was to identify the challenges faced by students in learning the Sindhi alphabet, implement Game-Based Learning (GBL) approaches to address those challenges, and assess the impact of these interventions by comparing the learning outcomes of students using the developed prototype versus those not using it. The study was conducted in four key phases:

1. Identification of difficulties in the Sindhi learning

2. Optioning for the major difficulties
3. Design and development of the prototype
4. Experimental Evaluation

Identification of difficulties in Sindhi learning

To identify the challenges in learning the Sindhi alphabet, individual performance tests were conducted. Additionally, a mixed-mode questionnaire was developed, consisting of four distinct activities designed to target the foundational learning outcomes in the cognitive domain of Bloom's Taxonomy.

Activity 1: Find the difference between the pair of characters given in the chart (like ج and خ) as shown in (Table-1).

Table 1: Finding the difference between pair of Sindhi characters

4	3	2	1
ٹ	چ	ڈ	ج
ٹ	چ	ڀ	خ

Activity 2: Identify the number of characters without dots, with one dot, with two dots, with three dots, and with four dots within the given chart as shown in (Table-2).

Table 2: Identification of characters with different numbers of dots.

5	4	3	2	1
ت	ط	ڑ	ش	ا
د	ڤ	جھ	پ	ب

Activity 3: Create different characters from base shapes by putting the various number of points, by putting the points on various places, and by putting the points with different orientations as shown in (Table-3).

Table 3: Creating characters by putting dots on base shapes.

3	2	1
د	ح	ب
ع	س	گ

Activity 4: Draw the lines to match characters with objects in the given chart as shown in (Table-4).

Table 4: Matching characters with objects.

گھ		1
ب		2
ٹ		3
چ		4

Demographical details

A total of forty participants, all from the KG-1 and primary school levels, took part in the survey. The study was designed to be unbiased with respect to gender, and therefore, gender was not a factor in the analysis.

Identification of Major Difficulties:

To identify the primary challenges faced by students, survey data was collected from various schools across the Hyderabad Division, Sindh Province. Student responses were analyzed using the developed model, with scores assigned to each response. The activities were structured with varying total marks: Activity 1, 2, 3, and 4 were scored out of 8, 10, 48, and 8 marks, respectively.

Rubric for assessment

This research study aimed to identify the challenges in learning the Sindhi language and evaluate the learning outcomes of KG and Grade 1 students, both with and without the use of the developed prototype games. The results from the survey were analyzed based on a scoring system: 2 marks were awarded for each correct response, -1 mark for each incorrect response, and 0 marks for no response or skipped questions. A detailed description of the rubric is provided in Table-5.

Table 5: Rubric for assessment.

Maximum Marks				Response Marks		
Activity-1	Activity-2	Activity-3	Activity-4	Correct Response (CR)	Incorrect Response (IR)	No Response (NR)
8	10	48	8	2	−1	0

Design and development of prototype

The GBL prototype was designed and developed using Android Studio 3.5, with API level 29, and SQLite to support the underlying model. Java was used to write the functional code, while XML was employed to design the user interface. The developed prototype was tested on an Android smartphone.

Experimental Evaluation

In this phase of the research methodology, an experimental analysis was conducted to assess the difference in students' learning outcomes when learning the Sindhi alphabet with and without using the developed prototype. The students were divided into two groups: the Control Group (CG) and the Experimental Group (EG), with an equal number of participants in each group.

Before assigning students to the groups, a questionnaire was distributed to obtain parental or guardian consent for mobile device access. Only students whose parents or guardians provided prior permission were included in the survey. Additionally, parents were asked to specify the type of mobile device they owned, whether a basic phone or a smartphone/tablet. The survey results showed that 96% of the students' parents or siblings used mobile phones, with 61% using smartphones and the remaining 31% using basic phones, which were incompatible with Android applications.

A meeting was held with the parents of the participating students, where they were advised to allow their children to use smartphones for one hour to play the "Learn Sindhi" game at home or school.

For the experiment, the EG was provided with tablets and smartphones pre-loaded with the developed prototype. Meanwhile, the CG continued with traditional classroom-based learning methods. After two weeks, an examination-style survey was conducted, using the same rubric as the initial survey for assessment.

To analyze the experimental data, the normality of the groups for all activities was first tested using the Shapiro-Wilk test. Groups that were normally distributed were then analyzed using the paired t-test, while non-normally distributed groups were assessed using the Wilcoxon signed-rank test.

RESULTS

This research study was conducted on a randomly selected sample of forty students from both public and private schools in the Sindh Province of Pakistan, including The Educators School Tandojam and Government Primary School Pangrio. The students were equally divided into two groups: the Control Group (CG) and the Experimental Group (EG).

The EG students were provided with the developed GBL prototype for practice and learning, while the CG students continued with traditional classroom-based instruction. After two weeks of intervention, an examination-style survey was administered to assess the learning outcomes. The details of the experimental evaluations are as follows:

Experimental evaluation for Activity 1

Activity 1 focused on identifying the differences between pairs of characters with similar base structures. For the experimental analysis, the average scores of the CG and EG were compared to assess the distinction between them. Before conducting any statistical tests, the normality of each group was examined. The results of the normality test are presented in Table 6.

Table 6: Result of the Normality test for Activity-1 scores.

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Activity1_Ctr_Gr	.192	20	.051	.939	20	.227
Activity1_Exp_Gr	.194	20	.046	.912	20	.071

a. Lillifors Significance Correction

Shapiro-Wilk's test ($p > 0.05$), presented in Table 6, indicates that the scores for both the CG and EG are normally distributed. Therefore, a paired t-test was conducted. According to the assessment rubric, the maximum score achievable for Activity 1 was 8. The results of the paired t-test, shown in Table 7, reveal a significant difference between the average scores of the CG and EG, with $t(19) = 5.313$, $p < 0.05$.

Table 7: The difference in the performance of students for finding the difference between pair of Sindhi characters.

Test-Data	Mean	Statistical test	t-value	df	Sig. (2-tailed)
Experimental Group- Score	6.00	Paired t-test	5.313	19	.000
Control Group-Score	3.35				

Experimental evaluation for Activity 2

This activity focused on identifying characters with different numbers of points. For the experimental analysis, the average scores of the EG and CG were compared to determine whether there is a significant difference between the two sets of scores. Before conducting any statistical tests, the normality of each group was assessed. The results of the normality test are presented in Table 8.

Table 8: Result of the Normality test for Activity-2 scores.

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Activity2_Ctr_Gr	.178	20	.098	.860	20	.008
Activity2_Exp_Gr	.285	20	.000	.816	20	.002

a.Lilliefors Significance Correction

The Shapiro Wilk's test ($p < 0.05$) given in Table-8 shows that scores of the EG and CG are not normally distributed, hence the Wilcoxon Signed-rank test was performed.

The assessment rubric indicates that the maximum score achievable for Activity 2 was 10. The results of the Wilcoxon test, shown in Table 9, reveal a significant difference between the scores of the two groups (EG and CG) at the 5% significance level, with $z = -3.202$, $p < 0.05$. Additionally, the mean scores of the EG are higher than those of the CG, indicating that the performance of EG participants in Activity 2 was superior to that of the CG students.

Table 9: The difference in students' performance for identification of characters with different numbers of dots.

Test-Data	Mean	Statistical test	z-value	Sig. (2-tailed)
Experimental Group –Scores	8.50	Wilcoxon Signed Ranks	−3.202	.001
Control Group – scores	6.20			

Experimental evaluation for Activity 3

This activity focused on creating different characters by adding dots to base shape characters. For the experimental analysis, the average scores of both groups (EG and CG) were compared to determine whether there is a significant difference between the two sets of scores. The results of the normality test are presented in Table 10.

Table 10: Result of the Normality test for Activity-3 scores.

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Activity3_Ctr_Gr	.207	20	.025	.897	20	.037
Activity3_Exp_Gr	.131	20	.200 *	.932	20	.171

*.This is a lower bound of the true significance
a. Lilliefors Significance Correction

Shapiro-Wilk's test ($p > 0.05$), presented in Table 10, indicates that the scores of both the EG and CG are normally distributed. Therefore, a paired t-test was conducted. According to the assessment rubric, the maximum score achievable for Activity 3 was 48. The results of the paired t-test, shown in Table 11, reveal a significant difference between the average scores of the EG and CG, with $t(19) = 7.326$, $p < 0.05$.

Table 11: The difference in the performance of students for creating characters by putting dots on base shapes.

Test-Data	Mean	Statistical test	t-value	Df	Sig. (2-tailed)
Experimental Group – Score	40.00	Paired t-test	7.326	19	.000
Control Group – Score	22.00				

Experimental evaluation for Activity 4

This activity focused on matching characters with given objects by drawing lines. For the experimental analysis, the average scores of both groups (EG and CG) were compared to assess whether there was a significant difference between the two sets of scores. The results of the normality test are presented in Table 12.

Table 12: Result of the Normality test for Activity-4 scores.

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Activity3_Ctr_Gr	.240	20	.004	.805	20	.001
Activity3_Exp_Gr	.487	20	.000	.495	20	.000

a. Lilliefors Significance Correction

The Shapiro Wilk's test ($p < 0.05$) given in Table-12 shows that scores of the EG and CG are not normally distributed.

The rubric for the assessment shows that the maximum score that could be achieved for activity-4 was 8. The result of the Wilcoxon test presented in Table-13 shows that at a 5% level of significance, $z = -2.639$, $p < 0.05$, which shows the significant difference between scores of two groups (EG and CG). Further, the mean values of the EG are greater than the CG. Therefore, it is concluded that the performance of EG participants was greater for activity-4 compared to the CG students.

Table 13: The difference in students' performance for matching characters with given objects by drawing lines.

Test-Data	Mean	Statistical test	z-value	Sig. (2-tailed)
Experimental Group –Scores	7.60	Wilcoxon Signed Ranks	−2.639	.008
Control Group –scores	5.60			

DISCUSSION

This research study aimed to identify the obstacles children face when learning the Sindhi language and to develop a Game-Based Learning (GBL) prototype to support K.G and Grade-1 students. From the literature review, it was evident that GBL is a modern and effective approach to facilitate language learning. However, a significant gap remains in utilizing GBL to improve writing skills, particularly in teaching the Sindhi alphabet to children.

The developed prototype was provided to the experimental group (EG) for one hour daily over two weeks, during which they engaged with the game. Meanwhile, the control group (CG) followed traditional learning methods. The results were assessed using statistical tests. The normality of each group's scores was tested, with normally distributed data being analyzed using the paired t-test, while non-normally distributed scores were assessed using the Wilcoxon Signed-Rank test. The results clearly

indicate that the GBL prototype led to improved learning outcomes for the EG students.

In Activity 1, a paired t-test revealed that the performance of the EG students was significantly better than that of the CG students. Similarly, in Activity 2, the Wilcoxon Signed-Rank test showed that the EG students had higher mean scores than the CG students, indicating better performance.

For Activity 3, the paired t-test revealed a significant difference between the average scores of the two groups, again favoring the EG. In Activity 4, the Wilcoxon Signed-Rank test showed a significant difference between the scores of the EG and CG, with the EG outperforming the CG in terms of mean values.

Overall, the results demonstrate that the EG students, who used the GBL prototype, consistently outperformed the CG students. Furthermore, it was evident that the GBL approach provided an engaging, fun, and immersive learning environment, which motivated children to participate actively. In contrast, the traditional learning methods often led to boredom and frustration. The GBL approach encouraged children to repeat activities in an enjoyable and stimulating way, significantly enhancing their learning experience.

CONCLUSION

A total of 40 KG and Grade-1 students from two different schools in the Hyderabad Division of Sindh were selected for this study. An initial survey was conducted to identify the challenges these students face while learning the Sindhi alphabet. It was found that 61% of the students used Android phones. Based on this, a game-based prototype with an interactive user interface was designed, and an experimental evaluation was carried out by dividing the students into two groups.

The results were analyzed using statistical tests, including paired t-tests and Wilcoxon Signed-Rank tests. The findings concluded that the students who used the developed game-based prototype outperformed those in the control group. These students demonstrated improved learning outcomes in a fun, engaging, and entertaining environment, and expressed a preference for learning through the game-based prototype over traditional teaching methods.

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