Mitigating the Urban-Rural Educational Gap in Developing Countries through Mobile Technology-Supported Learning

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Abstract

One form of educational inequality is the disparity that exists between urban and rural settings. Equal distribution of quality education is a challenge for developing countries due to the unavailability of resources. Various approaches to equal distribution are distance learning, telecast learning, and e-learning; however, these approaches cannot achieve the desired objectives due to their limitations. This research aimed to investigate the interesting question of whether mobile technology can bring the urban and rural settings closer together. A mobile application for learning Urdu grammar was designed to measure the learning gains of fourth-grade students at two different schools from urban and rural settings. A quantitative technique, the quasi-experimental pre-test and post-test method, was used to measure the effectiveness of the mobile application. The comparison of the students' performances at the urban and rural schools illustrated the role of mobile technology in mitigating the educational gap. The present study provides evidence that children from different social backgrounds may benefit equally from mobile technology.

Introduction

The slogan “Education for All” is an ongoing challenge for developing countries such as Pakistan. Educational equity is one of the most influential factors in overcoming this challenge (Robinson, 2008). Equal distribution of quality education provides an opportunity for all to learn. However, less qualified teachers and a shortage of resources in rural areas potentially create social injustice between rural and urban environments. This has been recognized by educationists, researchers, policy-makers, and agencies. To implement this equality of education, policy-makers force the educationists to follow the same curriculum. However, the accreditation of the curriculum is just the comparison of content rather than evaluating individuals’ learning (Hasan, 2010).

Distance learning has the potential to provide access to the same quality of education in both rural and urban areas (Masino & Miguel, 2016). The existing literature has thoroughly addressed the implementation of distance learning to narrow down the educational gaps between urban and rural environments (Hohlfeld, Ritzhaupt, Dawson, & Wilson, 2017; Leontidis, Halatsis, & Grigoriadou, 2011; Robinson, 2008). However, the infrastructure required to access distance learning is still questionable. Telecasting learning material through television networks has the limitation of its rigid scheduled broadcasting time. Similarly, broadcasting is not an interactive environment, and so limits the students’ learning (Chowdhury & Halder, 2016). Moreover, reliable and high-speed internet access to learning material is costly and so is impossible for poor rural areas in developing countries. The same can be observed for e-learning, web-based learning, virtual classrooms, and online collaborative learning (Aparicio, Bacao, & Oliveira, 2016; Boticki, Baksa, Seow, & Looi, 2015; Piper, Zuilkowski, Kwayumba, & Strigel, 2016; Potkonjak et al., 2016).

The present work considers learning through mobile technology (Castañeda & Cho, 2016; Piper et al., 2016; Revelle, Reardon, Green, Betancourt, & Kotler, n.d.; Sharples, 2013) as a remedy to the identified problem and the limitations of distance learning. Instead of accessing the learning content over a medium of communication, the content is delivered through mobile technology. Interactive content that implements an underlying curriculum is stored in the mobile devices for teaching and learning. This interactive learning content does not require infrastructure or communication resources. This work aimed to investigate the interesting question of whether the mobile technology could narrow the educational gap between urban and rural settings. A mobile application was designed to measure the learning gain achieved by the fourth-grade students at two different schools, one urban and the other rural. The learning gain in the present

work refers to the improvement in Urdu grammar learning of a student after using the application as compared to the traditional methods of books and worksheets. Moreover, the comparison of the students' performances at the urban and rural schools provided evidence of the role of mobile technology in mitigating the educational gap. A quantitative technique, the quasi-experimental pre-test and post-test method, was used to measure the effectiveness of the mobile application in terms of Urdu grammar learning. The provided empirical results of interactive mobile technology are deemed to be the novelty of the present work.

Literature Review

The disparities between urban and rural settings in less developed countries have been considered as an important form of educational inequality (Hohlfeld et al., 2017). The research community has sufficiently examined the causes of such disparities related to child education, such as two parameters affecting student learning, that is, the student's individual and the school characteristics. The proposed solutions in the existing literature are mainly concerned with the capacity building of an individual and his environment (Wang, 2011; Zhang, 2006). In contrast, the present work addresses the mitigation of the urban-rural educational gap through the induction of educational technology. A study by Palomer and Paredes (2010) showed the presence of an educational gap by evaluating the same test (SIMCE) at 17 different urban and rural schools in Chile. The present study evaluated the gap by conducting a pre-test before the actual intervention.

Distance learning combined with educational technologies is considered to be a solution to the educational inequality as it provides equal access to the educational resources (Macintyre & Macdonald, 2011; Robinson, 2008). Both teachers and students benefit from the shared learning content. Several synonyms have been coined by researchers for distance learning such as online learning, web-based learning, distributed learning, massive open online courses, and electronic learning or e-learning. Warugaba, Naughton, Gauthier, Muhirwa, and Amoroso (2016) reported the benefits and utilization of a massive open online course (MOOC) in rural Rwanda. Their study showed the need for internet access, in-class guidance, and employers' engagement for the successful implementation of MOOCs for capacity-building in a resource-limited area. These requirements for the implementation of distance learning make it difficult in developing countries where children lack even basic needs. Further, e-learning, with its goal of providing education to outreach students, still faces hurdles related to infrastructure, information access, development of electronic learning content, and technology adoption (individual characteristics) (Bhuasiri,

Xaymoungkhoun, Zo, Rho, & Ciganek, 2012; Diep, Zhu, Struyven, & Blieck, 2017) in developing countries. Despite these barriers, it is believed that e-learning has great potential in promoting the instructor quality, content quality, supportiveness, and learning satisfaction in developing countries.

A similar study identified issues and their impact on e-learning implementation in Pakistan (Farid et al., 2015). Some of the identified issues are localization, lack of an instructional design process, lack of instructional designers, internet bandwidth, power failures, and the low literacy rate. Localization of the learning content in the local language (Urdu) is the first hurdle in implementing e-learning. Higher education institutes / universities are developing centers for developing localized learning objects (LOs), but primary education at schools does not have any such facility (Farid et al., 2015). In the present work, we designed and developed Urdu grammar learning content in a game-like environment for children at primary education level.

Web 2.0 technologies are emerging as the collaborative social learning method. They provide facilities for developing and sharing learning content and collaborative environments for the learners. With Web 2.0 tools, learners and instructors can publish and share images, audio, or video learning content in a social network fashion. Research has identified emerging practices and attitudes associated with teaching and learning through Web 2.0 environments (Bennett, Bishop, Dalgarno, Waycott, & Kennedy, 2012). However, in developing countries like Pakistan, even with the proliferation of smart phones and 3G/4G mobile networks, the usage of social media such as Facebook, Twitter, and WhatsApp is still around 1% of the whole population. Furthermore, this usage of social media is primarily for non-academic purposes. A framework proposed by Williams, Karousou, and Mackness (2011) provides a way to shift the monolithic learning environment (i.e., instructor-centered) to a more pluralistic learning ecology (pupil-centered) using Web 2.0 and the cloud-based Web 3.0. Williams et al. identified some similar limitations (i.e., technical and infrastructural conditions) within their proposed framework for emergent learning environments.

The present work hypothesizes that mobile technology is a viable solution for the delivery of quality education equally to urban, rural, and remote regions in developing countries. Analysis of the literature reveals that mobile technology has the potential to increase learning outcomes (Caudill, 2007; Giannakas, Kambourakis, Papasalouros, & Gritzalis, 2017; Sharples, 2013; Valk, Rashid, & Elder, 2010) but no evidence exists that mobile technology can help to mitigate the urban-rural educational gap and provide equal education for all. Mobile learning (M-learning) is a

new field of study among other educational technologies (Giannakas et al., 2017; Piper et al., 2016; Sharples, 2013). In M-learning, a student can learn whatever, wherever, and anytime by using portable devices, that is, smartphones with teaching applications installed on them. Recent smartphones provide support for multimedia content, interactive input methods, and location-based services that in return enhance the interest and motivation of the learners (Caudill, 2007; Piper et al., 2016). Moreover, internet accessibility, through mobile phones, provides a link to a wider source of knowledge. Language learning with mobile technology is a common occurrence nowadays. Enhancing accuracy and confidence in conjugating Spanish verbs was studied by Castañeda and Cho (2016) through the use of a mobile application. Similarly, the effectiveness of mobile-assisted language learning (MALL) over computer-assisted language learning (CALL) has been reported by Lin (2014). The results showed that the participant group using the mobile technology outperformed the personal computer (PC) group in an English reading experiment. Lin's study provides evidence of enhanced knowledge acquisition through mobile technology, but how it can be done still needs further investigation, especially in learning a foreign language. Lin's identified limitations include development of the interactive book for reading on the mobile platform and the readers' interest in and attitudes toward reading. Furthermore, the study concluded that printed books will remain a requirement for serious study, primarily because of distractions on mobile devices. Another study conducted to evaluate the effectiveness of mobile technology for English as a foreign language (EFL) in Iranian universities (Dashtestani, 2016) highlighted the positive effects of mobile technology and observed discouragement of mobile usage in classrooms in Iranian culture.

Research Questions

The present work attempts to address the extent to which the mobile technology environment in rural and urban areas could improve learning of the Urdu language grammar. Following are the research questions:

- Does the proposed mobile technology method improve learning of Urdu grammar?
- Does mobile technology help to mitigate the educational gap?

The Game-like Educational Application

An Android game-like application named Baghecha-e-Ism (BISM) was used in the present research. The architecture of the BISM application is shown in Figure 1. The game was designed to help students to learn and exercise the Parts of Speech (Kalma ki Iqsam) and Types of Noun (Ism ki Iqsam) in the Urdu language. For a user to better understand the parts of speech and types of noun, the concepts and definitions are shown using images and sound.

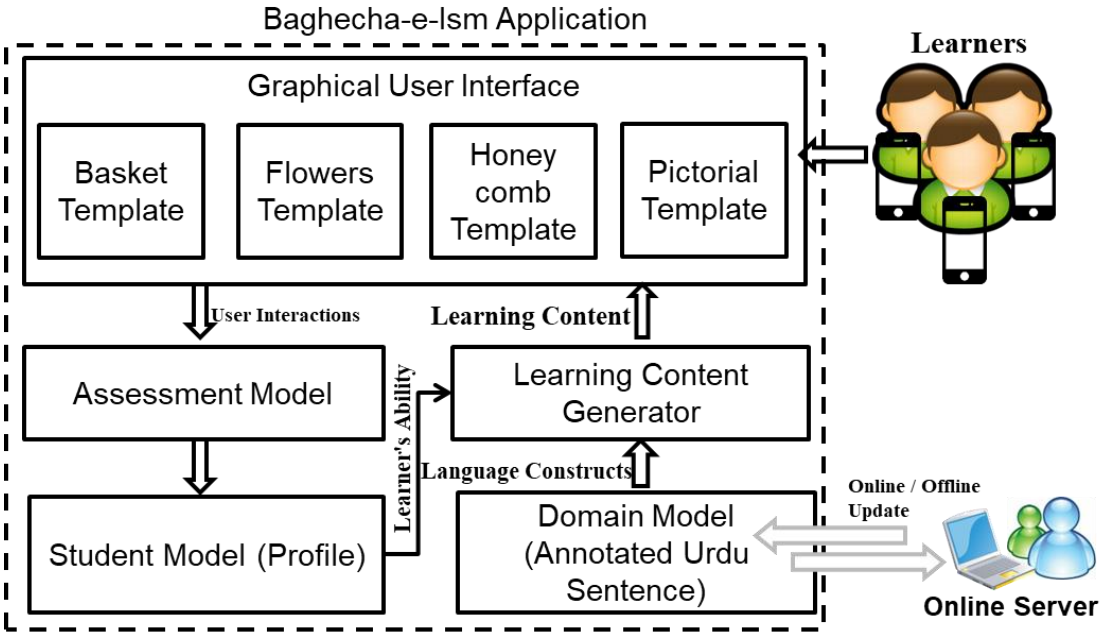

Figure 1: BISM architecture

This application was designed for Grade 4 students. The topics “Parts of Speech (Kalma ki Iqsam)” and “Types of Noun (Ism ki Iqsam)” were picked from the Grade 4 Urdu Grammar book. The content, already used for learning the topic, was considered before designing the application. While designing the interactive game, extra caution was taken to cater to the flaws in the already designed content. The application starts with a loading screen which leads to the Title screen where a user can tab on the play button to access the main menu screen. The user can then tab on different buttons to go to different environments of the game, as shown in Figure 2.

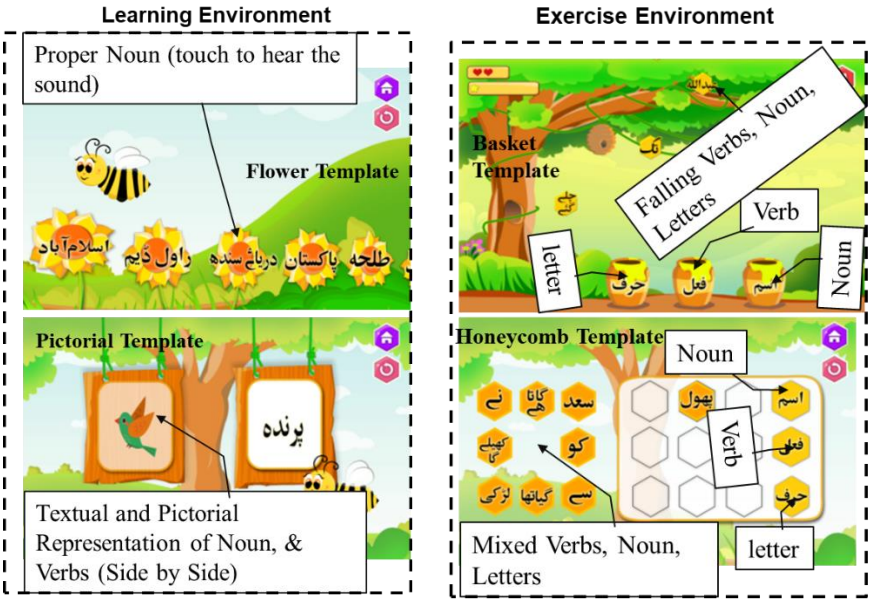

Figure 2: BISM learning and exercise environment

The theme chosen for the game-like application was honey bees and a garden. The reason to choose this is that most of the children are already familiar with the names of honey bees and gardens in their native language. The whole game is set in a bright and colorful garden which includes trees and flowers. Furthermore, the application is supported with audio and visual information. In this way, the child will retain attention for a longer period of time.

The domain model contains the domain knowledge that is modeled using extensible markup language (XML). Language items are annotated for the creation of the learning content. The student model holds the students' profiles which are required for navigation among the different content. Every interaction, mistake, and solution performed by the student is stored in the student model. The student model strongly relates with the assessment model to conceive the student's understanding of any given concept or learning content. The assessment model can be a statistical model or a heuristics-based model to evaluate the student's understanding or learning. Presently, this work does not report on the assessment model as it is a huge independent research domain in itself.

The learning content was generated by the content generator module using predefined content authoring rules. Rules are represented as conditional statements which utilize the domain knowledge and the student model to generate specific learning content. With the proposal of rules and dynamic content creation, the present work eliminates the domain expert (a person who manually receives the actions of the user and creates new content for further procedures) from the

system. The user interface module is responsible for displaying the learning content according to different representations selected by a user. The content is sequenced in the order of easy to difficult.

A user can practice what he/she has learned, and then there is an activity which the user needs to successfully complete to go to the next level. When an activity begins, the parts of speech randomly drop down from the top of the screen and the user needs to put the right word in the right basket. The application provides feedback on the users' answers in the form of stars for correct answers and a loss of lives if the answers are wrong. Secondly, it is an interactive game which helps users to learn and play at the same time.

The main menu consists of different buttons that contain information about the topic which leads to the activities about Parts of Speech (Kalma ki Iqsam) and Types of Noun (Ism ki Iqsam). These game-based activities allow a child to progress and to unlock other levels. The purpose of the practice screen is to further improve the understanding and practice the knowledge which the child listens to and understands in the learning screen. The activity is to further explore the difference between the Parts of Speech (Kalma ki Iqsam) and Types of Noun (Ism ki Iqsam). A scenario from a garden has been presented where the words are falling down from a tree and a child has to drag the correct word into the correct basket.

Method

For the effectiveness evaluation of the proposed application, a quasi-experimental pre-test and post-test design was used.

Participants

The research participants were fourth-grade students at a federal government urban and rural area school, with ages ranging from 8 to 11 years. The selected participants were from all (i.e., low, average, and high) achievement levels. The teachers in both schools had almost the same educational level (i.e., M.A and M.Ed, B.A and B.Ed) because both selected schools were from the federal government sector. For the same reason, the course content and the level of teacher qualification was the same at both schools.

A total of 168 participants (63 males and 105 females) from the two schools were involved in the study. The children of both schools were divided into two groups, the control (i.e., 83 students) and the experimental (i.e., 85 students) group. The subject schools did not permit us to

create experimental and control groups within a single class as they wanted to keep the class structure intact. As both selected schools had two different Urdu language classes, we chose one as the experimental class and one as the control class.

Experimental procedure

The experiment took 6 weeks of 5 hours per week, as shown in Figure 3. In the first 3 weeks, the students were taught about the fundamentals of Urdu grammar. The children in the control group took lessons of Urdu grammar in the traditional setting within the context of Parts of Speech (Kalma ki Iqsam) and Types of Noun (Ism ki Iqsam). The children in the experimental group worked with the targeted application (BISM) to learn the same topics of Urdu grammar as the control group. All of the participants in the experimental group were provided with an Android-based mobile tablet during their class time each day for 3 weeks. BISM was the only application installed on all provided tablets. The teacher had created a profile for every individual student on the allocated tablet during the first use of BISM. After the daily usage, the mobile phones were collected back from the children. During and after every usage, the application data or the student profile was extracted manually from the tablet memory. Both urban and rural schools follow an annual examination system, so the 3 weeks of learning with the BISM application did not affect the overall study plan of the schools. After initial study for 3 weeks, the participants took a prior knowledge test about Urdu grammar. In weeks 4-6, the control group in both schools learned via the traditional method whilst the experimental groups worked with the proposed application. In order to measure the effectiveness of the application, in the 7th week, all of the students were asked to finish the post-test of Urdu grammar. For the data analysis, the difference between the scores of the pre- and post-test were the dependent variables, whereas the learning method used to teach was the independent variable.

Moreover, focus group discussions were held with 40 randomly selected participants from the experimental group. The discussions helped us to gather the students' perceptions regarding the game-based learning approach. The open-ended and semi-structured questions used in the focus group discussions are presented in Appendix A.

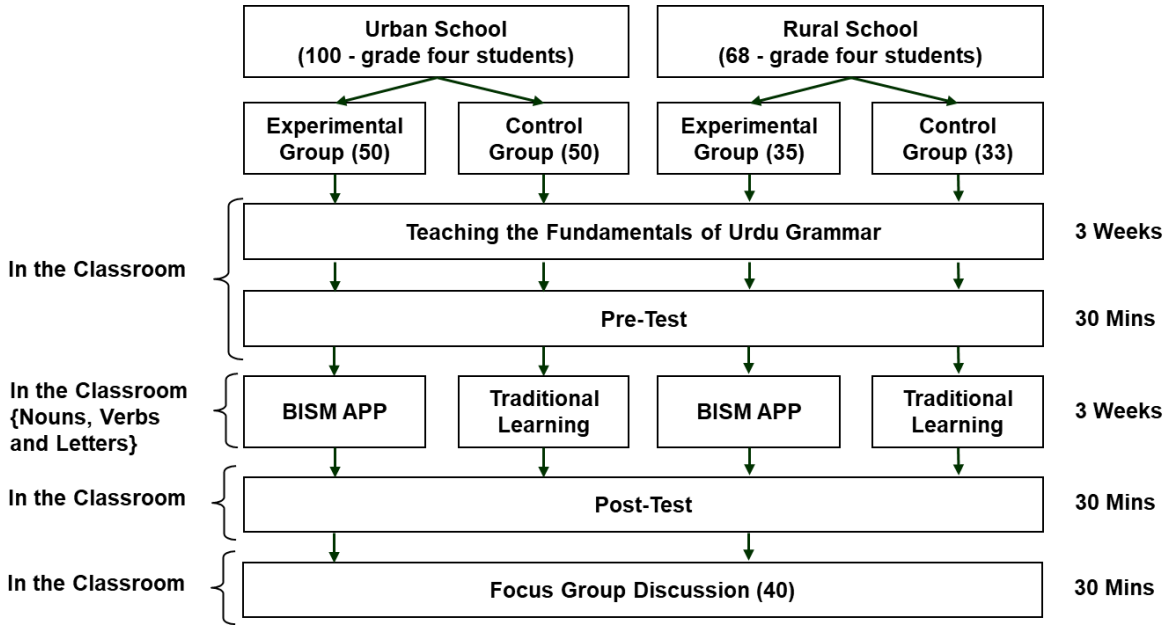

Figure 3: Experimental procedure

Pre- and Post-Tests Design

Before the actual experiment started, a pre-test consisting of carefully chosen learning content for Urdu grammar learning was conducted. The experiment was then continued for 3 weeks. Both the pre- and post-test were composed of content for measuring the Urdu grammar learning, and were formulated from the textbooks. Consent was obtained from several teachers through a moderation form about the acceptability of the pre-test and post-test which were very much aligned with the curriculum. The content (i.e., verbs and nouns) used in the tests was different from the content used in the application, because the tests were designed to check the students' understanding of the concepts rather than their memorization. The pre- and post-tests consisted of eight questions including five sentences under each question but with different sentences for each test. The students were required to circle nouns, verbs, letters, common nouns, and proper nouns in the provided sentences. The initial sentences contained only one noun or verb. Subsequently, the sentences included multiple proper and common nouns with multiple verbs in a single sentence. One question required the students to write verbs and common and proper nouns themselves. A double score was given to a word that had not been shown to a student in the BISM application or in the textbook. This validates the child's understanding of the concept.

During both tests, teachers remained in the experimental place for motivation and support, such as reading the question statements and helping students understand the asked problem. The

pre- and post-tests were conducted on paper worksheets so that the control and experimental groups had the same method of test conductance. After the 3rd week, the post-test was conducted. Finally, all tests were marked and then recorded using the Statistical Package for the Social Science (SPSS) version 23 software.

Results

The purpose of conducting a pre-test is to evaluate a respondent's existing knowledge before any treatment is applied. This measurement of existing level of knowledge provides a way to know about the level of improvement achieved by a respondent after receiving the necessary treatment. The descriptive analysis of the pre-test scores for the control and experimental groups is shown in Table 1.

Table 1. *t*-test results of the pre-test scores in each group

	Group	N	Mean	SD	t
(ER)	Experimental Group Rural	35	15.905	3.712	2.764*
(CR)	Control Group Rural	33	19.022	5.381	
(EU)	Experimental Group Urban	50	20.181	5.899	0.408**
(CU)	Control Group Urban	50	20.659	5.857	

* $p < 0.05$, ** $p > 0.05$.

The overall mean of the control group is 20.008 with a 5.696 standard deviation, while the overall mean score for the experimental group is 18.421 with a 5.509 standard deviation. Along with the pre-test evaluation, hypothesis testing was performed to compare the level of knowledge possessed by the children in both groups. An independent sample *t* test was performed to analyze the significant difference between groups, which evaluated the hypothesis (H01). The results of the *t* test show that the p-value for the independent *t* test in the rural school is $p < 0.05$, indicating that the children in both groups possessed a different level of knowledge before the treatment was applied {Rural school, $t(68) = 2.764$, $p=0.008$}. In the urban school, the p-value for the independent *t* test is $p > 0.05$, indicating that the children in both groups possessed the same level of knowledge before the treatment was applied {Urban school, $t(100) = .408$, $p=0.684$}. Based on analysis of significance value, the hypothesis (H01) was rejected for the rural school and accepted for the urban school. This also provides an indication of the existence of the educational gap between the rural and urban students.

The purpose of conducting a post-test in a quasi-experimental design is to determine the statistical significance between the control and experimental groups after applying a particular treatment. Table 2 illustrates the descriptive analysis of the post-test scores for the control and experimental groups. Based on Table 2, nearly all of the students showed an increase in their post-test scores, but a higher score was visible in the experimental group.

Table 2. *t*-test results of the post-test scores in each group

	Group	N	Mean	SD	t
(ER)	Experimental Group Rural	35	26.835	3.747	-3.027*
(CR)	Control Group Rural	33	22.749	6.845	
(EU)	Experimental Group Urban	50	28.241	6.115	-4.781*
(CU)	Control Group Urban	50	22.363	6.176	

* $p < 0.05$.

The independent sample *t*-test comparison of the post-test scores of the rural school is {Rural school, t (68) = -3.027, p=0.004} and for the urban school it is {Urban school, t (100) = -4.781, p=0.000}. The significance value (p-Value) of both schools is less than 0.05. This reflects the significant difference between the control and experimental groups. Therefore, the null hypothesis (H02) is rejected. However, in the rural school, the mean score of the control group was higher than that of the experimental group in the pre-test, but after the intervention the mean score of the experimental group was higher than that of the control group, which shows that the game-like application improved the students' knowledge of Urdu grammar. This concludes that the approach benefited the students in both rural and urban areas.

Increment evaluation was conducted to analyze the significance improvement achieved by the groups in both schools from the pre-test to the post-test. In general, increment is calculated by computing the difference between the mean values of the post-test and pre-test scores. Table 3 presents the descriptive analysis of the increment result for both the control and experimental groups. The experimental group showed better increment in terms of score achievement, especially at the rural school (10.929). Similarly, the control group too had an increment but it was less than that of the experimental group. The effect of the urban and rural settings is visible in this descriptive analysis; the increment is larger for the rural participants (10.929) and less for the urban participants (8.059).

Table 3. Comparison of incremental scores in each group

	Group	N	Mean	SD
(ER)	Experimental Group Rural	35	10.929	2.527
(CR)	Control Group Rural	33	3.727	6.654
(EU)	Experimental Group Urban	50	8.059	5.529
(CU)	Control Group Urban	50	1.703	5.282

In addition, the results of the focus group discussions showed that the grammar game was "fun," especially for learning Urdu grammar; for example, one student shared that "I want to learn more by using a game-like application." The participants also indicated that BISM provided an interactive learning environment; for example, an interviewee stated that "I enjoy that I can move the things in the game." Several students stated that the visuals helped them to better understand the concepts and motivated them to learn ("Honey bee was so beautiful"). They also stated that learning becomes easier when they learn by using visuals and colorful graphics which helps them to concentrate and focus their attention. Moreover, this way of learning motivated them to learn difficult and boring subjects in an interesting way, such as "I like that I got a star when I did right drags." It is also exciting to see that even though collaborative learning was not an item of discussion, one student stated a notion of collaboration between peers: "Suleman didn't know how to play so I helped him and he performed better."

Discussion

The present work examined the extent to which a mobile game-like application improved the Urdu language learning of students at an urban and a rural school in Pakistan. The mobile technology had a positive impact on the students' Urdu language learning at both schools.

In answer to the first research question: "Does the proposed method based on mobile technology improve the learning of Urdu grammar?", the independent sample *t* test shows a significant difference between the pre-test and the post-test in both areas, indicating the learning gain achieved by the students via the mobile technology. We may relate the difference in academic achievement of the groups to a number of factors. The medium of instruction is an important factor to boost the motivation and to enhance academic achievement. In a conventional classroom,

usually one teacher has to cater to many students at one time and only one-way communication is encouraged, which places students in a passive role and hinders their learning. Use of interactive applications in learning Urdu grammar not only increases students' motivation, but also helps them to achieve better grades. Students found it interesting to learn and play at the same time. The idea that they could play/pause and replay the activities in the application as many times as they wanted gave them confidence and control over their learning. It can be argued that the game-based learning was highly motivating because the students were actively involved in the lesson. In addition, by using the application, the students felt more confident and competent. They had a positive reaction to learning through the game because it helped them to learn the content in a fun way.

Similarly, the difference between the increment (i.e., pre-test subtracted from post-test) scores of the experimental groups provides an indication of narrowing the urban and rural educational gap. Surprisingly, the experimental group at the rural school achieved the larger increment score. The reasons for the difference may be as follows. The Urdu language, which was selected for the experimentation, is native to all the students in both the urban and rural areas. Urban schools, however, are more inclined toward English language learning and hence put more emphasis on it. Moreover, urban students use several English words in place of Urdu in their conversation. Moreover, nearly all of the students at urban schools have television at home showing English content on a daily basis. In the rural setting, English is studied as a subject, mostly by way of memorization of the content. Conversations mainly take place in Urdu, and include very few or negligible words from English. The population in rural areas is largely illiterate. Moreover, in the rural areas, the television only has local channels mainly in the Urdu language.

The results of the research indicate that students in the rural school gained higher scores than the students in the urban school. The reason is that the children in a rural area do not have much access to technology as compared to an urban area and when they found the opportunity to learn by using games they found it charming and interesting and took a keen interest in learning. They were excited to use the gadgets to learn and it improved their learning. The urban participants were quite familiar with technology and thus had less interest in using the mobile technologies. This answers the second research question: "Does mobile learning help to mitigate the educational gap?"

We may relate the difference in academic achievement of the groups to a number of factors. The medium of instruction is an important factor to boost motivation and to enhance academic achievement. In a conventional classroom, usually one teacher has to cater to many students at a

time, and only one-way communication is encouraged, which places students in a passive role and hinders their learning. The overall impression of the students was that the grammar game was “fun,” and they especially emphasized that it was a fun way of learning Urdu grammar. Their enjoyment was described by various comments such as, “We play and learn at the same time,” “It’s the best way to learn grammar,” and “We want to learn more by using a mobile game-like application.”

The students were really excited that the application gave them a great degree of control over how to manipulate items with their finger gestures and to select an activity for learning a concept. Students can take as much time as they want to learn and understand a concept. If they get bored from learning they can easily switch to the next level. The students felt that they had control over their learning as whenever they wanted they could pause/resume and repeat the application and activities.

The students stated that the visual screens helped them to better understand the concepts and motivated them to learn. Learning becomes easier when they learn by using visuals and colorful graphics which help them to concentrate and which draw their attention away from other irrelevant things. The students found that this way of learning motivated them to learn difficult and boring subjects in an interesting way. They found that the interactive activities were more enjoyable and interesting. They said that they did not know that they were learning and practicing; rather, they were only motivated to complete the activities and get the maximum number of stars.

Although the results of the research are promising, the study reported here has a number of limitations that must be taken into consideration before applying it to other research settings. The study was implemented for a time period of just 3 weeks. It may have affected the results of the long-term retention of knowledge as the pre- and post-tests were carried out within this time frame. This research should be further extended by the replication of this study for a longer period of time (e.g., 3 months) to investigate students’ motivation over time and its impact on learning results and for investigation of the retention component. Secondly, most of the students came from middle-class families with average incomes and thus only some of them had access to mobile and tablet technologies at home. These results may differ from those of higher class children who use these gadgets regularly, and thus could affect the outcomes of this research. Thirdly, some features of the mobile game-like application designed for the study could not be completed as planned due to the limited time available for the design and development. If there was more time available,

elaboration of the current activities could be possible, and further game activities could have been designed.

A potential threat to the validity of the present study is that the development of the learning content for mobile devices is resource intensive. How can the present study reduce the cost compared to distance learning? The justification is that learning content development is also required in distance learning and the content is delivered over a communication medium. In contrast, the methodology followed in the present study using mobile technology has eliminated the provision or accessibility (over a communication medium) cost of the learning content. With mobile technology, pre-authored interactive learning content is loaded on the devices. Furthermore, the proposed mobile application can become a potential system by incorporating dynamic capabilities such as curriculum sequencing (learning plans), interactive problem solving, and intelligent analysis of students' solutions.

Conclusions

The basic goal of this study was to explore the extent to which mobile technology increases students' academic achievement and motivation to learn Urdu grammar, and to determine its impact as compared to traditional classroom instruction. Analyses of all the data revealed that implementing game-based learning in Urdu grammar classrooms had a positive influence on students' motivational level and knowledge. Moreover, the results of the research indicate that students in the rural school gained higher scores than those in the urban school.

The first phase of the study involved the design and development of the game-like application. The curriculum content used in the application has the same objectives as those of a traditional classroom. The second phase of the study involved collecting and analyzing data in order to compare the results of the two groups. The results of the study show that the students were highly motivated to learn Urdu grammar by using the game-like application, and it also increased their academic achievement.

It is clear that the students who used the game-like application were more efficient and confident in their knowledge and understanding of the topic. This method appears to be more beneficial to the Urdu grammar learner for achieving significantly higher as compared to a learner who has received traditional classroom instruction. Another factor which should also be taken into consideration is the learning environment, that is, either in the classroom setting or outside the

classroom. Further research can be carried out by considering this factor and comparing the outcomes of game-based learning, both in and outside the classroom.

This study provides experimental results that challenge the traditional methods of teaching Urdu grammar. Typically, Urdu grammar is learned by using worksheets (instructional pedagogy); however, the current study suggests that the mobile game-like application can provide a platform to learn Urdu grammar in motivating and interesting ways (constructive pedagogy).

Such an approach can also be applied to other languages such as Arabic and Persian, that have similar characteristics to those of the Urdu language. In addition, vocational education in developing countries (Ng & Lam, 2018) is a potential application of the proposed mobile learning approach. More specifically, women residing in rural areas of developing countries can learn different skills, trades, and crafts through electronic content provided via the mobile technologies. It is suggested that more experimental studies can be conducted to investigate the impact of mobile applications on the acquisition of some specific skills learning as compared to learning in resource-intensive vocational training centers.

Moreover, the results show the comparison of a traditional classroom with mobile technology-supported learning. However, to assess the true viability of this type of approach, further evaluation in remote areas where children have no access to schools or teachers is needed. Therefore, the findings of this study can be a good reference for those who intend to conduct research on technology-supported learning as well as improving students' learning outcomes in school settings.

Statements on open data, ethics policy and conflicts of interest

The participants were protected by hiding their personal information during the research process. They knew that their participation was voluntary and that they could withdraw at any time. Participant of the focus group took part voluntarily and with informed consent. There is no potential conflict of interest in this study, the data and the questionnaire (in Urdu language) can be obtained by sending request e-mails to the corresponding author.

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Appendix A

Engagement Questions:

1. Have you ever played any digital game before?
2. What is your favorite game?
3. Are they of educational benefit?

Exploration Questions:

4. Do you like the Urdu grammar game? Why do you like it?
5. Do you think this grammar game helps you in Urdu grammar learning? Please explain further.
6. Which activity/scene do you think was most attractive to you in the Urdu Grammar game? Why do you like it?

Exit Question:

7. Is there anything else you would like to say about this Urdu grammar game or any suggestions that can help to make the game better?