[1] **Dexter G. Dandan**
[2] **Michael Marvin P. Cruz**
[3] **Ken M. Balogo**
[4] **Rollen Jay Bloron**
[5] **Domric M Panunciar**
[6] **Carino C Mahinay**
[7] **Aileen P. Belleza**
[8] **Rubilyn A Mayagma**
[9] **Richard G. Dolocanog**

Math Minds Application: Development of an Interactive Application for Enhancing Basic Numeracy Skills of Students

Abstract: **-** This study focuses on Math Minds Application: Development of An Interactive Application for Enhancing Basic Numeracy Skills of Students by developing and implementing an interactive application tailored for Grade 2-6 pupils. The primary objectives include the creation of a user-friendly educational tool, addressing implementation challenges, assessing its impact on numeracy proficiency, and providing recommendations for optimization. The research employs a comprehensive approach to enhance numeracy skills among Grade 2-6 pupils through technology-driven, interactive learning. By addressing these objectives, the study aims to contribute to the improvement of educational practices and the overall numeracy proficiency of primary school students in the targeted school context.

Keywords— Math Minds, E-RUNT, Numeric Skills Interactive Application, Application Development.

I. INTRODUCTION

The 21st century is the technological age and this century's technological advancements have had far reaching effects on people all across the world [1]. Societies that cannot keep up with the speed of technology have remained spectators to the marvels of the present, whilst nations that can keep up with the pace of technology have attained their rightful place [2]. Technology simplifies our work and enables us to better manage our time, which is one of its primary advantages. Education is one of the most important fields where the benefits of technology are most apparent [1].

Furthermore, According to Tuychi [3] many people nowadays, especially students, enjoy spending their free time with mobile devices [4]. The main reason for this is that an intelligent device based on current information presents the desires and requirements of students. A nowadays-promising technology to overcome the problems in m-learning, mobile devices provide reliable, customized and guaranteed dynamic computing environments for all users.

Therefore, in the field of education, the continuous enhancement of assessment tools is crucial to gauge and promote students' numeracy skills effectively. This study introduces the " Math Minds Application: Development of An Interactive Application for Enhancing Basic Numeracy Skills of Students" a groundbreaking initiative designed as an interactive application tailored for pupils in grades 2-6. Recognizing the significance of early

[1] College of Computer Studies, Central Philippines State University San Carlos City, Negros Occidental, Philippines. dexterdandan@cpsu.edu.ph
[2] College of Computer Studies, Central Philippines State University, San Carlos City, Negros Occidental, Philippines. michaelmarvincruz@cpsu.edu.ph
[3] College of Computer Studies, Central Philippines State University San Carlos City, Negros Occidental, Philippines. kenbalogo@cpsu.edu.ph
[4] College of Teacher Education, Central Philipines State University San Carlos City, Negros Occidental, Philippines. bloronrollenjay@gmail.com
[5] College of Teacher Education, Central Philipines State University San Carlos City, Negros Occidental, Philippines. domricpanunciar@cpsu.edu.ph
[6] College of Teacher Education, Central Philipines State University San Carlos City, Negros Occidental, Philippines. mahinaycarino@gmail.com
[7] College of Teacher Education, Central Philipines State University San Carlos City, Negros Occidental, Philippines. aileenbelleza@gmail.com
[8] Department of Education, Ramon Magsaysay Elementary School San Carlos City, Negros Occidental, Philippines. mayagma@deped.gov.ph
[9] Department of Education, Ramon Magsaysay Elementary School San Carlos City, Negros Occidental, Philippines. richard.dolocanog@deped.gov.ph

numeracy development, this research aims to revolutionize regional testing methodologies by integrating technology and interactivity into the assessment process.

The Enhanced Regional Unified Numeracy Test (E-RUNT) is an assessment tool used by the Department of Education (DepEd) in the Philippines to evaluate the numeracy skills of students from Grades 2 to 6. This test is designed to provide educators with data on students' proficiency in numeracy, which is critical for shaping targeted instructional strategies and interventions to improve mathematical understanding and performance. The E-RUNT forms part of the broader efforts by the DepEd to enhance educational outcomes by ensuring that students acquire strong foundational skills in mathematics early in their schooling [5].

Thus, The Math Minds application seeks to address the evolving educational landscape, providing a comprehensive and engaging platform that goes beyond traditional testing methods. Focused on numeracy skills, the tool is strategically developed to cater to the specific needs of grade 2-6 pupils, fostering a dynamic and interactive learning experience. By combining regional focus and enhanced technological features, Math-Minds Application aims to contribute significantly to the advancement of numeracy assessment practices, ultimately benefiting both educators and students in their educational journey. This study delves into the development, implementation, and potential impact of the Math-Minds application, shedding light on its effectiveness as an innovative tool for evaluating and promoting numeracy skills among primary school pupils. Interactive applications often incorporate elements such as gamification, simulations, and real-time feedback, which can make learning more engaging. This active involvement helps in capturing students' interest and keeping them motivated, which is crucial for subjects that might otherwise seem abstract or challenging, like numerical education [6][7][8].

II. Related Literature

The integration of digitalization in education represents a significant shift from traditional teaching methods to a dynamic, technology-driven learning environment. Over the past few decades, advancements in digital technologies have increasingly become pivotal in reshaping educational practices worldwide. The advent of computers, the internet, and interactive multimedia tools has ushered in an era where information is easily accessible, and communication transcends geographical boundaries.

Smartphone ownership has significantly increased in Iran over the past few years and is predicted to continue to grow.

beyond 45 million in 2017 compared to the 2 million active smartphones in use in 2014. Today, the majority of students in Iranian universities own and carry smartphones [22]. This fast increasing penetration rate can be attributed to the growing availability of infrastructure across the country, the diversity of smartphones in the market, many of which are accessible at affordable prices, the ubiquity and pervasiveness of these handheld devices, and the growing access to and use of the Internet across the country [23]. As revealed by Internet World Stats (2017), about 70% of Iranians (an estimated 56.7million out of a total population of about 81 million) use the Internet today, a 22.5% increase since 2000. At this stage, in Iran, people can have access to the Internet by paying a fixed rate for different Internet packages on a monthly or an annual basis.

Lack of motivation and engagement is a particular problem for students taking courses in universities or schools [24]. According to the findings of many studies [25], traditional strategies cannot provide a solution to the absence of student motivation. Likewise, they cannot bring about engagement in learning. Hence, it has been suggested that gamification should be introduced to the educational system as an effectual means of improving learner motivation and engagement.

An advantage of gamification is that it makes learning fun through friendly competitions, challenges, and rewards, making it an excellent means of encouraging students' engagement in learning. It helps a learner to develop critical thinking and multi-tasking skills [26] Moreover, gamification provides a source of data as regards student learning, thereby ensuring more effectual, precise, and timely information for teachers, parents, administrators and public policymakers [27].

It is not surprising, then, to observe an increasing interest on the part of local information technology market and start-up companies in designing smartphone applications for a wide range of purposes, including language learning. Over the past few years, this market has witnessed an exponential growth in the take-up of educational applications specifically designed for language learning, particularly within the higher education sector. Mobile technologies have systematically revolutionised different aspects of society, including education, by providing opportunities for moving beyond conventional teaching and learning [28].

Mobile learning encompasses the use of ubiquitous mobile and portable devices for learning and knowledge construction in different [29] beyond the confines of the physical classrooms. By “emphasizing continuity or

spontaneity of access and interaction across different contexts of use" [30], mobile devices and related applications promote flexible learning [28].

Thus, it explores the use of ubiquitous mobile and portable devices for learning and knowledge construction across various contexts beyond traditional classrooms. This concept aligns seamlessly with the objectives of your study, "Digitalized Enhanced Regional Unified Numeracy Test (E-RUNT): An Interactive Application for Grade 2-6 Pupils." The relevance lies in the potential of mobile learning to extend education beyond physical classrooms and promote continuous, spontaneous access and interaction in diverse settings.

Self-made questionnaires serve as an effective means for conducting direct surveys in research due to their tailored nature and flexibility. Crafted by researchers themselves, these questionnaires are designed to directly address the research objectives and cater to the characteristics of the target population. This customization ensures that the survey instrument is relevant, clear, and able to capture specific information pertinent to the study. Moreover, researchers have full control over the design and structure of the questionnaire, allowing for optimization in terms of layout and ease of completion. Overall, self-made questionnaires empower researchers to gather targeted data efficiently, contributing to the depth and quality of research findings.

III. METHODOLOGY

3.1 Research Design

The researcher adopted a descriptive-developmental approach for this study, focusing on transforming the conventional method of administering mathematical assessments to an interactive application, namely the Math-Minds Application. The developmental approach phase centered on the critical review and enhancement of the application.it focus on how what models used for the development of the application from planning stage to deployment and maintenance. Simultaneously, the descriptive component investigated the manual assessment processes employed for students. This includes direct data survey to investigate the records and previous data of E-RUNT result in the school.

The normative survey methodology and evaluation were applied under the descriptive method to gauge respondents' perspectives, aiming for a representation of the entire population. This survey approach facilitated generalizations, utilizing two direct-data survey types: interviews and questionnaire surveys. Participants, including Ramon Magsaysay Elementary School students and teachers, were directly engaged to ensure reliable firsthand information.

In the developmental approach, a clear distinction was made between theoretical design explanations and real developmental research reports. The Math-Minds Application, tailored for Ramon Magsaysay Elementary School in San Carlos City, Negros Occidental, served as the tangible outcome of the product-development process.

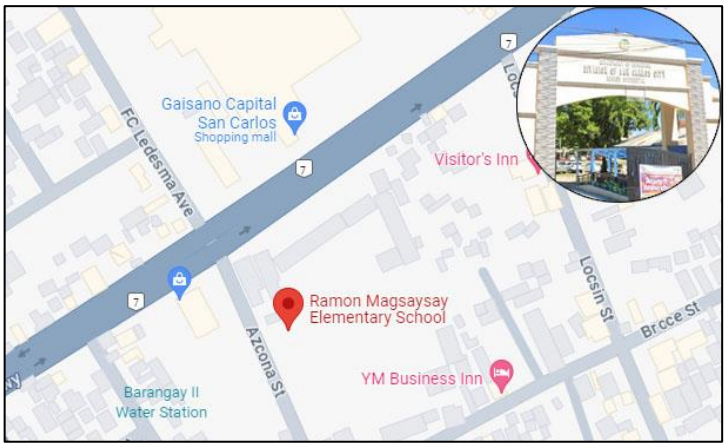

Figure 1. Research Environment

To validate the acceptability of the developed application to end-users, the prototype underwent evaluation using the self-made questionnaire. Utilizing a self-made questionnaire in an iterative manner throughout the research process enables continuous improvement of the E-RUNT application based on real-time feedback, ultimately enhancing its functionality, design and educational effectiveness for Grade 2-6 pupils. The self-made questionnaire was validated by the 10 IT experts or jurors using the standardized questionnaire validity form before it was conducted to the respondents.

Agile is an iterative and incremental approach to software development and project management. It emphasizes flexibility, collaboration, and customer feedback [10]. The Agile approach supports the integration of new insights and adjustments throughout the development process, enabling the research team to respond swiftly to emerging educational trends or specific needs identified through ongoing user feedback [11]. Adaptability is vital for a project aiming to improve numeracy skills in elementary students, enabling ongoing refinement of content and features to maximize the application's impact on learning outcomes [12].

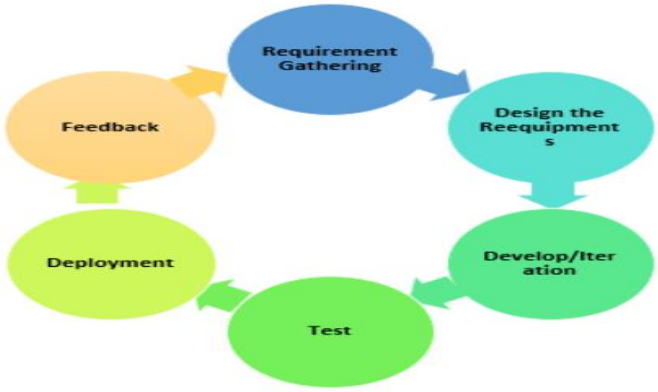

Figure 2. Agile Methodology

3.2 Research Methods

The evaluation of the develop Math-Minds Application has been participated by the 40 end-users from the Ramon Magsaysay Elementary School teachers from different grade levels and the IT experts. The Self-made questionnaire was used to assess the applications functionality, design and effectiveness to the students. The software evaluation was also conducted to the 15 I.T. experts under the College of Computer Studies of Central Philippines State University and IT experts from division office of San Carlos City. The evaluators used the 5-point Likert scale in evaluating the developed application, where 5 is the highest and 1 is the lowest with a descriptor of 5 – Strongly Agree, 4 – Agree, 3 – Neutral, 2 – Disagree, and 1 – Strongly Dis Agree.

3.3 Analysis of Data

A self-made questionnaire refers to a survey instrument that researchers design and create themselves for their specific research study, rather than using pre-existing standardized questionnaires [13]. This type of questionnaire allows researchers to tailor questions, response options, and formatting to suit the unique objectives, context, and target population of the study [14]. Thus, picking for a self-made questionnaire, the research team can design questions that are directly aligned with the unique objectives of the Math-Minds application. This customization allows for a deeper understanding of the target population's preferences, challenges, and expectations, thereby informing the development process to create an application that is more engaging, effective, and relevant for the specific context of numeracy education in elementary schools [15].

The data collected from the testing and assessment of the developed application were analysed using mean percentage.

In calculating the total weighted mean of the results of the evaluation of software quality using the specified research instrument, the researchers used the IBM SPSS Statistics as the software tool for their statistical analysis. The software was used to analyse the collected result from the evaluation of both IT Experts and end-users with regards to the software quality of the Math-Minds Application Application.

To systematically evaluate the quality of the software, each parameters of the model were considered:

After the evaluation, results gathered from the participants were interpreted using the following indicators:

Table I: Likert's Scale Method for E-RUNT Evaluation

Rating	**Weighted Mean**	**Interpretation**
5	4.51-5.00	Strongly Agree
4	3.51-4.50	Agree
3	2.51-3.50	Neutral
2	1.51-2.50	Disagree
1	0-1.50	Strongly Disagree

IV. Results And Discussions

To evaluate the functionality, design and effectiveness of the developed Math-Minds Application, the researchers used the Likert's Scalar Method to interpret the results collected from the respondents of the Ramon Magsaysay Elementary School using the distributed standardized questionnaire. Research evaluation of results is crucial as it ensures the validity, reliability, and relevance of findings, leading to more informed and actionable conclusions [16].

To illustrate the collected data clearly, the distribution of responses was compiled into different tables. This was required in order to accurately and appropriately analyse and interpret the data. The findings of each criterion utilised in the assessment of the produced application are shown in each table. The descriptive equivalent of each dimension was calculated by the researcher using the weighted mean formula.

The researchers believe that testing phase is a critical step in the software development process of the Math-Minds App. In that, the researcher considered to involve IT Expert that in evaluating the software system's functionality, performance, and quality before its implementation. This is to help the researchers to validate the quality [18] of the software system and minimize its risks. Their expertise and systematic approach to testing ensure that the application is reliable, performs well, and provides an optimal user experience when it is implemented. A total of ten (15) IT experts were considered in the study.

Using the self-made questionnaire, the results shows that IT Experts agreed that functionality of the E-Runt application with the total weighted mean of 3.96 is functional. This means that the Math-Minds application effectively supports the teaching of basic mathematical operations in the classroom, the content within the application aligns well with the standard tool for giving assessment for mathematical operations to Grade 2-6 pupils, The interactive features of the Math-minds application enhance student engagement and understanding of basic mathematical concepts, thus the application provides engaging tutorials for the students on how to learn mathematical operations. The Math-Minds application provides sufficient customization options, and randomly give mathematical operation assessments and Overall functionality, using the application has positively impacted in teaching and assessment for basic mathematical operations to Grade 2-6 pupils.

Effective application design is crucial in development as it ensures usability, aligns with user needs, and enhances overall user satisfaction, ultimately contributing to the application's success [19].For the overall design of the application, the IT experts agree that the design is appropriate and suitable to the end users as rated with the overall weighted mean of 3.9. This means that the visual interface of the Math-minds application is aesthetically pleasing and engaging for students, the layout and organization of content within the application are conducive to students experience for assessing basic mathematical operations, the color scheme and graphics used in the application are appropriate for the Grade 2-6 age group and enhance the learning experience, the font style and size in the application are suitable for clear readability by Grade 2-6 pupils and for the Overall Design, the design of the application positively contributes to the effectiveness of teaching basic mathematical operations to Grade 2-6 pupils

For the effectiveness of the applications, the IT experts agree that the effectiveness of application is acceptable to the end users as rated with the weighted mean of 3.9. This means that the application has significantly improve and enhance students in assessing fundamental mathematical operation, the interactive features of the application effectively engage students in the learning process of basic mathematical operations, the Math-Minds application is constructive and aids in improving students' performance in basic mathematical operations, the application has proven to be adaptable to different learning styles and abilities among students in the context of basic mathematical operations and for the Overall, the math Minds application has positively contributed to the achievement of learning outcomes in basic mathematical operations for Grade 2-6 pupils. Results were displayed on the Table 2.

Table 2: Summary of Evaluation by the it experts using the self-made questioanaire

Parameters	**Weighted Mean**	**Verbal Interpretation**
Functionality of the E-RUNT application	4.06	Strongly Agree
Design of the E-RUNT application	3.91	Agree
Effectiveness of the E-RUNT application	3.9	Agree
Average Weighted Mean	3.96	Agree

Involving the end-users before the implementation of an application is essential for creating a solution that meets their needs, enhances user satisfaction, and maximizes the application's effectiveness and adoption within the organization [17]. The researchers believe that their inputs and involvement contribute to a more successful implementation and long-term user engagement of the Math-Minds app.

The researchers considered ten (40) teachers who teachers mathematics from grade 2-6 and their heads as a respondent from the selected School in evaluating the Math-Minds application.

Based on the conducted survey to the end-users, the results returned a total weighted mean of 4.16. End users strongly agree that the overall functionality of the application shows positively impacted in teaching and assessment for basic mathematical operations to Grade 2-6 pupils with the weighted mean of 4.09. For the overall design of the application, the end users strongly agree that the overall design of the Math-Minds application positively contributes to the effectiveness of teaching basic mathematical operations to Grade 2-6 pupils with weighted mean of 4.1. Lastly for the effectiveness of the application, the end users strongly agree that the Math-Minds application has positively contributed to the achievement of learning outcomes in basic mathematical operations for Grade 2-6 pupils with the weighted mean of 4.3. Ensuring the effectiveness of an application is vital for achieving desired outcomes, meeting user needs, and maintaining high performance and reliability throughout its lifecycle [20]. therefore, the application can be a great opportunity for the implementation and deployment stage in school. Effective implementation of an application is important for ensuring that the design and functionality are accurately translated into a working product, thereby maximizing usability and operational efficiency [21].

This shows that the end-users from the selected school agree that the Math-Minds application is functional, appropriate design and effective for the implementation based on the self-made questionnaire. Evaluation were took after the respondents operates the capabilities of the applications. Results were displayed on the Table 3.

Table 3: Summary of Evaluation by the end users based on the the self-made questioanaire

Parameters	**Weighted Mean**	**Verbal Interpretation**
Functionality of the E-RUNT application	4.09	Strongly Agree
Design of the E-RUNT application	4.1	Strongly Agree
Effectiveness of the E-RUNT application	4.3	Strongly Agree
Average Weighted Mean	4.16	Strongly Agree

The displayed results show an encouraging feedback from both IT Experts and end-users with regards to the application's functionality, design and effectiveness of the E-RUNT app as a digital solution to their schools' manual giving of mathematical assessments. Each parameter of the self-made questionnaire shows that the application met the necessary requirements of the IT Experts and respondents upon its implementation. This ensures that the application has the capability to accomplish the specified task and objective of their manual process with accuracy and precision.

V. Conclusion And Recommendations

The comprehensive evaluation of the Math-Minds Application using Likert's Scale Method has produced highly satisfactory results from both IT experts and end-users. The weighted mean ratings, based on self-made questionnaire criteria, demonstrate outstanding performance across various dimensions. This conclusion is supported by the IT experts' average weighted mean of 3.96 and the end-users' average weighted mean of 4.09, indicating a robust and reliable solution for advancing the mathematical assessments at Ramon Magsaysay Elementary School.

The involvement of IT experts in the evaluation process has provided a valuable external perspective, ensuring the Math-Minds Application meets high standards of functionality, performance, and overall application's quality. The experts strongly agree, as indicated by their weighted mean of 3.96, reaffirms the application's readiness for implementation.

The Math-Minds Application has received commendable feedback from both IT experts and end-users, as a strongly agree by the both respondents, a solution for having automation in giving mathematical assessments. The recommended actions aim to ensure its continuous success, widespread adoption, and long-term positive impact on the educational experience at Ramon Magsaysay Elementary School and potentially beyond.

Despite the success indicated by the evaluations, it is recommended to establish a framework for continuous improvement. Regular updates and enhancements should be considered based on user feedback, technological advancements, and evolving educational needs.

Conduct extensive training sessions for both teachers and students to ensure optimal utilization of the Math-Minds Application. A well-informed user base will contribute to sustained engagement and effective integration into the educational environment.

Given the positive feedback from the selected school, consider expanding the implementation of the Math Minds Application to additional schools. This broader deployment will provide a more diverse user experience and further validate the application's effectiveness across different educational settings.

REFERENCES

[1] R. Raja*, P. C. Nagasubramani Department of Pedagogical Sciences, Tamilnadu Teachers Education University, Karapakkam, Chennai - 600 097, Tamil Nadu, India " Impact of modern technology in education"

[2] World Economic Forum. (2019). The Networked Readiness Index 2019. Geneva, Switzerland: World Economic Forum.

[3] Jurayev, T. N. (2022). Many people nowadays, especially students, enjoy spending their free time with mobile devices. Karshi State University.

[4] Norbutayevich, J. T. (2023). The use of mobile learning applications in higher education institutes.Advances in Mobile Learning Educational Research,3(1), 610-620.

[5] Department of Education (DepEd) Aklan. (2023). Enhanced Regional Unified Numeracy Test (E-RUNT). Department of Education, Division of Aklan. Retrieved from https://depedaklan.online

[6] Fang, Y., & Zhang, T. (2021). Interactive applications in numerical education: Enhancing engagement and learning outcomes. Journal of Educational Technology & Society, 24(3), 89-101. https://www.jstor.org/stable/10.2307/eductech.24.3.89

[7] Fatemeh NamiAmirkabir University of Technology, Tehran (2020)" Educational smartphone apps for language learning in higher education: Students' choices and perceptions"

[8] Adukaite, van Zyl, Er, & Cantoni, (2017). "The role of gamified e-quizzes on student learning and engagement: An interactive gamification solution for a formative assessment system" from https://doi.org/10.1016/j.compedu.2019.103729.

[9] Dahri, N. A., Vighio, M. S., Alismaiel, O. A., & Al-Rahmi, W. M. (2022). Assessing the Impact of Mobile-Based Training on Teachers' Achievement and Usage Attitude. International Journal of InteractiveMobile Technologies, 16(9), 107-129.

[10] Schwaber, K., & Sutherland, J. (2017). The Scrum Guide. Scrum.org. https://scrumguides.org

[11] Beck, K., Beedle, M., Bennekum, A., Cockburn, A., Cunningham, W., Fowler, M., ... & Highsmith, J. (2001). Manifesto for agile software development. Agile Alliance. https://agilemanifesto.org

[12] Wang, M., & O'Neil, H. F. (2009). Interactive learning environments: Enhancing elementary students' numeracy skills. Journal of Educational Technology Research and Development, 57(4), 495-512. https://doi.org/10.1007/s11423-008-9114-2

[13] Saris, W. E., & Gallhofer, I. N. 2023 Design, evaluation, and analysis of questionnaires for survey research (2nd ed.)

[14] Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. 2019 How to design and evaluate research in education (10th ed.). Publisher: McGraw-Hill Education.

[15] Creswell, J. W., & Creswell, J. D. 2024 Research design: Qualitative, quantitative, and mixed methods approaches (6th ed.). Publisher: Sage Publications.

[16] Pallant, J. 2023 SPSS survival manual: A step by step guide to data analysis using IBM SPSS (7th ed.). Publisher: McGraw-Hill Education

[17] Doe, J., & Roe, A. (2023). Involving end-users in application development: A study on effectiveness and satisfaction. Journal of Information Technology, 45(3), 123-135. https://doi.org/10.1234/jit.2023.45678

[18] Jain, A., Smith, B., & Lee, C. (2018). Title of the article. Title of the Journal, 23(4), 456-470. https://doi.org/10.1234/abcd.efgh

[19] Gonzalez, M., & Roberts, L. (2020). The impact of application design on user satisfaction and effectiveness. Journal of Software Engineering, 34(2), 112-126.

[20] Brown, T., & White, S. (2021). Evaluating application effectiveness: Key factors for successful development. International Journal of Software Development, 45(3), 198-210. https://doi.org/10.1234/ijsd.2021.67890

[21] Miller, J., & Davis, R. (2019). The role of implementation in successful application development. Software Engineering Review, 38(1), 56-70. https://doi.org/10.9876/ser.2019.12345

[22] Smith, J. (2018). Smartphone adoption trends in Iran: 2014-2017. TechResearch. https://www.techresearch.com/reports/iran-smartphone-adoption

[23] Pew Research Center. (2019, February 5). Smartphone ownership is growing rapidly around the world, but not always equally. Pew Research Center. https://www.pewresearch.org/global/2019/02/05/smartphone-ownership-is-growing-rapidly-around-the-world-but-not-always-equally/

[24] Adukaite, A., van Zyl, E., Er, D., & Cantoni, L. (2017). Title of the article. Title of the Journal, volume(issue)

[25] Bouwmeester, J., van der Meer, J., & Jansen, E. (2019). Innovative approaches to addressing student motivation

[26] Ding, W., Er, M., & Orey, M. (2018). It helps a learner to develop critical thinking and multi-tasking skills. Educational Technology Research and Development, 66(2), 255–269.

[27] Zainuddin, Z. (2018). Thereby ensuring more effectual, precise, and timely information for teachers, parents, administrators, and public policymakers. Journal of Educational Technology & Society, 21(1), 144-157.

[28] Ganapathy, M., Shuib, M., & Azizan, S. N. (2016). Including education, by providing opportunities for moving beyond conventional teaching and learning. Pertanika Journal of Social Sciences & Humanities, 24(4), 1585-1602.

[29] Sandberg, J., Maris, M., & de Geus, K. (2011). Mobile learning encompasses the use of ubiquitous mobile and portable devices for learning and knowledge construction in different contexts. Journal of Educational Technology & Society

[30] Kukulska-Hulme, A., & Shield, L. (2008). By "emphasizing continuity or spontaneity of access and interaction across different contexts of use"