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RESEARCH ARTICLE

BEsMART: Board Examinations Mobile Application Reviewer for Pre-Service Science Teachers using Space Repetition and Hypercorrection

Nestor L. Lasala Jr[1*], Jonel B. Prado[2], Noemi D. Dioneda[3], Jhonner D. Ricafort[4]

[1,2,3,4] Sorsogon State University Magsaysay Street, Sorsogon City, Sorsogon, 4700 Philippines

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***Corresponding Author:**

nestor.lasala@sorsu.edu.ph

ABSTRACT

This study developed and validated BEsMART, a mobile review application for pre-service science teachers preparing for the Licensure Examination for Teachers (LET). Addressing challenges such as high review costs, inconsistent study habits, and concept retention difficulties, BEsMART integrates spaced repetition for memory retention and hypercorrection techniques to correct misconceptions. Other features include question-based drills, multimedia resources, instant feedback, and progress tracking. A mixed-method research design was employed, combining ISO/IEC 25010 standards, the U.S.E. Questionnaire, and qualitative feedback from 9 experts and 48 pre-service teachers. Using the Scrum methodology, the application underwent iterative development to enhance usability. Results showed high functional suitability, usability, and reliability, with overall ratings of 4.72 (experts) and 4.75 (users). Findings confirm BEsMART's effectiveness as a self-directed, accessible, and cost-efficient LET review tool, reinforcing mobile learning's transformative potential in professional examination contexts and paving the way for future improvements and broader adoption.

1.0. INTRODUCTION

In the Philippines, passing the Licensure Examination for Teachers is one of several requirements for obtaining and keeping a teaching license (Libman, 2009). The LET, or Licensure Examination for Teachers, is a standardized test of the knowledge and ability of prospective teachers in order to offer a trustworthy structure against which their practice may be tested and confirmed and to allow access to further professional development. In addition, the results of certification exams are used to evaluate educational institutions and their programs. An excellent program will have a high percentage of its students pass on their first try (Professional Regulation Commission CHED, 2004).

When it comes to the actual license exam, however, most teacher preparation programs in the Philippines perform poorly, as reported by the Philippine Business for Education, according to a March 2014 Rappler Philippines report (PBED). According to the results of their latest investigation, the vast majority of schools that prepare teachers fail to meet the national test-taker passing rate. Moreover, students' difficulties with science coursework, specifically, often translate into subpar performance in the classroom and on standardized tests. Teachers-in-training who struggled in arithmetic as students must take remedial courses offered by schools and review centers to improve their skills. Likewise, results on the LET have been shown to be considerably influenced by participation in LET review classes, according to several studies (Visco, 2015; Ferrer et al., 2015; De Guzman et al., 2020). For this reason, Kalaw (2018) advocated for mandatory heightened LET review for future educators. Salundaguit (2018), advocated for a re-evaluation of teacher education regulations, including those pertaining to student admissions and retention, faculty dedication, and the implementation of practice tests.

Most of our newly minted educators then enroll in review courses in preparation for the board examination. However, some graduates take a break from school-related activities and put off studying for the board test, which could affect their performance on the exam later. The time that passes between studying for an exam and taking the exam itself may have an impact on how well you remember the material covered. The Decay Theory states that as time passes, our ability to recall past experiences and facts declines. According to this notion, our propensity to forget increases over time. As a result, memories fade over time (Brown, 1958). Similarly, if you do not take the time to examine and internalize the information and ideas you learn, you will inevitably forget them. Furthermore, review courses are not cheap and demand commitment. Exam resources are expensive and not gratis. The reviewer must also devote substantial time to the schedule of review classes. Thus, time is essential for learning and practicing scientific concepts.

To address this, keeping abreast with the demands of society today is necessary, and with the advancement of science and technology along with globalization, the way we learn nowadays has been reshaped and completely different (Umamah et al., 2016; Ma'rifatullah et al., 2021; Pinatil & Ramos, 2023). Various software and applications can be used to reorganize review material that has previously been presented in textbooks and permit students to visualize the material in a new way (Demuyncк & Laureys, 2002; Bord, 2008). That is the foundation of Education 4.0 and the model for education in the twenty-first century. It is imperative that universities and colleges continue to adopt and implement cutting-edge forms of instruction if they hope to maintain their current levels of graduate success (Halili, S. H., 2019; Joshi, N. 2022). Students learn not from technology but with technology when they are exposed to exciting technologies in contexts where they may make real progress in their education (Lee, 2017; Ma'rifatullah et al., 2021).

In conjunction, mobile phones are one of the most portable forms of technology (Prensky, 2005), an emerging trend that expands beyond the traditional classroom constraints and allows for around-the-clock access to course materials anytime, anywhere, and at any place (Malavolta et al., 2015; Ghasia, 2019; Barker, Krull, and Mallinson, nd; Crompton, 2013; Kuimova et al.,2018). According to Klimova (2019) and Gangaiamaran (2017), mobile device's accessibility and interactivity support personalized learning in a variety of settings, as well as connections to peers and teachers in casual and formal settings. In addition, mobile learning has the potential to improve educational outcomes thanks to advances in mobile technology, as well as the development and incorporation of a wide range of applications for use in syllabi and other review activities (Alexander, 2004; Chen, 2013). Likewise, multiple studies have found that mobile applications enhance students' motivation to learn and retain new information due to their accessibility and potential for immediate and interactive feedback (Klimova, 2018; Bachore, 2015). With these in mind, the researchers hope to include the findings of various studies in the field of learning and memory with these tools, which suggest that people retain knowledge better if they read it once and then try to recollect it rather than re-reading it multiple times (Roediger & Butler, 2011; Roediger & Karpicke, 2006). Spaced-repetition testing is a technique for improving long-term memory retention by gradually increasing the amount of time that elapses between each test of recall (Roediger & Butler, 2011). Similarly, learners cannot rectify their misconceptions without receiving feedback, and when a learner has a high degree of certainty in his perspective, such feedback may be the most useful. The hypercorrection effect refers to the seemingly counterintuitive observation that learners are more likely to correct a misperception they hold with high confidence than a misconception they hold with low confidence after receiving feedback indicating they do, in fact, hold that misconception (Butterfield & Metcalfe, 2001; Eich et al., 2013).

It is in this context that this study was conducted. The researchers find it vital to develop a mobile application reviewer, BEsMART (Board Examination Mobile Application Reviewer for pre-service science education teachers using hypercorrection and space repetition), specifically designed to help and support pre-service science education teachers in preparation for the Licensure Examination for Professional Teachers (LEPT). Recognizing the need for accessible, practical, engaging study tools and quality resources, this study focused on creating an interactive reviewer mobile application that may enhance learning and provide a comprehensive array of evaluation questions aligned with the Professional Regulatory Board for Teachers Resolution No. 11, series of 2022, also known as Issuance of the Enhanced Table of Specifications (TOS) for the Subjects of the Licensure Examination for Professional Teachers, specifically the TOS for Secondary-Science Pre-service teachers.

2.0. METHODOLOGY

2.1. Research design

This study utilized a mixed-methods approach, combining qualitative and quantitative techniques, specifically a Sequential Explanatory design. This involved collecting quantitative data and then using qualitative data to explain those findings (Toyon, 2021). This balanced the weaknesses of both approaches and allowed for a more comprehensive data analysis. A quantitative approach was used to evaluate the result of the validation of experts and pre-service science education teachers. Moreover, a series of interviews were conducted to support the findings of the study, which were analyzed, interpreted, and presented using a qualitative approach (Lasala, 2023; Ahmad et al., 2019). Inter-reliability test scores were also employed in the study to ensure the consistency of the data gathered.

In the development of the mobile application, the framework used in the study of Ayuningsih et al. (2023) was adopted. The framework is composed of several stages, such as literature review, problem identification and needs analysis, application development, results analysis, and conclusion. Central to this framework is the scrum methodology integrated into the application stage. This methodology was chosen due to its capability to support an iterative approach offering speed, adaptability, efficiency, and flexibility (Masood Z. et al., 2020), and is recognized as one of the best for software development methodology, offering a practical approach to following best practices (Chua et al., 2021). Moreover, it ensures a secure and transparent environment that fosters continuous progress, minimizing resource waste, is designed to adapt to changes, no matter how challenging, and ensures smooth transitions throughout the development process (Chantil, S., & Essebaa, I., 2021). The scrum methodology consists of several stages, which include determining the product backlog, creating a sprint planning and sprint backlog, conducting a sprint review, and a retrospective sprint. Figure 1 shows the framework used in the study.

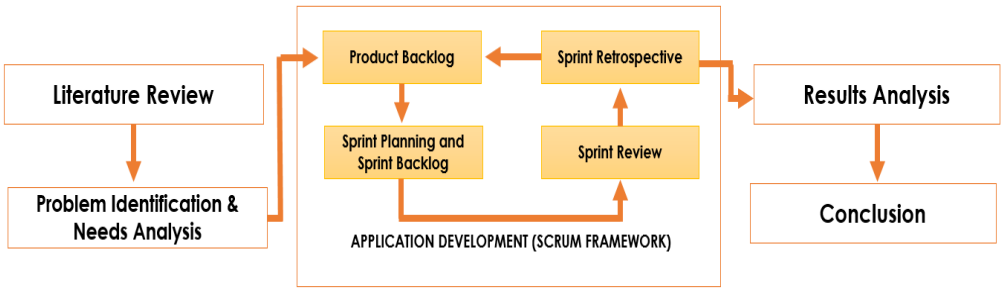


Figure 1: The framework used in the study adopted from Ayuningsih et al., (2023)

A systematic review of research on mobile learning, Education 4.0, and task-technology fit models was conducted in the initial stage in order to identify gaps in developing a LET-aligned mobile review app for pre-service science teachers. While mobile learning enhances accessibility and knowledge retention (Klimova, 2019; Bachore, 2015), few studies address science-focused LET preparation. The need for instant feedback and iterative testing, proven to improve standardized exam performance (Roediger & Butler, 2011), underscores the significance of this research in developing a specialized reviewer to enhance mastery and exam readiness.

Following the initial stage is the conduct of Surveys, interviews, and focus group discussions for the problem identification. It needs an analysis phase with pre-service teachers, faculty, and review center representatives to identify key challenges: high review costs, inconsistent preparation, knowledge retention issues, and limited real-time assessments (Gall et al., 2007; Torp & Sage, 2002). Many students struggled with structured study schedules due to financial constraints, making traditional programs inaccessible. The lack of real-time feedback led to persistent misconceptions, affecting exam performance. Findings guided BEsMART's design, incorporating spaced-repetition quizzes for retention, hypercorrection feedback for immediate explanations, and on-demand lectures and review materials aligned with the LET Table of Specifications (TOS). A performance-tracking dashboard was also integrated to help students monitor their progress. These features ensure an affordable, structured, and effective review platform addressing academic and logistical barriers in LET preparation.

Then, the Application Development began using the Scrum framework for agile development, allowing iterative improvements based on user feedback. The process included a Product Backlog, which identified essential features based on needs analysis. Sprint Planning – Organized tasks into manageable development cycles, such as designing spaced-repetition quizzes and performance tracking. Sprint Development – Created prototypes using Figma for UI design, Android Studio for mobile development (Boza et al., 2021), and PHP for back-end functionalities (Barlun, 2008). Java was the primary programming language due to its adaptability and cross-platform support (Armasha et al., 2021). Usability testing involved black box testing for functionality and user acceptance testing (UAT) with 48 pre-service science teachers using Lund's U.S.E. Questionnaire. Evaluation by experts followed ISO/IEC 25010 standards, ensuring quality in usability, security, and performance (ISO, 2024), and Sprint Review & Retrospective – User feedback refined app features. Identified improvements included enhancing Hypercorrection for real-time feedback and incorporating animated video explanations for engaging content. The Scrum approach allowed quick adaptation to changes in exam structure and content, ensuring continuous improvement.

Finally, the result analysis and conclusion, where a mixed-methods approach was used, integrate quantitative statistical analysis and qualitative insights from expert and user feedback. Mean values from ISO/IEC 25010 and the U.S.E. Questionnaire ensured the app met the required standards. Interrater reliability tests validated expert evaluations, while qualitative reflections provided user experience insights. This rigorous validation process refined BEsMART to align with pre-service teachers' needs, enhancing LET preparedness while ensuring affordability and accessibility.

2.2. Respondents

A purposive sampling technique was employed to evaluate the developed BEsMART. A panel of nine experts consisting of science professors, education program supervisors in science, master teachers in science, and content and media experts evaluated the application. Meanwhile, forty-eight third and fourth-year pre-service science education teachers enrolled in the school year 2024-2025 in one of the higher education institutions in Sorsogon, Philippines, served as the student evaluators of BEsMART and the primary respondents of the study. This method ensured the selection of participants with relevant qualifications, aligning with the study's objectives. In addition, to account for possible survey attrition, fifty-five pre-service science education teachers were invited to participate in the testing and evaluation of the BEsMART. Survey attrition happens when participants of the study either choose not to participate or do not complete the survey (Hochheimer et al., 2016). Likewise, participants were selected because they had at least 85% to 100% of the coursework completed and participated in the institution's series of in-house review programs in preparation for their board examinations. This background was deemed crucial by the researchers, making them ideal respondents of the study as they possess relevant knowledge and skills and are primary beneficiaries of the application's intended purpose.

2.3. Research instruments

The researcher utilized different research instruments to collect relevant data for the study and to ensure a comprehensive evaluation of the BEsMART application.

ISO/IEC 25010 Software Product Quality Questionnaire (ISO, 2024). This adapted evaluation questionnaire was utilized to assess the software's quality based on internationally recognized standards. In this study, expert evaluators, including content and media specialists, assessed the application using this tool across eight key attributes: functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability.

U.S.E. Questionnaire (Lund, 2001). This was used to measure the user experience of pre-service science education teachers. This tool evaluates four aspects: Usefulness, Ease of Use, Ease of Learning, and Satisfaction. It was administered to 48 pre-service teachers who participated in the study, and their responses were statistically analyzed to determine the application's effectiveness as a mobile review tool. To further ensure consistency in expert and user evaluations, percentage agreement reliability (Lasala, 2023) was employed.

Journal Logs and Interview Guide Questions. User feedback was gathered through interviews, comments, and rater journal logs to provide deeper insights into the application's functionality and usability. The content analysis method was applied to categorize responses and identify recurring

concerns, suggestions, and usability challenges. In addition, journal logs maintained by raters documented real-time observations, including user difficulties, system errors, and feature recommendations, reinforcing the findings from the quantitative analysis.

2.4. Data gathering procedures

To follow ethical procedure, a formal letter was sent to the President of a public higher education institution in Sorsogon, Philippines, asking permission to conduct the said undertaking. The letter contains detailed information about the study, including its objectives and purpose. Likewise, an informed consent form was given to the participants before the study was conducted. To access the prototype mobile application, a link was created for the respondents; then, they were instructed to download and install it on their mobile phones. Prior to this, to ensure that the application is free from viruses, the researchers run the applications through reputable antivirus software, conduct initial testing using several devices, and perform code reviews focusing on the security best practices and potential vulnerabilities. Once installed, a data privacy statement will ask and inform the respondents on how their data will be collected and protected. If granted permission, the respondents were asked to use the application as if they were already preparing for their board examination, dedicating four weeks to explore its functions thoroughly. Then, an evaluation questionnaire was provided, and they were asked to complete it via the Google form link. Moreover, they were also tasked to write about their learning experiences, problems, glitches, errors, and issues encountered, and follow-up informal interviews were done.

Likewise, the researchers assured the respondents that all the data, information, and feedback collected would be treated with utmost confidentiality. A data privacy statement compliant with the Republic Act No. 10173, also known as the Data Privacy Act of 2012 of the Philippines, was provided immediately after the installation process. The statement informed the users that the app will collect personal data, educational, usage, and location data to enhance its services, provide support, improve performance, and ensure compliance with legal requirements. At the end of the data privacy statement, users were required to choose whether to agree or not before proceeding to the application. Furthermore, participants were informed that their participation in the study was entirely voluntary and that they had the right to withdraw at any time without facing any consequences. Meanwhile, the researchers asked permission from the rightful owners of the various learning materials, such as educational videos and review materials, that their work would be part of the BEsMART and declared that it would be solely used for educational purposes. Their works were also adequately cited and acknowledged in the application. The researchers took these measures to promote transparency, build trust, and make the respondents feel comfortable while engaging in the study.

2.5. Data analysis and statistical treatment

This study employed descriptive statistics and analysis for quantitative data. Descriptive statistical tools such as standard deviation, mean, and frequency percentage were used to describe the rating of experts and students for the developed BEsMART. Percentage agreements were also utilized to determine consistency among the evaluators. Descriptive interpretation was employed to analyze and interpret the results. For the qualitative data obtained through interviews and journal logs, thematic analysis was employed to find patterns in data gathered to support findings from quantitative data (Nowell et al., 2017).

3.0. RESULTS AND DISCUSSIONS

3.1. Development of the board examinations mobile application reviewer for pre-service science teachers (BEsMART)

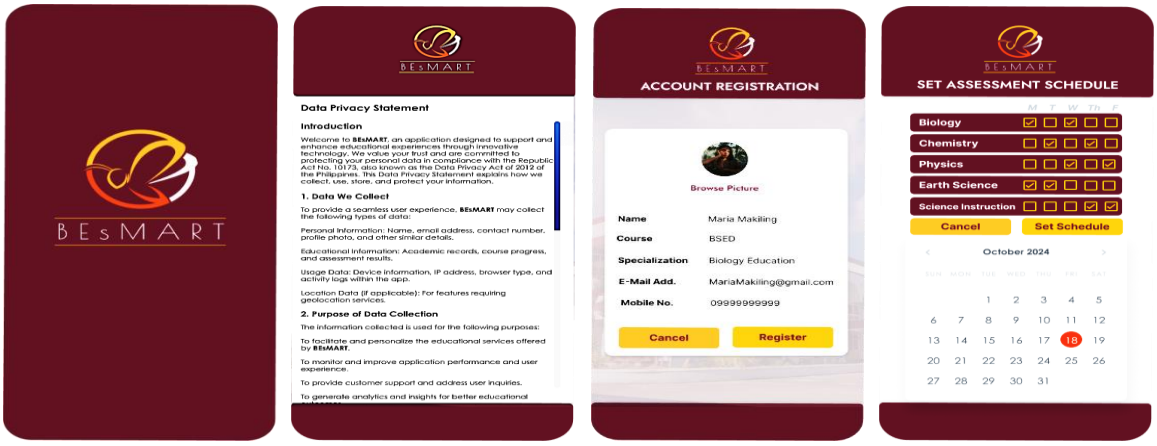
The prototype BEsMART application was created to have two primary interfaces, each serving different functions. However, both are important to ensure efficient user interaction, accessibility, usability, and alignment of content to the table of specifications for LET.

3.1.1. BEsMART: Student interface (mobile application)

The student interface (mobile application) provides seamless access to the different modules or features of the developed application. BEsMART's student interface has three primary modules:

account registration and application settings management, educational review materials, and examination and statistical analysis.

For user authentication, the welcome screen greets the user with the app's name, a bee-inspired logo, and a maroon-colored background representing the researchers' institution, as shown in Fig. 2 (a). These designs were carefully selected by the researchers not just to make the BesMART visually appealing but to represent essential qualities for success in taking the LET. The Bee logo symbolizes students' tireless determination and diligence, just like a bee's relentless work ethic. At the same time, the maroon-colored background signifies the institution's wisdom and commitment to supporting students in achieving their dreams, which is often associated with color. Now, upon installation, a data privacy statement will appear (shown in Fig. 2.b), asking permission from the users and informing them about how their personal information is collected, stored, and protected. Once granted, students register by inputting their personal information (profile picture, identification number, name, course, specialization, and email address), as can be seen in the registration screen in Fig. 2 (c). Afterward, the students can access their accounts and explore other features of the mobile app. They are then prompted to set their preferred exam schedule, selecting up to two exam sessions per week, excluding weekends, with intervals that gradually increase. This feature follows the principles of spaced repetition; that is, by scheduling review sessions at progressively increasing intervals, the retention of information improves (Seibert Hanson & Brown, 2020). The students will also set specific days to take exams for the five major science subjects in the LET: Biology, Chemistry, Physics, Earth Science, and Science Instruction, as displaced in Fig. 2 (d). Additionally, students can personalize, manage, and configure the account by adjusting the settings based on the user's preference, such as sounds, profile information, and exam schedules.



(a) Welcome Screen (b) Data Privacy Statement (c) Registration (d) Exam Schedule

Figure 2: BEsMART: Student Interface for account registration and configuration settings.

(a) Review Material Menu (b) Review Material in PDF (c) Sample Video Material

Figure 3: BEsMART: Student interface for educational review materials

Another feature of the BEsMART application, which is probably one of the most important, is the Assessment Module (Fig. 4.a). This is where the review proper will start after setting the schedule and choosing the number of items to take per subject. Here, BEsMART presents a randomized set of multiple-choice questions patterned from the same type of test used in the board examination (Fig.4.b). These tests were developed by researchers based on the enhanced table of specifications for LET of pre-service science education teachers and undergo a process of validation. When taking the test using the BEsMART, the instruction is to choose the letter of the best answer by clicking the bar of their chosen answer. The app will then immediately respond if the student gets the correct answer by turning the bar green and showing the word 'correct' on the screen, as shown in Fig. 4 (c). Meanwhile, if the student does not get the answer correctly, an incorrect icon will be displayed along with the corresponding feedback (Fig.4.d). It is in this sense that the hypercorrection techniques are applied in BEsMART. The hypercorrection effect happens when a student receives feedback showing they have a misconception, and those held with high confidence are more likely to be corrected than those with low confidence (van Loon et al., 2015). According to Metcalfe et al. (2012), this phenomenon occurs because students are often surprised when a high-confidence answer is wrong, which captures their attention. As a result, they tend to focus more on the correct information given in the feedback, leading to a better correction of the misconception. Likewise, studies show that immediate feedback is effective in helping students remember correct answers on future tests (Carpenter et al., 2018).

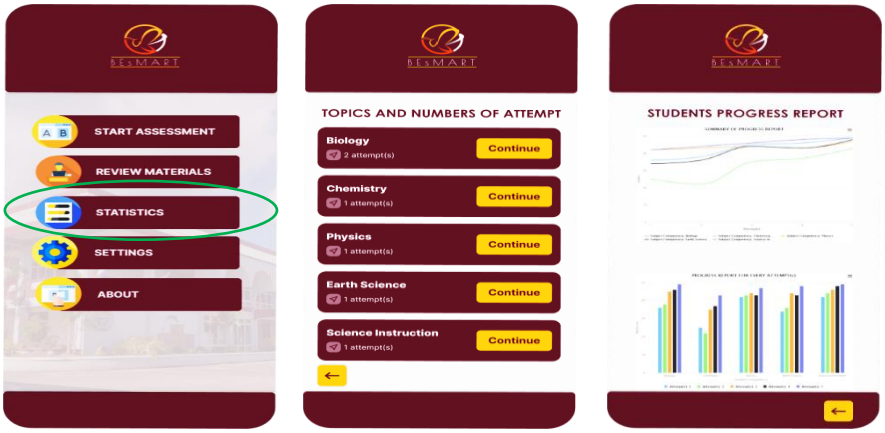
In addition to Hypercorrection, the principle of spaced repetition was also integrated into the application, from which questions that were previously answered incorrectly will reappear first after increasingly extended intervals, allowing the students to focus on areas or concepts that need improvement. In contrast, questions answered correctly will appear less frequently and will gradually fade as students show mastery of the concepts. In this case, retention of information improves because of the continuous lengthened delay in the appearance of the questions answered incorrectly (Roediger III & Butler, 2011). This was further supported by several studies that claim space repetition as an effective study technique for improving long-term memory retention through timed review intervals (Seibert Hanson & Brown, 2020; Kang, 2016), which is also effective for both recalling studied material (Amiri et al., 2017; Reddy et al., 2016) and correcting misconceptions (van Loon et al., 2015; Ecker et al., 2011).

With these techniques integrated into BEsMART, the app may offer a unique and powerful review experience for the users in preparation for the LET. Spaced repetition helps strengthen students' retention of information by systematically revisiting challenging topics over time. Meanwhile, hypercorrection effects deliver immediate feedback to correct misconceptions. Together, these techniques support a more targeted, efficient, and engaging review experience, enabling students to prepare for LET with confidence and mastery.

(a) Assessment Menu **(b) Multiple-choice Question** **(c) Correct Answer** **(d) Wrong Answer**

Figure 4: BEsMART: Student interface for assessment module

Once the student is done taking the test, the Progress Tracking feature of BEsMART will display comprehensive statistics of the result, as indicated in Fig.5. The progress displayed in a line graph provides a visual presentation of the scores obtained by the students on each subject and for every attempt, allowing the student to track performance over time. In addition, the application can show the detailed attempt history, displaying each attempt along with detailed information on correctly and incorrectly answered questions. Moreover, BEsMART enables students to send their assessment records directly to the admin; with this, the admin can review the data and can use it to support the student further, ensuring an efficient communication channel between them.



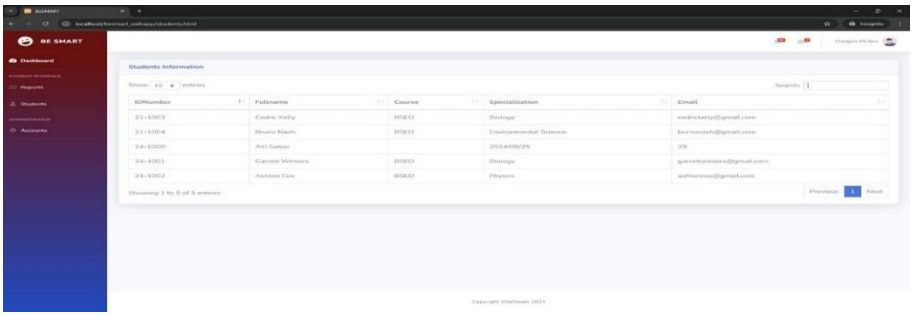
a) Statistics Menu **(b) Summary of Attempts** **(c) Review Report**

Figure 5: BEsMART: Student interface for review result and statistical analysis

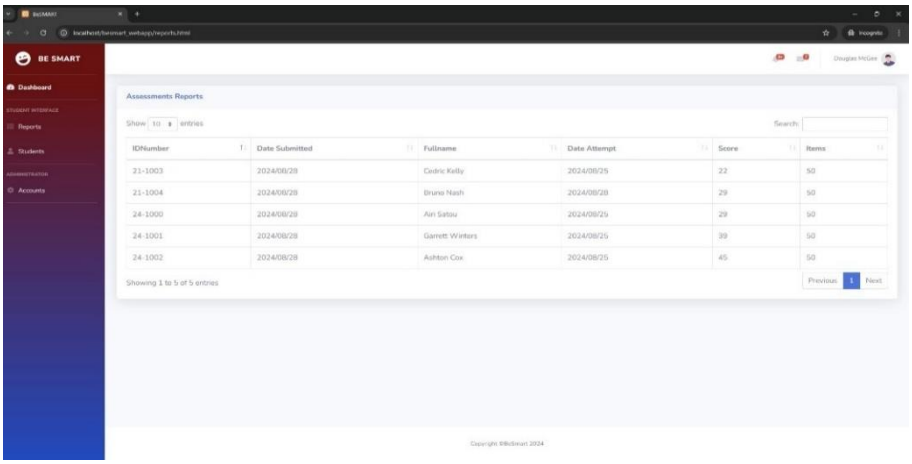
3.1.2. BEsMART: Admin interface (web application)

The admin interface is a web application developed and designed to streamline student progress tracking through these four modules: Student Management, User Account Management, Assessment Report Management, and Dashboards. For student management, BEsMART allows the admin (Instructors or Teachers) to efficiently add, manage, and update students' information (like ID number, full name, course, specialization, and email) and records as needed, keeping them up-to-date, as shown in Fig. 6 (a). Because this streamlines management, the admin can tailor support for students preparing for LET, aligning the guidance with students' academic backgrounds and needs.

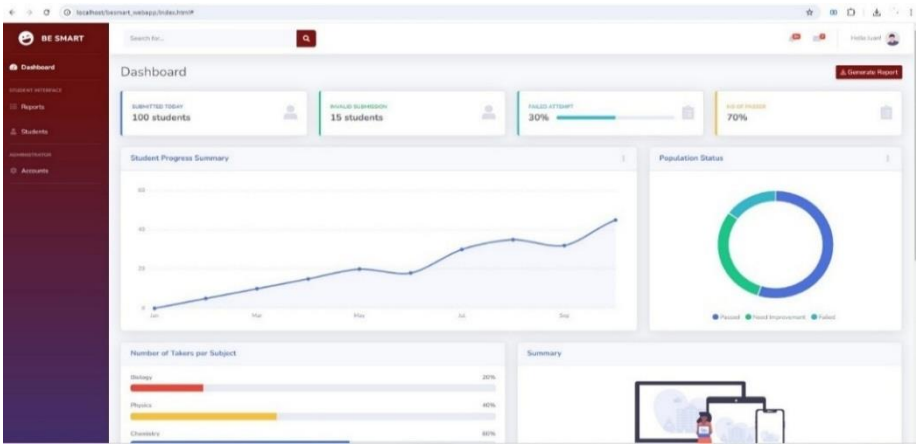
User account management allows the admin to create an account on the website before accessing other web app functionalities. It also allows registered accounts to modify their information. The Assessment Report module grants the admin access to the students' assessment records; with this module, the BEsMART can display records detailing each student's information (student ID, score, date of attempt, subject, and the number of items per attempt) as illustrated in Fig. 6 (b). Moreover, a search feature was integrated into the BEsMART admin interface so the administrators could quickly locate students' records, review their performance trends, and identify their strengths and areas needing further review. These things are necessary for targeted LET Preparation. Lastly, the Dashboard module provides a summary of students' performance across the different subjects. This feature enables the admin to quickly get an overview of the critical metrics, which support the continuous tracking of students' progress, as shown in Fig. 6 (c). By analyzing the data and insights from the dashboard, the admin can tailor instructional support and add necessary resources to reinforce students' review in preparing for the exam.



(a) Student information management



(b) Assessment report management



(c) Dashboard Management

Figure 6: BEsMART: Admin interface

3.1.3. BEsMART: System architecture

Below is the system architecture used in BEsMART, which illustrates the user and admin interfaces, their roles in the information system, and the flow of data and information within. This architecture follows a three-tier model composed of the presentation, application, and data tires.

For instance, the presentation tire illustrates the interfaces through which both users (students and admin) interact with the system, facilitating data input that generates meaningful insights for both. The student interface, developed for mobile devices, is built using Java and extensive markup language (XML); this ensures its compatibility and usability with a wide range of smartphones. Meanwhile, the admin interface is a web application accessible from any browser and designed with PHP, HTML, CSS, and Bootstrap framework. The application tire is another tire responsible for managing the system's core functions, such as student management, scheduling management, assessment management, and progress tracking. This tire processes operations and communicates interactions between the user interfaces and the back-end data layer.

Lastly, there is the data tire, which serves as the back-end layer of BEsMART and is responsible for storing, manipulating, and retrieving data to provide important information. The mobile application utilizes SQLite as its database, optimized for local and offline features and capabilities. On the other hand, MySQL is the database used for web applications to handle larger datasets and support the app's advanced management functionalities. Together, these three-tier structures make the app efficient and ensure its data flow, accessibility, and functionality. This allows BEsMART to support and provide a seamless review experience and valuable feedback for both students and administrators.

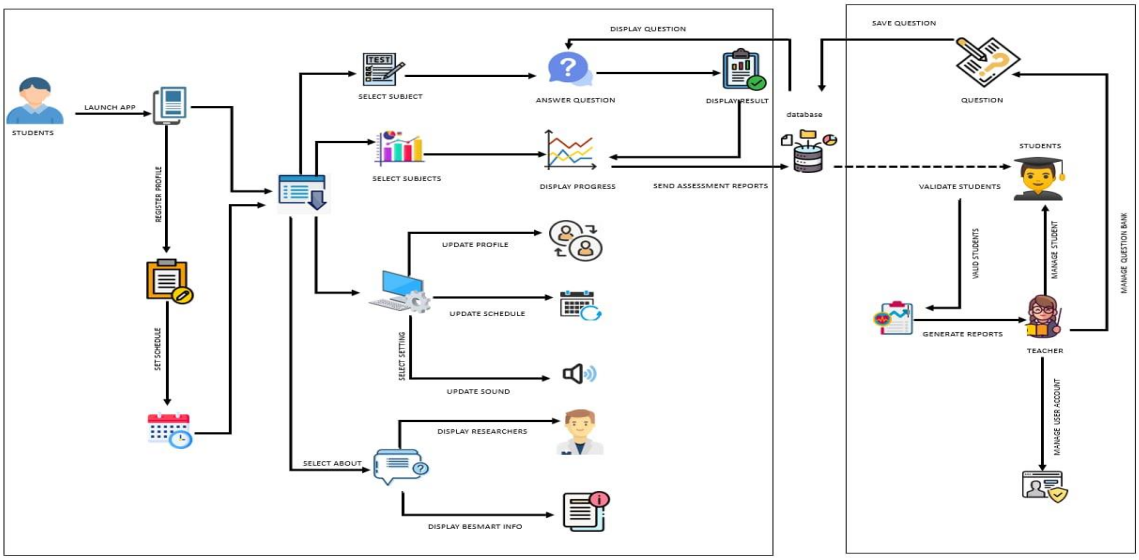


Figure 7: BEsMART system architecture

3.2. Evaluation of the developed BEsMART application

The BEsMART was validated by the experts and students using the Software Product Quality Questionnaire or ISO/IEC 25010 in terms of functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability, and the adapted U.S.E. Questionnaire of Lund (2001), specifically along Usefulness, Ease of Use, Ease of Learning, and Satisfaction. The researcher gathered, analyzed, and interpreted the expert's and students' responses based on frequency distribution and weighted mean scores in each given item or criteria in the evaluation instrument. These were done to limit bias in the validation process and ensure consistency and reliability of the data and findings. According to Kizlik (2014), evaluation is one of the most important indicators of the quality of generated learning materials. It also determines the worth of BEsMART of their suitability, goodness, validity, and legality.

3.2.1. Experts evaluation of the developed BEsMART

Below is the summary of the Experts' evaluation of the BEsMART presented in Table 1 across the eight quality indicators based on ISO/IEC 2510 standards. Overall, BEsMART gets a weighted mean of 4.64 and a standard deviation of 0.29, suggesting a high level of agreement among experts that the application meets the quality standards for educational software and may have the potential to be used for LET preparation.

Table 1: Summary of experts' evaluation of BEsMART using ISO/IEC 25010

Criteria	Weighted Mean	SD	Description
Functional Suitability	4.94	0.17	Completely Applicable
Performance Efficiency	4.70	0.24	Completely Applicable
Compatibility	4.44	0.30	Mostly Applicable
Usability	5.00	0.00	Completely Applicable
Reliability	4.78	0.15	Completely Applicable
Security	4.85	0.15	Completely Applicable
Maintainability	4.85	0.15	Completely Applicable
Portability	4.44	0.30	Mostly Applicable
Over-all	**4.72**	**0.23**	**Completely Applicable**

Experts rated BEsMART highly for functional suitability ($\bar{x}$=4.94, SD=0.17), confirming that it effectively meets its purpose as a targeted LET review tool. Its content and resources align with the LET Enhanced Table of Specifications (TOS), ensuring structured and goal-oriented learning. The high rating reflects the platform's ability to enhance exam preparedness by providing relevant materials tailored to pre-service science education teachers. A comprehensive needs assessment and literature review informed its development, ensuring alignment with learning objectives and exam requirements (Nandakishore et al., 2020; Al Nawaiseh et al., 2020).

For performance efficiency, BEsMART scored $\bar{x}$=4.70, SD=0.24, indicating smooth operation with minimal delays. The spaced repetition and hypercorrection features, combined with low-memory usage, enable efficient learning, making it ideal for students using entry-level mobile phones or in resource-limited environments. Since exam preparation is time-sensitive, performance efficiency ensures a seamless user experience, which can enhance engagement and satisfaction (Pahuriray & Algara, 2021; Sung et al., 2016). In terms of compatibility and portability, BEsMART received a rating of $\bar{x}$=4.44, SD=0.30, reflecting strong system compatibility but some device limitations. The app was primarily designed for Android devices, given Android's widespread adoption and affordability (Haris et al., 2018; Hall & Anderson, 2009). Android's open-source nature makes it a flexible choice for educational tools, ensuring accessibility across various brands (Lazareska & Jakimoski, 2017; Walter, 2015; Thomas, 2015). However, this limits accessibility for iOS users. To address this, developers are working on expanding BEsMART's compatibility to enhance inclusivity for a broader user base (Novaliendry et al., 2020).

Usability received the highest rating ($\bar{x}$=5.00, SD=0), with unanimous expert agreement on its ease of navigation and accessibility. The platform's simple layout, responsive navigation, and personalized learning paths make it user-friendly. Features such as interactive feedback mechanisms, lesson videos, and structured content pathways enhance engagement and adaptability to user preferences. Experts emphasized that BEsMART leverages technology creatively, making learning fun and enjoyable. The well-organized interface allows users to revisit content, track progress, and engage with interactive learning experiences, supporting active learning and review retention. This aligns with findings from Davis et al. (2022), which highlight how intuitive educational software can improve engagement and learning outcomes.

For reliability, BEsMART was rated $\bar{x}$=4.78, SD=0.15, affirming its consistent performance with minimal errors. Its offline functionality ensures users can access materials without an internet connection, and the auto-save feature prevents progress loss during disruptions. These reliability features support continuous study, making BEsMART a dependable review platform (Collins, 2007). Lastly, security and maintainability were rated highly ($\bar{x}$=4.85, SD=0.15). Experts confirmed that BEsMART implements strong data protection measures and facilitates efficient content updates and user management. These elements are critical in educational platforms, ensuring user data security while adapting to evolving LET standards and technological advancements (Mukherjee et al., 2024).

Table 2: Percentage agreement of the experts' evaluation of BEsMART

	Experts' Rating									% of
Criteria	E1	E2	E3	E4	E5	E6	E7	E8	E9	Agreement
Functional Suitability.	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	4.5	89%
Performance Efficiency	4.6	4.6	4.6	4.6	5.0	5.0	5.0	4.3	4.6	89%
Compatibility	4.5	4.0	4.5	4.5	4.5	4.0	4.5	4.5	5.0	89%
Usability	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	100%
Reliability	4.5	4.8	4.8	4.8	4.8	4.8	4.8	5.0	5.0	89%
Security	4.5	4.8	4.8	4.8	4.8	5.0	4.8	5.0	5.0	89%
Maintainability	4.5	4.8	4.8	4.8	5.0	4.8	4.8	5.0	5.0	89%
Portability	4.3	5.0	4.3	4.3	4.3	4.3	4.3	4.3	4.3	89%
Total										90.38%

With the use of percentage agreement to determine the consistency or agreement among the raters, it is implied that BEsMART passed the Software Standard Quality set by the ISO/IEC 25000, also known as SQuaRE (System and Software Quality Requirements and Evaluation) for software product such as this one. The majority of the criteria got an 89% agreement among experts, which shows that it is within the standards set by ISO/IEC 25000. However, revisions or clarifications should be made to ensure the quality of the material. This further indicates high reliability, which means that most of the raters genuinely believe that the criteria for the developed BEsMART are aligned with the standard. Meanwhile, one notable highlight is the experts' unanimous rating (100%) regarding BEsMART's usability. This agreement shows that the application features and interface are

accessible, simple, and easy to understand, making it a highly user-friendly software product. Overall, there is a 90.38% agreement, which implies high reliability of the data owing to the fact that most of the raters have the same opinion about the validity and quality of the developed BEsMART. However, while BEsMART has shown substantial ratings from the experts, some changes or revisions remain to be made, providing opportunities for improvement.

3.2.2. Users' evaluation of the developed BEsMART

Table 3 shows the summary of the users' evaluation (Pre-service science education teachers) of the BEsMART across the four criteria of the U.S.E. questionnaire adapted from Lund (2001). The results show that the developed application received a highly positive perception from the user, as indicated by the overall weighted mean of 4.75 (Sd=0.38). This demonstrates that BEsMART meets not only the critical needs of the user but also its intended purpose, which is to offer potential review material for LET preparation.

Table 3: Summary of users' evaluation of BEsMART using the U.S.E. questionnaire.

Criteria	Weighted Mean	Sd	Description
Ease of Use	4.78	0.20	Strongly Agree
Ease of Learning	4.72	0.40	Strongly Agree
Usefulness	4.90	0.19	Strongly Agree
Satisfaction	4.75	0.34	Strongly Agree
Over-all	**4.75**	**0.38**	**Strongly Agree**

BEsMART received a high rating for ease of use ($\bar{x}$=4.78, SD=0.20), indicating substantial agreement among users on its accessibility and user-friendly design. Users particularly praised its easy navigation and engaging interface, with one noting, "As someone about to take the LET, having this kind of tool is really helpful. It's easy to use and engaging." The researcher ensured a minimal yet efficient interface while incorporating a system design that prevents technical errors and allows for quick recovery. Studies support that more straightforward navigation leads to better user performance and engagement (Dehinbo, 2011; Ng'uni & Phiri, 2019), ensuring that users can maximize their review time without technical difficulties.

For ease of learning, BEsMART was rated $\bar{x}$=4.72, SD=0.40, reflecting its intuitive design that allows even new users to understand and utilize its features quickly. The logical flow of processes and user-friendly interface minimize complexity, ensuring effective interaction between users and the platform. Usability is crucial for educational platforms, as it supports seamless learning experiences (Lew et al., 2010) and promotes fast adoption and efficiency in educational settings (Loraas & Diaz, 2011).

In terms of usefulness, BEsMART scored $\bar{x}$=4.90, SD=0.19, demonstrating strong agreement among users on its practical benefits. Its built-in help mechanisms, structured layout, and clear formatting allow users to navigate effortlessly, even without prior training. The design of icons reflects their functions, making the system intuitive and easy to use. Usability, as defined by ISO standard 9241-11 (ANSI 1998, as cited in O'Bryan et al., 2010), is the extent to which a product enables users to achieve specific goals effectively, efficiently, and with satisfaction. Users affirmed this, with one stating, "BEsMART's interactive features exceed expectations—it mimics a teacher's presence and allows self-paced progress." Another user highlighted its accessibility, saying, "BEsMART truly helps board exam reviewers, and I hope more applications like this are developed." Designed to be compatible with various devices and require minimal system resources, BEsMART aims to bridge digital inequality by ensuring accessibility, particularly for students using only smartphones. Digital inequality remains a barrier to education, as seen during COVID-19, where only those with stable digital access continued learning without disruption (Aldama, 2020, as cited in Cuisia-Villanueva & Nuñez, 2020). According to human capital theory, limited family resources hinder educational investment, affecting academic progress (Becker, 1964; Li & Qiu, 2018). BEsMART's offline mode addresses this gap by allowing students to download and use the app without internet dependency (Rahmatsyah & Dwiningsih, 2021).

For satisfaction, BEsMART achieved $\bar{x}$=4.75, SD=0.34, confirming that it met user expectations and provided a positive experience. Users found its features intuitive and reliable, making it accessible

even to those with limited technical expertise. The app's alignment with users' study routines enhanced its practicality, and the unanimous recommendation for wider adoption reflects confidence in its ability to deliver meaningful and consistent results.

Overall, the evaluation confirms that BEsMART is a well-designed and effective educational tool. Its strong ratings across all usability indicators demonstrate its alignment with users' needs and recognized quality standards. To maintain this performance, continuous updates and refinements based on user feedback will ensure its long-term relevance and effectiveness. With ongoing improvements, BEsMART will remain a valuable tool for LET preparation, supporting productivity, satisfaction, and accessibility in educational settings.

Table 4. Interrater reliability Test Results of Users' Evaluation of the developed BEsMART

	Rating					
Criteria	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Percentage Agreement
Ease of Use	0	0	2	2	44	92%
Ease of Learning	0	0	2	3	43	89.60%
Usefulness	0	0	0	2	46	95.83%
Satisfaction	0	0	0	5	43	89.60%
Total						91. 76%

Using the percentage agreement inter-rater reliability test, the findings indicate that there is a strong agreement among the users (pre-service science education teachers) evaluators, given the percentage agreement value of 91.76%. While all the users rated BEsMART as strongly agreed, there is a small portion of the users agreement that may have a different opinion, but they are still leaning towards the positive side of the spectrum. This suggests that the ratings given by the users are consistent, with at least 91.76% of the respondents showing high reliability of the results and supporting the findings of this study. This consistency supports the conclusion that BEsMART effectively meets its intended purpose and aligns with the needs of its target audience, reinforcing the findings of this study and underscoring the application's potential to enhance the review journey of those preparing for the LET examination.

4.0. CONCLUSIONS

The study concluded that BEsMART is a practical and effective mobile application for pre-service science teachers preparing for the Licensure Examination for Teachers (LET). Integrating spaced repetition and Hypercorrection enhances memory retention and corrects misconceptions. Evaluations by experts and pre-service teachers confirmed its strong usability, functionality, and reliability, aligning well with LET's Enhanced Table of Specifications. However, the study identified limitations, including its Android-only compatibility, restricting access for iOS users, and its evaluation within a single academic institution, limiting broader applicability. These findings highlight opportunities for future improvements to increase inclusivity and scalability.

To maximize BEsMART's impact, pre-service teachers should integrate it into their review routines, using features like progress tracking for targeted learning. Teacher education institutions are encouraged to adopt it as a supplementary review tool and conduct workshops for optimal use. Developers should expand compatibility to iOS devices and incorporate gamified quizzes, adaptive question sets, and video-based learning for better engagement. Policymakers and educators should support mobile learning tools like BEsMART in teacher education, particularly in underserved areas, to enhance access to quality review resources. Future research should explore its long-term impact on LET performance and expand evaluations across multiple institutions. Additionally, integrating AI-driven personalized learning and real-time feedback could further optimize its effectiveness. BEsMART also serves as a model for developing subject-specific review tools, addressing key challenges in accessibility and digital equity in education.

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