UPDATE AND EVALUATION OF A CLINICAL BACTERIOLOGY MOBILE APP AS A DIGITAL LEARNING TOOL IN HEALTHCARE

[1]Bruna Ferreira Pfeiffer, [1]Ana Beatriz Gorini da Veiga

[1]Universidade Federal de Ciências da Saúde de Porto Alegre (UFCSPA)
<bruna.fepf@gmail.com> <anabgv@ufcspa.edu.br>
DOI: 10.21439/conexoes.v20.4116

Abstract. Digital learning technologies have become popular among academics, teachers and professionals of various levels and areas of knowledge. Regarding the health area, m-Health can serve as support in decisions regarding diagnoses, procedures and processes. Considering that clinical bacteriology is an area with wide theoretical content and, in many cases, manual procedures, the use of m-Health in the form of applications presents potential contribution in teaching, research, and clinical/laboratory practice. The aim was to update a mobile application of clinical bacteriology and evaluate its usability score based on user experience. The study followed the steps of the Systematic Instructional Design model, which included 4 stages. For the 4th stage, online forms containing 10 questions System Usability Scale were sent to 2 coordinations of undergraduate biomedicine courses in Rio Grande do Sul, Brazil, in 2023. In total, 15 participants answered the form, and the final average was 82.0 points, showing a good classification in the overall assessment of satisfaction, efficiency and effectiveness. It was possible to show that the app Bacterial Identifier can be an auxiliary tool in the process of presumptive bacterial identification, contributing to academic and professional training.

Keywords: bacterial identification; digital learning; digital health; mobile application; smartphone.

ATUALIZAÇÃO E AVALIAÇÃO DE UM APLICATIVO MÓVEL DE BACTERIOLOGIA CLÍNICA COMO FERRAMENTA DE APRENDIZAGEM DIGITAL NA ÁREA DA SAÚDE

Resumo. Tecnologias digitais de aprendizagem têm se popularizado entre acadêmicos, professores e profissionais de diversos níveis e áreas do conhecimento. No que se refere à área da saúde, o *m-Health* pode servir de suporte em decisões de diagnósticos, procedimentos e processos. Considerando que a bacteriologia clínica é uma área com amplo conteúdo teórico e, em muitos casos, com procedimentos manuais, o uso do *m-Health* na forma de aplicativos apresenta potencial contribuição no ensino, pesquisa e prática clínica/laboratorial. O objetivo foi atualizar um aplicativo móvel de bacteriologia clínica e avaliar seu escore de usabilidade com base na experiência do usuário. O estudo seguiu as etapas do modelo *Systematic Instructional Design*, que incluiu 4 etapas. Para a quarta etapa, formulários online contendo 10 questões *System Usability Scale* foram enviados para 2 coordenações de cursos de graduação em biomedicina no Rio Grande do Sul, Brasil, em 2023. No total, 15 participantes responderam ao formulário, e a média final foi de 82,0 pontos, demonstrando uma boa classificação geral de satisfação, eficiência e eficácia. Foi possível evidenciar que o aplicativo Identificador Bacteriano pode ser uma ferramenta auxiliar no processo de identificação bacteriana presuntiva, contribuindo para a formação acadêmica e profissional.

Palavras-chave: identificação bacteriana; aprendizagem digital; saúde digital; aplicativo móvel; smartphone.

Artigo submetido em 11 maio 2025 e aceito em 28 abr. 2026

1 INTRODUCTION

The consolidation of the Fourth Industrial Revolution, characterized by the “Internet of Things” and the widespread proliferation of digital devices (Yang; Huang, 2021), established a context in which smartphone use has wide notoriety among academics and professionals, being one of the main devices used to access e-learning. The possibility of personalized, unlimited, and access to reliable theoretical and technical bibliographic information at any time, "in the palm of your hand", is the key driver of this learning model. Consequently, both the demand for and the expectation of high-quality information continue to grow (Cavus *et al.*, 2020; Jesus; Jesus, 2022; Lima; Vicente, 2019).

The smartphone application in digital learning – mobile learning – brings educational understanding closer in a cost-effective and financially accessible way (Ajayi; Ayo; Olamide, 2019; Suner; Yilmaz; Pişkin, 2019). The use of smartphones in health and education as mHealth promotes autonomous and intuitive learning, enabling knowledge exchange, protocol reinforcement, and sharing of clinical information through digital platforms (Baghcheghi *et al.*, 2020; Floren *et al.*, 2019).

Given the global scenario of bacterial infections and their various complications for public health, it is necessary to invest in mobile learning platforms that aim to educate students and professionals working in the sector/discipline of Clinical Microbiology, specifically Clinical Bacteriology, interactively and intuitively, and at the same time maintain the quality of the proposed content. In most teaching laboratories of Higher Education Institutions (HEI) and clinical laboratories in Brazil, the area of clinical microbiology operates manually; therefore, the vast content about the area, combined with the importance of understanding the content and contributing to public health, makes the smartphone an auxiliary tool for teaching and consultation. Therefore, this study aimed to update a clinical bacteriology mobile app and evaluate users’ scores on its usability.

2 METHODS

The study follows the Systematic Instructional Design (SID) methodology, structured in four stages: Analysis, Design and development, Implementation, and Evaluation (Sousa; Turrini, 2019). It is a continuation of Pfeiffer, Mattos and Lopes (2020), which addressed the development and initial usability evaluation of the Bacterial Identifier app.

2.1 Analysis

Initially, meetings were held to define the study objectives, schedule, budget, and procedures, including the hiring of an IT professional and the identification of potential participating institutions through e-mail contact. Two HEIs returned by e-mail, indicating interest in participating in the study – the biomedicine course at Universidade Luterana do Brasil (ULBRA), *campus* Carazinho; and the biomedicine evening course at Universidade Federal de Ciências da Saúde de Porto Alegre (UFCSPA). The study also distinguished the population between professors and students to analyze possible similarities or divergences between the results. According to the population profile of the 2 institutions, there was an estimate of 40 students and 1 professor from the UFCSPA biomedicine evening course per semester, and 30 students and 1 professor from the ULBRA biomedicine course per semester, totaling an estimated 72 participants.

At this stage, we also chose bibliographic references from the area of clinical bacteriology with high scientific impact to be used as a reference base for the new version of the Bacterial Identifier (Oplustil *et al.*, 2020; Procop *et al.*, 2018; Trabulsi *et al.*, 2015). The contents of interest were taken from the 3 references and compiled in an Excel spreadsheet organized into 3 tabs: Gram-positive (21 bacterial groups/species, 17 biochemical tests), Gram-negative fermenting (22 groups/species from the Enterobacterales order, 24 biochemical tests), and Gram-negative non-fermenting (BNF) (31 groups/species of clinical importance, 17 biochemical tests). Each tab presents a table correlating the results of the most common biochemical tests with the main bacteria of clinical importance.

2.2 Design and development

The second stage of the updating process was divided into two blocks: design and development. The Design block was characterized by meetings to define the scope of the study regarding the updating of the graphical interface, inclusion and editing of programming resources, and inclusion, editing, and removal of learning content.

The Excel spreadsheet presented in the previous step served as a source of consultation regarding the learning content. After meetings, the IT professional organized, within his professional competencies, the work resources needed to update the screens, a moment belonging to the Development block.

2.3 Implementation

The implementation stage consisted of publishing the updated version of the Bacterial Identifier on the digital platforms Google Play Store – for Android smartphones – and the Apple App Store platform – for iOS smartphones. The choice of publishing on both platforms aimed to reach as many users of interest as possible.

2.4 Evaluation

This stage was characterized by the participation of users of interest for usability testing and evaluation of the Bacterial Identifier. Inclusion criteria were: being a student enrolled in the discipline of Clinical Microbiology/Clinical Bacteriology or a professor of the same discipline at the participating HEIs, and having signed the ICF. Exclusion criteria were: failure to complete the full System Usability Scale (SUS) questionnaire and withdrawal from the study at any point during data collection. After the HEIs returned to participate in the study, they received an email with a link to access the Google Play Store and Apple App Store platforms to download the Bacterial Identifier and a link to access the Informed Consent Form (ICF) and the Bacterial Identifier Usability Evaluation Form.

The SUS was chosen as the usability evaluation form because it meets the objective of the study. This scale is widely used as a reference in usability evaluations of websites and apps. To measure user perception, a 5-point Likert Scale is used for the 10 questions (Martins *et al*., 2015):

1. I think that I would like to use this system frequently.
2. I found the system unnecessarily complex.
3. I thought the system was easy to use.
4. I think that I would need the support of a technical person to be able to use this system.
5. I found the various functions in this system were well integrated.
6. I thought there was too much inconsistency in this system.
7. I would imagine that most people would learn to use this system very quickly.
8. I found the system very cumbersome to use.
9. I felt very confident using the system.
10. I needed to learn a lot of things before I could get going with this system.

At the end of the evaluations the answers were collected, stored and calculated to obtain the final evaluation score. The final calculation is expressed in points, from 0 to 100 (Brandão *et al*., 2025). The present study was approved by the Research Ethics Committee of UFCSPA in august 2022 (no. 5.577.099; CAAE 51229421.6.0000.5345) and finalized in 2023.

3 RESULTS

The Bacterial Identifier app was updated in a way that does not require user registration, does not get access to the smartphone's Global Positioning System (GPS), and does not require an internet connection. The results are distributed into 3.1 Updating the Bacterial Identifier and 3.2 Evaluation on Usability of the Bacterial Identifier.

3.1 Updating the bacterial identifier

The app provides a quick startup screen when opened on the device. When loading the information, the startup screen consists of 2 utility features and additional information such as “New” (“*Novo*”), “Contact” (“*Contato*”) and “About” (“*Sobre*”).

When selecting the “Gram-positive” (“Gram-positivo”) utility, a list will appear with the main tests commonly used in clinical laboratories. By default, the tests are selected as “Not performed” (“*Não realizado*”). It is possible to report only the result of the test performed, without having to modify the results of the others in the list. It is worth noting that the more results reported, the shorter the list of suggestions displayed for the probable isolated bacterium.

The feature “Update serial” (“*Atualizar em série*”) allows the app of the same result for all the tests in the list, reducing the time to fill the results. The “Identify” (“*Identificar*”) option is located at the end of the test list. In cases of discrepancy between the results entered, the app displays an alert communicating the impossibility of presumptive identification. The resource "Change test"allows the user to return to the test list screen without changing the results already entered, and to readjust only the result that is needed. The option “New test” returns immediately to the initial screen.

The "Fermenter"and "Non-Fermenter"screens also have the same features as the Gram-positive screen. However, unlike the “Gram-positive” utility, the bacterial suggestion screen of the “Fermenter” utility is made up of probable bacteria/species and respective percentages of positivity probability, as proposed by the Farmer’s Table. Percentages are automatically recalculated based on selected tests and reported results.

When returning to the home screen or browsing the features located at the bottom of the screen, it is possible to see additional information such as “New”, “Contact”, and “About”. The “New” feature provides an instant return to the home screen. The “Contact” feature provides the contacts of the individuals involved with this study. The “About” screen informs the general aspects of the app, such as the purpose of use and the bibliographic references used. Figure 1 illustrates the main screens of the app, including simulations.

3.2 Evaluation on usability of the bacterial identifier

Despite the action of sending multiple invitations, 20.8% (n=15) of the estimated 72 participants participated by evaluating the app, which is recognized as a limitation of this study regarding sample representativeness. The participants’ answers stored in the Google Forms platform were converted into an Excel file (.xlsx) to analyze the results and save them on a device.

Regarding the analysis of the academic profile of the participants, 80.0% (n=12) were students enrolled in the discipline of Clinical Microbiology/Clinical Bacteriology, and 20.0% (n=3) were professors in Clinical Microbiology/Clinical Bacteriology. Regarding the participants’ HEI, 46.7% (n=7) were from ULBRA, and 53.3% (n=8) from UFCSPA.

For each question, the usability evaluation correlates to one of the 5 attributes of Nielsen’s Heuristics (Nielsen, 1994), where it is possible to analyze in an isolated way which items keep and which items need correction: ease of learning (questions 3, 4, 7 and 10), efficiency (questions 5, 6 and 8), ease of memorization (question 2), minimization of errors (question 6) and satisfaction (questions 1, 4, 9). In the present study, the results of the questions were grouped by participant, and the SUS calculation was applied.

When analyzing the questions by participant, similarities were observed in both responses and overall scores. Of the 15 participants, 13.3% (n=2) scored below the expected goal of 68 points, whereas 86.7% (n=13) achieved scores >68 points, resulting in an overall mean score of 82.0 points (Table 1). Measures of dispersion indicated moderate variability in performance, with a standard deviation (SD) of 8.4, a median of 82.5, and scores ranging from a minimum of 65.0 to a maximum of 92.5. It should be noted that the reduced number of respondents (n=15; 20.8% of the estimated 72 participants) limits the statistical representativeness of this result, and the values presented should be interpreted with caution.

Table 1: Evaluation results per participant and scoring

Participant	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Score
1	4	2	4	2	4	2	4	1	5	1	82.5
2	4	2	5	1	4	2	4	1	4	2	82.5
3	5	2	4	1	5	2	4	1	4	2	85.0
4	4	2	5	1	5	2	5	1	5	1	92.5
5	4	2	4	1	4	2	5	1	3	1	82.5
6	5	2	5	2	4	2	2	4	2	2	65.0
7	5	2	5	1	4	2	5	2	4	2	85.0
8	4	1	5	1	5	2	4	1	4	2	87.5
9	3	1	5	1	4	2	3	1	3	1	82.5
10	4	1	5	1	5	1	4	1	4	1	92.5
11	3	1	5	1	5	1	3	1	3	1	85.0
12	4	2	3	2	5	1	4	2	3	2	75.0
13	5	3	4	2	4	1	5	2	3	2	77.5
14	4	4	4	3	4	3	4	2	4	2	65.0
15	4	2	5	1	5	2	5	1	4	1	90.0
Final average score											82.0

Q = Question

The analysis of the results also sought to identify the average score between the populations (teachers and students). According to the analysis, there were no significant variations in the averages obtained. The average among professors was 85.8, and the average among students was 81.0.

The odd-numbered questions (Q1: frequency of use; Q3: ease of use; Q5: integrated functionality; Q7: quick learning; Q9: confidence), which relate to positive aspects of usability, predominantly received "Agree"and "Strongly Agree"ratings. However, Q7 and Q9 also received "Disagree"ratings, indicating aspects for improvement (Table 2).

The even-numbered questions (Q2: complexity; Q4: need for technical help; Q6: inconsistency; Q8: difficulty; Q10: prior learning required), which relate to negative aspects of usability, predominantly received "Disagree"and "Strongly Disagree"ratings. However, Q2 and Q8 also received "Agree"ratings, which diverged from the expected results, suggesting the app can still be simplified.

4 DISCUSSION

Updating and evaluating the Bacterial Identifier app was necessary to meet the needs of users, such as academics, professors, and professionals in the field of clinical bacteriology, as well as incorporating relevant literature reviews. The changes included the addition of biochemical tests, new clinically relevant bacterial species, and a third bacterial group (BNF), with the aim of facilitating and speeding up presumptive bacterial identification, which often relies on manual processes.

These updates also sought to increase the assertiveness, reliability, and speed of the app, making it a viable tool for decisions, learning, and consultation. The app has been enhanced with a user-friendly interface and features such as the selection of results for all biochemical tests and the ability to change only one result while keeping the others saved.

The presumptive bacterial identification step is based on tests that provide presumptive results, as bacterial species can vary in the results of the same tests due to their ability to alter their genomic structure (Procop *et al.*, 2018). The Bacterial Identifier offers a list of suggested probable bacteria based on the reported results. The more test results are provided, the shorter the list of suggestions, and vice versa. The Gram-negative fermenting group shows percentages of positives, highlighting the variability in results for the same bacterial species.

The app was designed as an auxiliary tool for presumptive bacterial identification, with no access restrictions, no GPS or camera requirements, and validated content organized in a practical and agile format. Despite the variety

Table 2: Distribution of ratings by question

Q	Variables	Evaluations	%	N
1	Frequency of use	Strongly disagree	0.0	0
		Disagree	0.0	0
		Neither agree nor disagree	13.3	2
		Agree	60.0	9
		Strongly Agree	26.7	4
2	Complex usage	Strongly disagree	26.7	4
		Disagree	60.0	9
		Neither agree nor disagree	6.7	1
		Agree	6.7	1
		Strongly Agree	0.0	0
3	Ease of use	Strongly disagree	0.0	0
		Disagree	0.0	0
		Neither agree nor disagree	6.7	1
		Agree	33.3	5
		Strongly Agree	60.0	9
4	Need for technical technique	Strongly disagree	66.7	10
		Disagree	26.7	4
		Neither agree nor disagree	6.7	1
		Agree	0.0	0
		Strongly Agree	0.0	0
5	Integrated functionalities	Strongly disagree	0.0	0
		Disagree	0.0	0
		Neither agree nor disagree	0.0	0
		Agree	53.3	8
		Strongly Agree	46.7	7
6	Inconsistency	Strongly disagree	26.7	4
		Disagree	66.7	10
		Neither agree nor disagree	6.7	1
		Agree	0.0	0
		Strongly Agree	0.0	0
7	Usage learning	Strongly disagree	0.0	0
		Disagree	6.7	1
		Neither agree nor disagree	20.0	3
		Agree	40.0	6
		Strongly Agree	33.3	5
8	Complicated use	Strongly disagree	66.7	10
		Disagree	26.7	4
		Neither agree nor disagree	0.0	0
		Agree	6.7	1
		Strongly Agree	0.0	0
9	Trust	Strongly disagree	0.0	0
		Disagree	6.7	1
		Neither agree nor disagree	33.3	5
		Agree	46.7	7
		Strongly Agree	13.3	2
10	Need for prior learning	Strongly disagree	46.7	7
		Disagree	53.3	8
		Neither agree nor disagree	0.0	0
		Agree	0.0	0
		Strongly Agree	0.0	0

Q = Question; N = Number.

of clinical bacteriology apps available, there is a lack of scientific publications on the use of m-Health in the area, especially for academic and professional purposes (Dewi; Djamil; Anwar, 2019).

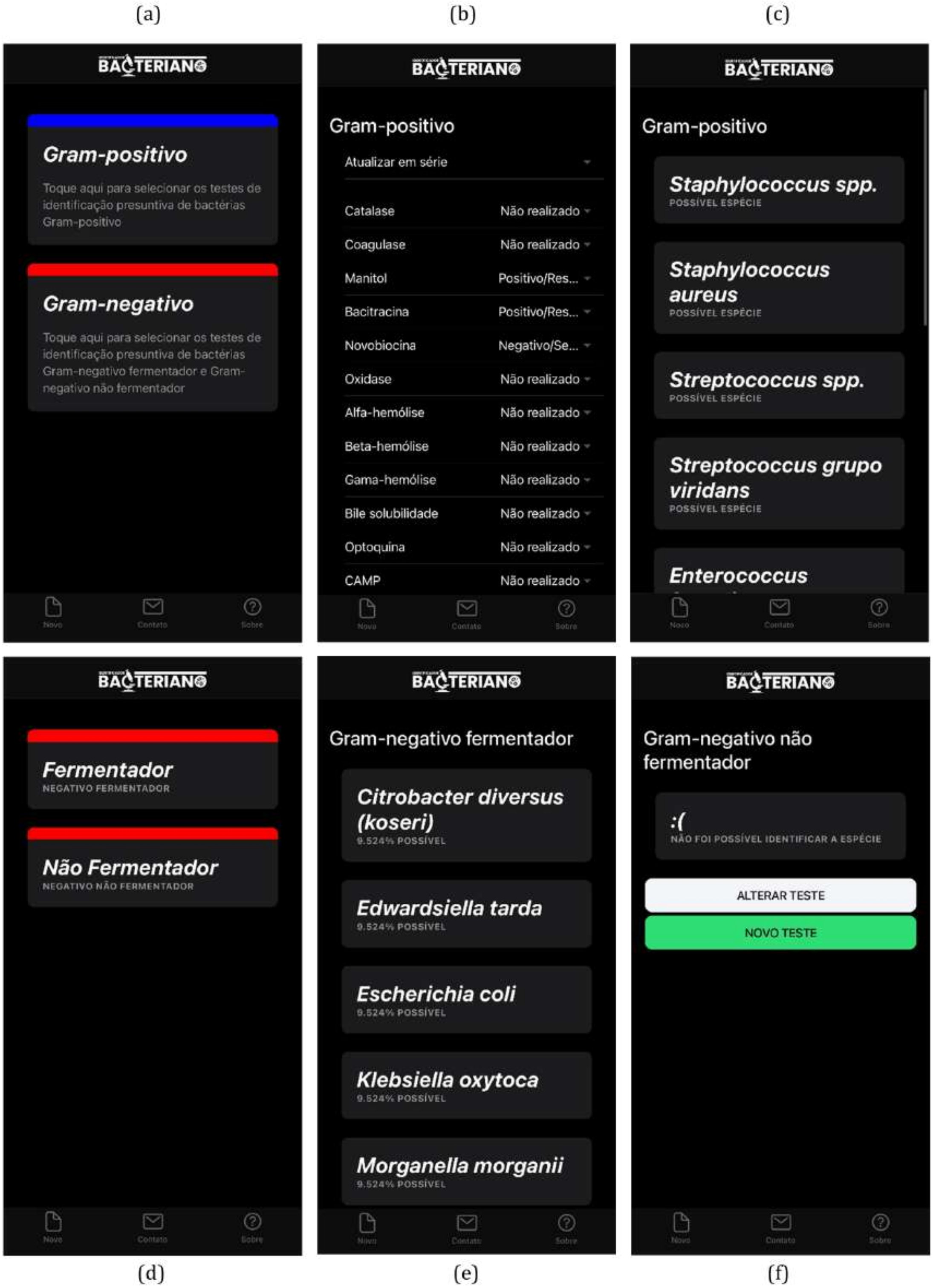
The quality of healthcare app development is a growing concern, with usability being assessed by scales such as the SUS. The Bacterial Identifier obtained an average of 82.0 points, above the minimum acceptable threshold of 68 points. According to Hyzy *et al.* (2022), who benchmarked SUS scores for digital health apps in a meta-analysis of 92 studies, the mean score for this type of application is 68 points (SD 12.5), placing the Bacterial Identifier above the expected average in the "Good"usability classification. The internal SD of this study (8.4), below the meta-analysis benchmark, reflects a more homogeneous perception among evaluators than typically reported in the literature for this category of application. The predominance of positive ratings for functionality integration (Q5: 100% agree/strongly agree) and absence of need for prior training (Q10: 100% disagree/strongly disagree) highlights the intuitive design and low learning curve as key differentials of the tool. However, Q7 (quick learning) and Q9 (confidence in results) indicate aspects to be improved in future versions; the latter is particularly critical in clinical contexts, where trust in the information provided directly influences the adoption of the tool in diagnostic practice. The low participation rate (20.8%; n=15 of an estimated 72 participants) is recognized as a main limitation of this study. Voluntary online evaluations tend to have reduced adherence, especially without direct monitoring of the interaction with the tool before completing the SUS questionnaire, which also represents a potential source of bias. The observed score range (minimum = 65.0; maximum = 92.5) reveals isolated evaluators near the acceptability threshold, reinforcing the need for larger samples in future research. Despite this, the average score of 82.0 points was consistent between professors (85.8 points) and students (81.0 points), a 4.8-point difference suggesting a homogeneous usability perception across groups with distinct clinical experience levels. Unlike printed manuals or generic databases, the Bacterial Identifier operates offline, requires no registration or GPS access, and has content validated against specialized clinical bacteriology references (Oplustil *et al.*, 2020; Procop *et al.*, 2018; Trabulsi *et al.*, 2015), representing a relevant contribution to the area, given the still limited number of studies evaluating m-Health tools in this specific field (Dewi; Djamil; Anwar, 2019).

5 FINAL CONSIDERATIONS

Digital technologies, specifically mobile devices, enable access to m-Learning and m-Health tools. The inclusion of these devices in the academic and professional environment contributes to better learning and communication. When comparing the experience of the use of m-Health, as apps, in the area of health and higher education, the results present the same similarity: good acceptance by users and good perspectives for use. However, the importance of using apps developed with reliable information is emphasized.

The update of the Bacterial Identifier app aimed to include biochemical tests, bacterial species, and bacteria belonging to the BNF group. In addition, it aimed to expand the range of use by users of interest by making it available on the digital platforms Google Play Store and Apple App Store. These actions aimed to assist students, teachers, and even professionals in the area of clinical bacteriology regarding the process of presumptive bacterial identification, a process that in most clinical laboratories and school laboratories occurs manually, which can consequently lead to increased operational errors and increased time in the process of presumptive identification. The process of updating the app occurred according to the steps presented; however, the usability evaluation step faced significant challenges to obtain a larger number of participants. The usability evaluation results revealed an average score of 82.0 on the SUS (Good category), indicating the app met user expectations regarding usability, efficiency, and effectiveness. Future versions should address aspects such as confidence in results and reduction of perceived complexity. Among the study's main limitations are the low participant adherence rate (20.8%), the reduced sample size in relation to the estimated universe, and the absence of direct supervision during the interaction session. These factors limit the representativeness of the results and should be addressed in future studies. As with every educational and clinically relevant app, the Bacterial Identifier will also undergo constant updates seeking to present new processes, bacterial groups and biochemical tests duly validated by regulatory agencies.

Figure 1: Main screens of the app Bacterial Identifier.



(a) main screen to select the Gram; (b) simulation screen of a Gram-positive test; (c) presumptive results screen for Gram-positive; (d) screen to select the Gram-negative; (e) simulation screen for Gram-negative Fermenter; (f) error simulation screen

REFERENCES

AJAYI, A.; AYO, C. K.; OLAMIDE, O. Mobile learning and accounting students' readiness in tertiary and professional institutions in nigeria. **Cogent Arts Humanities**, v. 6, n. 1, 2019.

BAGHCHEGHI, N. *et al*. Factors affecting mobile learning adoption in healthcare professional students based on technology acceptance model. **Acta Facultatis Medicae Naissensis**, v. 37, n. 2, p. 191–200, 2020.

BRANDÃO, G. A. *et al*. Avaliação da usabilidade de um aplicativo para pacientes com sepse em unidades de terapia intensiva. **Asklepion:** Informação em Saúde, v. 4, n. 1e, 2025. Disponível em: https://asklepionrevista.info/asklepion/article/.

CAVUS, N. *et al*. Perceptions of foreign language teachers for m-learning. **International Journal of Emerging Technologies in Learning (iJET)**, v. 15, n. 23, p. 95, 2020.

DEWI, M. M.; DJAMIL, M.; ANWAR, M. C. Education m-health android-based smartphone media application "mama asix" for third trimester pregnant women as preparation for exclusive breastfeeding. **Journal of Health Promotion and Behavior**, v. 4, n. 2, p. 98–109, 2019.

FLOREN, L. S. *et al*. A mobile learning module to support interprofessional knowledge construction in the health professions. **American Journal of Pharmaceutical Education**, v. 84, n. 2, p. 847519, 2019.

HYZY, M. *et al*. System usability scale benchmarking for digital health apps: Meta-analysis. **JMIR mHealth and uHealth**, v. 10, n. 8, p. e37290, 2022.

JESUS, J. S. R. d.; JESUS, B. S. d. O impacto do uso do smartphone na educação escolar: Uma revisão sistemática. **Revista Prática Docente**, v. 7, n. 2, p. e22057, 2022.

LIMA, J. d. S. B.; VICENTE, K. B. As vantagens do uso das tics como apoio complementar da metodologia do docente no ambiente acadêmico. **Multidebates**, v. 3, n. 1, p. 36–46, 2019. Disponível em: http://revista.faculdadeitop.edu.br/.

MARTINS, A. I. *et al*. European portuguese validation of the system usability scale (sus). **Procedia Computer Science**, v. 67, p. 293–300, 2015.

NIELSEN, J. **Usability engineering**. Amsterdam: Morgan Kaufmann, 1994.

OPLUSTIL, C. P. *et al*. **Procedimentos básicos em microbiologia clínica**. 4. ed. São Paulo: Sarvier, 2020.

PFEIFFER, B. F.; MATTOS, C. M. W. d.; LOPES, L. A. Desenvolvimento e validação de um aplicativo móvel para identificação de bactérias gram-positivas e gram-negativas. **Revista Brasileira de Análises Clínicas**, v. 52, n. 4, 2020.

PROCOP, G. W. *et al*. **Koneman:** Diagnóstico microbiológico: texto y atlas. 7. ed. L'Hospitalet de Llobregat: Wolters Kluwer, 2018.

SOUSA, C. S.; TURRINI, R. N. T. Desenvolvimento de aplicativo de celular educativo para pacientes submetidos à cirurgia ortognática. **Revista Latino-Americana de Enfermagem**, v. 27, 2019.

SUNER, A.; YILMAZ, Y.; PIsKIN, B. Mobile learning in dentistry: Usage habits, attitudes and perceptions of undergraduate students. **PeerJ**, v. 7, p. e7391, 2019.

TRABULSI, L. R. *et al*. **Microbiologia**. 6. ed. S ao Paulo: Atheneu, 2015.

YANG, W.-D.; HUANG, H. Analysis of the influence of biochemical indexes of athletes under training based on the internet of things and cloud computing. **Revista Brasileira de Medicina do Esporte**, v. 27, n. spe2, p. 27–30, 2021.