Mobile Technology for Learning Assessment: Design Process for the NursE-Quiz Mobile Application

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Abstract—This paper traces the development of a mobile application designed to simplify and support learning in nursing education. This application is based on the principles of dynamic formative assessment, a method that encourages student involvement in the formative assessment process and supports student learning through formative feedback. A formative assessment model was derived from these principles and informed the application's design. This mobile application project, which ran from February to September 2020, aimed to improve formative assessment practices by developing a learner-centred assessment tool and identifying key formative processes within the application. The application's function was based on the needs of the actors, which were analysed according to Black and William's theoretical perspective on formative assessment and Keller's motivational model; both were used to inform the pedagogical design of the application. This application is intended for nursing teachers working in ISPITS in Morocco and student nurses enrolled in the professional license cycle in these training institutes.

1   Introduction

Today, technological progress is transforming all fields, including education. Therefore, it is possible to use information and communication technologies (ICT) to improve students' learning experiences [1, 2]. Several studies have shown that learners are more motivated to participate in an ICT learning activity than in traditional classroom approaches [3, 4, 5]. This interest is because ICT allows teachers to diversify teaching methods and materials, making learning student-centred [6].

Digital formative assessment is an example of using technology in education. This form of assessment has been widely adopted in nursing education, and numerous research studies worldwide have demonstrated its positive effects [7, 8, 9]. Generally, it allows students to develop their knowledge and skills in the care field, generates situations that students cannot encounter in real life through digital simulations, encourages critical thinking and reflection, and develops self-regulation abilities [10,11]. Furthermore, digital assessment generates student motivation and engagement [12,13], which is necessary for academic success.

In Morocco, limited empirical studies have examined how nursing faculties conceptualise and implement formative assessment in the classroom. Furthermore, there needs to be a clear and formalised strategy to guide and assist faculties in implementing formative assessment. In addition, we found that formative assessment occupies a relatively minimal place in official texts that govern nursing education and establish the modalities of learning assessment. Existing literature offers little information on teachers' implementation of this type of assessment.

In this study, the authors propose an e-learning system to overcome the problems associated with the formative assessment process in the classroom. The contribution of this research is to use mobile systems to design e-learning support that can be used for learning assessment. This is particularly relevant as mobile applications in education are becoming increasingly popular in institutions and different training areas.

Indeed, the place of mobile learning in nursing education is supported by extensive literature demonstrating its significant pedagogical potential [14,15,16]. Specifically, mobile applications can support and enhance skill acquisition in the clinical domain [17]. [18] believe that mobile applications are equally effective as high-fidelity simulators in maintaining memory and teaching cardiopulmonary assessment skills. Similarly, mobile applications facilitate clinical problem-solving skills development, helping students improve their learning performance and reducing cognitive load [19]. Overall, mobile application analysis offers an alternative or complementary method to improve the quality of nursing education [20,21].

Based on this background, we aim to develop a mobile application for use in nursing education that teachers can use to support the integration of formative assessment in their classroom practices.

1.1 Catalyst for the invention

The evolution of mobile technologies and the growing number of studies on mobile learning in education support the authors' design of an interactive online learning system to support formative assessment. Research has found many advantages of mobile applications, such as self-assessment, quick feedback, automatic correction of quizzes and monitoring of student progress. Many studies have shown that several systems, through mobile technology, have dramatically transformed teaching and learning. The following literature review outlines existing research on using mobile applications in education and specifically in nursing.

Use of mobile technology in education. There has been significant research on the use of mobile technology in education. Some of these works have tried to measure the benefits of using mobile applications by learners. The review by [22] examines scientific research papers. It shows that children can learn and acquire problem-solving and nursing fluency skills by using coding applications, encouraging policymakers to use these applications in school programs.

Other studies have examined users' perceptions of mobile applications in teaching. The study by [23] explores learners' perception of mobile applications in English language learning. It showed satisfactory results regarding ease of use, usability and functionality. The study by [24] revealed that using the ScratchJr application, which allows

children to program interactive stories and games, generated positive teacher acceptance scores regarding its usefulness and ease of use.

Similar studies have attempted to explore the common characteristics of apps used in teaching by investigating theoretical foundations and pedagogical principles. This is exemplified by [25]'s review, which examined work on mobile applications for science learning published from 2007 to 2014. This review found that mobile applications for science learning offered several similar design features, geolocation functionality, visual/audio representations, digital knowledge-building tools and differentiated roles.

Further studies have been conducted on the role of mobile applications in education. For example, the study by [26] exploring mobile applications use in higher education showed that mobile applications were used by academics and students mainly in the form of document and data storage and exchange and communication. Very few applications were used for classroom (teaching) or field (research) activities. The study concluded that institutional support is needed to motivate students to use the applications for learning. Another study by [27] showed that parents play an influential role in selecting and using educational applications for kindergarten students.

Mobile technology in nursing education. Over the past few decades, mobile learning has been widely discussed in nursing education. A literature review by [28] concluded that the use of mobile technologies in nursing education and training has greatly advanced recently. Mobile learning has been mainly applied to training basic nursing concepts and skills and to long-term care and obstetrics.

Several works have presented results that encourage the use of mobile learning in this field by demonstrating its great pedagogical potential. The study by [29] concluded that smartphone-based mobile learning significantly influenced nursing students' knowledge, skill, confidence, performance and learning attitude. [30] used an experimental sample and found that the application 'mobile chatbot' improved nursing students' learning outcomes and self-efficacy in obstetric vaccination compared to the traditional teaching approach based on explanations in a lecture. Furthermore, [17] examined the effectiveness of mobile virtual reality as a strategy for teaching aseptic surgical skills in a surgical nursing course. The study showed that the experimental group outperformed the control group in most surgical aseptic skills, and the control group participants reported feeling anxious during conventional education.

Other studies have shown that mobile smartphone-based learning can be an alternative or supporting method to improve nursing training [31,32,33]. These studies, along with others that this paper's scope prevents us from citing, pave the way for further research on a national level to promote mobile learning in nursing education. They further encourage research to determine mobile learning's relevance according to specific variables.

1.2   The technological solution

This project aimed to design and develop a mobile application grounded in the principles of innovative formative evaluation to reduce paramedical teachers' workload and optimise their time when performing evaluation tasks. The application features quiz games and is animated by illustrations. It also provides formative feedback, making

learning more productive and efficient. When nursing students take the quizzes, they receive automatic correction and feedback per the learning objectives established in the training documents. The quizzes are divided into subtopics according to the course chapters (specification table). In the following section, we describe our methodological approach to designing and developing the application 'NursE-Quiz'.

2 Methodological approach and theoretical framework

2.1 The technological solution

Integrating technology into education is complex. The design of pedagogical tools that integrate technology must be based on scientific principles to ensure the tool will be user-appropriate. We aimed to develop a mobile application with relevant content and pedagogical effectiveness that meets students' needs and teachers' expectations for digital formative assessment. Specific goals guided our thinking throughout the development of the project:

- Design a mobile application for innovative formative assessment that meets the needs of stakeholders.
- Design a mobile application that engages and motivates students.
- Design a mobile application that is practical, attractive and effective.

In this work, we expect to develop an e-learning system that involves potential users in formative assessment.

2.2 Theoretical foundations and modelling

We adopted a working methodology based on theoretical research models to achieve our project's goals. The first objective was to design instructional materials that followed expert recommendations on formative assessment. Our theoretical foundation was William and Thompson's (2007) [34] model, which conceptualises five key strategies that guide formative assessment. Following these strategies, the NursE-Quiz was designed to incorporate these principles of formative assessment. Each feature referenced the recommendations of the theoretical model, primarily in the areas of self-assessment and formative feedback.

Based on the principles of innovative formative assessment, the application allows students to assess and correct themselves beyond the classroom context. Students can make mistakes without being penalised, making them more active and motivated to solve problems themselves. With the help of a dashboard, students can follow their progress, for example, through scores achieved, rates of progress and incorrect answers and various quiz games. In addition, the application fosters competitiveness among learners by displaying the names of the top three highest-scoring students, motivating other students to make several attempts to pass their quizzes.

The quizzes, illustrations and formative feedback in the NursE-Quiz allow students to identify their strengths and weaknesses, deepen their understanding of the material and review the course content, leading to engaged and self-regulated learning. For the teacher, the application reduces their workload and makes it easier to correct work more efficiently. It also provides immediate feedback to students via text, images, sounds and links to videos and other websites. Students will engage with effective formative feedback and formative evaluation by accessing these resources.

In addition, teachers have direct access to statistics that allow them to track students' progress in the formative assessment activities through the dashboard (for example, via scores achieved, rates of progress and questions that lead to more student errors). The NursE-Quiz application reduces teachers' workload and optimises their time when performing formative evaluation tasks. This is a crucial strength of the application, which contains a database (made up of quiz sets) that can be consulted and used by teachers in other training institutes. Therefore, the application encourages collaboration between teachers: each teacher can add to the database, and another teacher of the same subject in another city can use that content.

The design of a pedagogical tool should follow a methodological approach specific to development in the field of education [35]. Therefore, we based our project on Van der Maren's (2004) [35] theoretical development framework. According to this model, a development project must undergo six stages: analysis of the demand, specifications, object design, technical preparation, prototype construction and development.
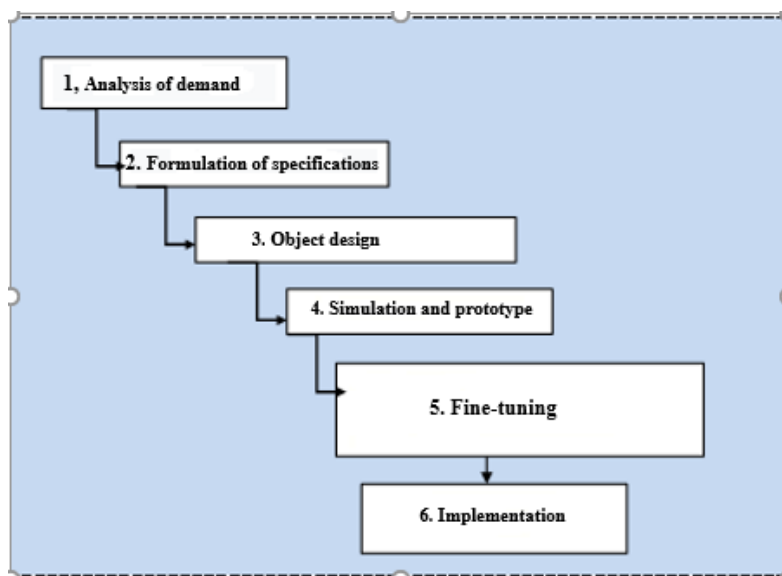

Fig. 1. Model for developing an educational tool (Van Der Maren, 2003)

a. Analysis of demand: The first step in the model was to identify the needs of stakeholders for digital formative assessment. To achieve this, a collaborative, participatory approach was used. We engaged with teachers to identify their needs related to

digital formative assessment and their expectations for a mobile application designed for this purpose. These needs were analysed and negotiated with reference to the theoretical model of formative assessment.

Interviews were conducted with ten teachers interested in using digital technology in nursing training. The questions focused on the application's objective, pedagogical perspectives and functionalities. We further investigated the target audience and potential users, the scope of the formative assessment in the application, the question types, quiz content and the configuration of the home screen. We also identified the statistical indicators necessary for monitoring students' progress. Several indicators were set with the modalities of visualisation on the phone screen. The potential for teacher-student communication using the application was also explored.

The content analysis of the qualitative data allowed us to establish explicit links between the pedagogical principles and design features of the mobile learning environment. The emerging themes related to four major constructs: 1) the learning domain targeted by the interactive system, 2) the formative assessment components to be prioritised regarding the adopted theoretical model, 3) the statistical indicators necessary to track student progress in integrating the mobile application and 4) the overall design of the application.

b. Formulation of specifications: After identifying needs and considering teachers' recommendations, a specification was developed that included the application's name, features and modelling, objectives, technical features, target audience and potential users, operating system, home screen elements and visuals. This specification was the primary document that guided the development of the mobile application**.**

c. Object design: For this phase, we consulted scientific literature related to the application's objectives of formative e-assessment, contribution to information and communication technology (ICT), pedagogical innovation and mobile learning. The theoretical models in our research were used to prepare and define the application's essential structures and pedagogical content. We used a storyboard to illustrate these.

d. Simulation and prototype: In this stage, the application's technical specifications were simulated, and a prototype of the screens was prepared according to the techno-pedagogical specifications of the application. The features were adapted to meet user expectations. Several adjustments and updates were made to improve the application and make it practical and attractive for users. A tutorial was developed to teach the target audience how to use it. A mobile development agency oversaw the technical specifications that led to the application's creation.

e. Fine-tuning: The final stage of development involved testing the prototype on a sample of users and revising it as necessary. A committee of nursing teachers evaluated the application's technical, pedagogical, and ergonomic aspects. A fine-tuning session with nursing students and teachers took place during the 2020/2021 academic year in the lead-up to implementation.

For this evaluation, we measured the users' satisfaction with the interactive system developed using the System Usability Scale (SUS). This questionnaire consisted of ten items, formulated as affirmative sentences, on a 5-point Lickert scale (1 = Strongly disagree; 5 = Strongly agree). Data from the questionnaire were processed using SPSS software.

In addition, to encourage students to use the application, we followed the guidelines of Keller's motivational model for learning, which focus on learner motivation during instruction that integrates ICT. This model proposes four steps for promoting and maintaining motivation in the learning process: attention, relevance, confidence and satisfaction (ARCS). Our application supports these principles by allowing students to participate in the evaluation of their learning and employing different types of exercises to motivate and engage them. In addition, feedback is provided via formative texts to consolidate learning and reinforce the benefits of the application in the students' minds.
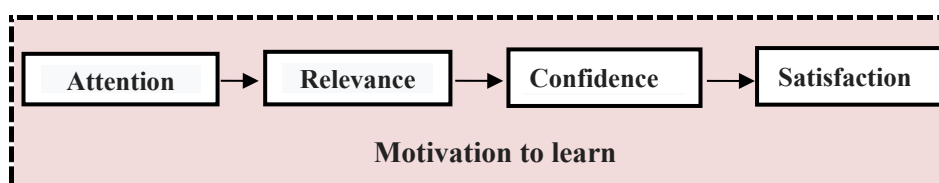

Fig. 2. ARCS Model of Motivational Design (Keller)

3   Benefits and educational interest

As discussed in previous chapters, the NursE-Quiz application fills a gap in pedagogical innovation in nursing education in Morocco. This application differs from standard online quizzes because of its educational and pedagogical benefits. NursE-Quiz encourages innovative formative evaluation through self-assessment and self-correction. It supports learning through formative feedback during the quiz and encourages student responsibility and commitment to learning. The application allows teachers to track student progress in the formative assessment activities, while the automatic correction process reduces workload and optimises teachers' time. Finally, NursE-Quiz promotes collaboration, as any teacher can contribute to the database. Therefore, NursE-Quiz meets the needs of the stakeholders in formative evaluation by supporting students' learning through quizzes and formative feedback, reducing teachers' workloads and optimising teachers' time.

To evaluate NursE-Quiz, the authors conducted a usability test using the SUS questionnaire. It scored 80.5 on a scale of 100 according to the scale interpretation mode [36]. Therefore, the online system obtained an excellent score in terms of acceptability, as shown in Figure 3.
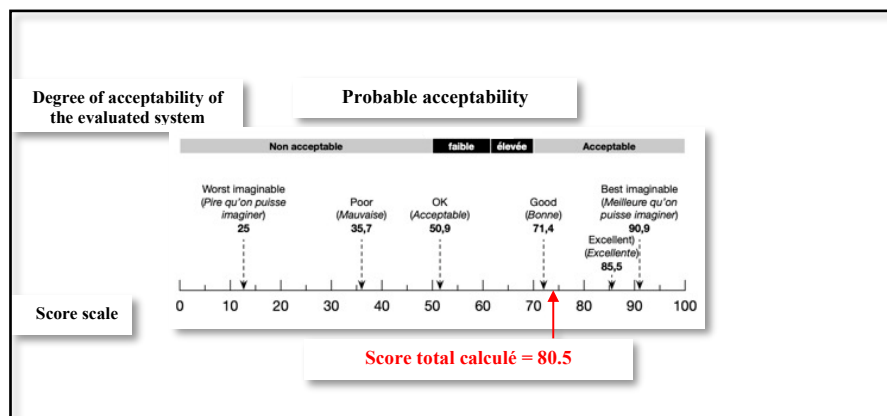
Fig. 3. Interpretation of the SUS score

Compared with other scientific works investigating mobile learning use, our NursE-Quiz application reinforces the scope of mobile learning systems in nursing education. Existing studies show that mobile systems can reinforce knowledge and skills in nursing. [33] aimed to determine the effect of a game-based mobile application on nursing students' skill levels in flushing and locking venous catheters with pre-filled syringes. Following an experimental approach, the study concluded that the game-based mobile application effectively improved nursing students' skills in flushing and locking venous catheters. Other studies have shown how mobile learning can facilitate learning in specific training courses. For example, [37] developed a mobile application 'Anatopass' to support anatomical learning in caregiver training.

Our study corroborates previous similar works' findings about the accessibility of mobile learning. For example, the review by [32] concluded that the developed application is acceptable and usable for nurse educators and nursing students and is an effective tool for improving the quality of education. The earlier review by [31] examined user perceptions of mobile learning in nursing education by reviewing several research studies. This review showed that health professionals appreciated aspects of mobile devices such as efficiency, interaction and personalisation; however, they were concerned about mobile devices' ability to provide training and support.

The NursE-Quiz application is the first mobile application designed by Moroccan researchers to improve classroom-teaching practices. The functionalities developed can assist teachers in delivering formative assessments in the classroom.

4 The tool: NursE-Quiz

NursE-Quiz is a mobile educational application. Its name references its content – a quiz game for nursing students. It is accessible via the Android operating system to those who have obtained a username and password from a designated administrator at their training institution.

The application features quizzes with different question types, such as true or false, fill-in-the-blanks, MCQs, CROC, drag and drop, matching and selecting an image. The application provides automatic correction with formative feedback following each question, and students can track their progress, scores and answers on the quizzes.

The application has a dashboard that enables teachers to create quiz sets in different courses, provide feedback, and view students' tracking indicators at any time. Teachers can also send messages to students via WhatsApp or email within the application. These are some examples of the application's screens:
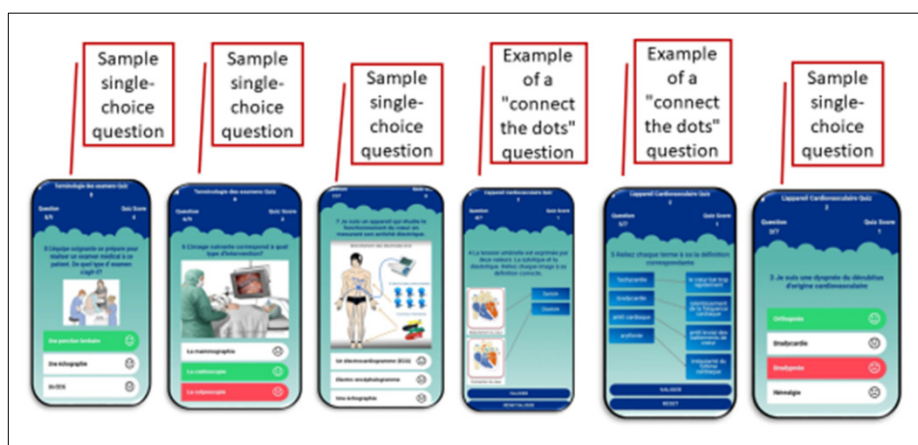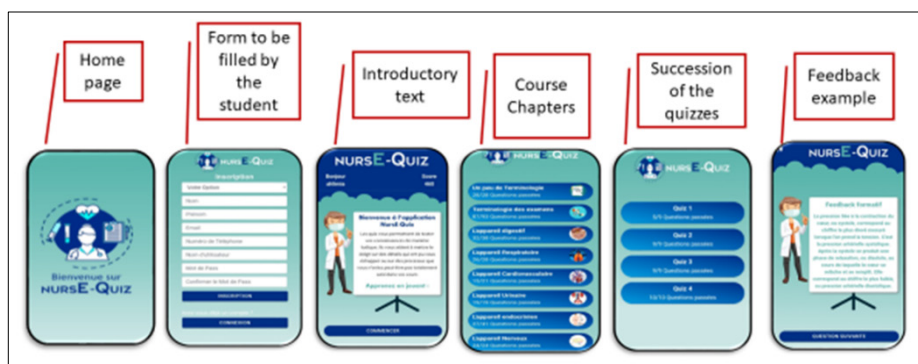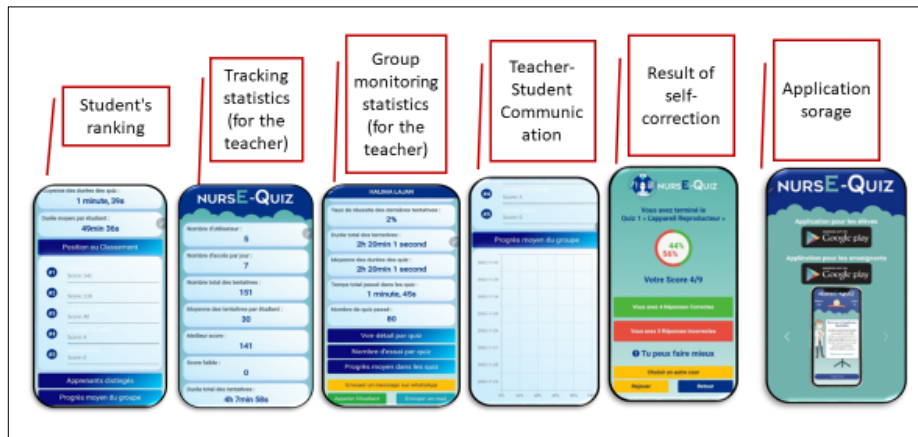
Fig. 4. Application's screens

5   Conclusion

This project's objective was to develop a mobile pedagogical tool to support student nurses' learning while fulfilling the principles of formative assessment. We used theoretical models to design and develop the tool to achieve our goal.

When implemented, the NursE-Quiz application can promote digital formative assessment, optimizing teachers' time and allowing students to identify their strengths and weaknesses. Further research is needed on how mobile applications can support teaching and learning approaches in nursing education.

More research is needed on how mobile applications can be used to support teaching and learning approaches in nursing education.

In the same sense, it is highly necessary to provide institutional support to teachers in their practice, in order to initiate them to integrate interactive learning systems in their daily practice. It is necessary to focus on the training of teachers and also the involvement of learners in these innovative processes. Our work, based certainly on the design of a tool to promote formative evaluation, can be an initiation to other similar projects that incorporate the research component for the improvement of classroom practice.

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