



## Development of Mobile App as an Educational Tool for Understanding Nanomedicine

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Research Article

### Abstract:

Nanomedicine, an emerging field at the intersection of nanotechnology and medicine, holds great promise for revolutionizing healthcare by enabling targeted diagnostics and treatments at the molecular level. However, due to its complex nature, understanding nanomedicine concepts and applications can be challenging for healthcare professionals, researchers, and the general public. To bridge this knowledge gap and promote awareness, a mobile application was developed to enhance the understanding of nanomedicine, and named it "MyNanoRia". The MyNanoRia was developed by initially designing suitable content, compiling information and creating the apps using Unity platform, specifically for the Android operating system. The MyNanoRia provides users with readily available knowledge about nanomedicine's concepts, methods, and applications as an interactive educational tool. Specific facets of nanotechnology, nanomedicine, nanomaterials, and cancer are covered in this app. MyNanoRia also includes definitions for particular keywords. This app's creation required consulting and validation by subject-matter specialists, such as chemists, biologists, and medical scientists. The development of MyNanoRia is challenging since nanotechnology is a multidiscipline topic that indeed emphasizes scientific understanding, but the intended users are those who know little to nothing about it. Creating the MyNanoRia app for understanding nanomedicine seeks to close the knowledge and awareness gap between science and the general public, enabling researchers, healthcare professionals, and the general public to fully value nanotechnology's potential in healthcare.

**Keywords:** Educational tool; Mobile app; Nanomaterial; Nanomedicine; Nanotechnology

## 1. INTRODUCTION

Nanotechnology is an emerging technology that affects our daily life and will be more prominent in the future (1). Nanotechnology is a technology related to tiny particles, materials or phenomena  $10^{-9}$  m which are smaller than bacteria or viruses (2). Nanotechnology also usually refers to the application of nanomaterials for various purposes, such as for medicine, referred to as nanomedicine (3). Because of their tiny size, the nanomaterials possess unique properties different from their bulk material, such as high surface area and smaller particle size (4). Figure 1 shows the size range of examples of nanomaterials (carbon, quantum dots and liposome) as compared to other biomolecules. The size of the nanomaterials is higher than that of the atom but lower than that of bacteria and eukaryotic cells (5). Many recent review papers reported on the application of nanomaterials in various fields, such as wastewater treatment (6), biomedical and sensing applications (7), antibacterial agent (8) and drug delivery systems for anticancer drugs and cancer biomarkers (9).

The nanomaterials market has grown substantially in recent years, and many innovations have been created based on nanomaterials (10). According to a report published on [www.alliedmarketresearch.com](http://www.alliedmarketresearch.com), the global nanomaterials market was valued at \$16.3 billion in 2021 and is expected to reach \$62.8 billion by 2031, rising at a compound annual growth rate (CAGR) of 14.6 percent from 2022 to 2031. Nanomaterials, which are distinguished by their unique properties at the nanoscale, have found significant application in a variety of industries, including electronics, healthcare, energy, and aerospace (9, 11, 12). These materials are desirable for modern technological breakthroughs because of their improved mechanical, electrical, and thermal qualities. The market for nanomaterials is driven by increased demand for lightweight

and durable materials, rising research and development (R&D) spending, and a growing emphasis on sustainable solutions. The need for nanomaterials will likely expand as nanotechnology advances, providing enormous opportunities for existing companies and startups to profit from this quickly growing industry.

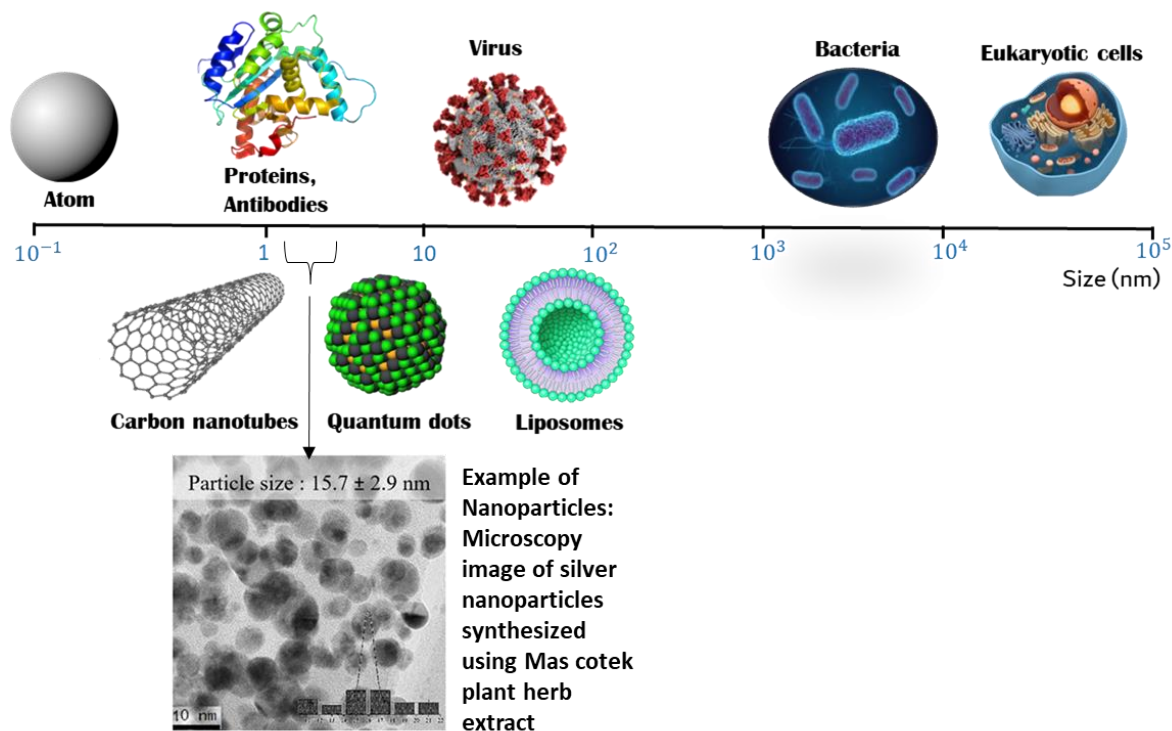


Figure 1. Comparison of nanomaterials' sizes and examples of nanoparticles.

Nanomedicine has emerged as a promising field in the fight against cancer, revolutionizing how we approach diagnosis, treatment, and prevention. Nanoparticles and nanoscale devices are being extensively researched and developed to target cancer cells, specifically, delivering therapeutic agents directly to tumors while minimizing damage to healthy tissues (13). This targeted approach increases drug efficacy, reduces side effects, and improves patient outcomes. Nanomedicine for cancer encompasses a wide range of applications, including drug delivery systems (14), imaging agents (15), and diagnostic tools (16). Nanoparticles can be engineered to carry chemotherapy drugs, gene therapies, or immunotherapeutic agents, enhancing their stability, solubility, and bioavailability. As research and development in nanomedicine continue to advance, integrating nanotechnology into cancer care holds immense potential to improve the effectiveness and personalization of cancer treatment strategies (17). Therefore, there will be an increased prospect of the application of nanotechnology in treating cancer; hence, understanding the basic knowledge of nanomedicine is very important nowadays.

One way to make the public understand this new and complex knowledge is by developing a mobile app and disseminating this app to specific groups. Mobile apps have revolutionized how information is accessed, making it convenient and accessible anytime, anywhere (18). These apps provide platforms for interactive learning, offering engaging and immersive experiences that aid in comprehending intricate concepts. Educational apps designed specifically for understanding new and complex knowledge employ multimedia elements, such as videos, animations, simulations, and quizzes, to enhance learning. With the continuous advancement of technology, the development of mobile apps to understand new and complex knowledge will continue to shape the education landscape, making learning more engaging, accessible, and effective (19, 20). Hence, using the mobile app to disseminate knowledge and information about nanotechnology and nanomedicine is important because of emerging nanotechnology applications in our daily lives. Therefore, this paper reports on the development of a mobile app that can be used for understanding the application of nanotechnology in the medical area, specifically for treating cancer.

## 2. MOBILE APPS DEVELOPMENT

Designing suitable content for understanding nanotechnology applications for cancer management is quite challenging because it is complex knowledge that involves multi- and inter-disciplinary disciplines. The disciplines include chemistry, physics, biology and medicine. Furthermore, transferring this complex knowledge to the public is challenging because people with limited knowledge must understand this nanotechnology information. Therefore, the development of the mobile apps should be based on these three objectives:

1. Design appropriate mobile app content that relates to knowledge of nanomedicine.
2. Gather and compile information on the fundamentals of nanotechnology, nanomaterials, nanomedicine, and cancer.

### 3. Create an app for the general population that will help them comprehend nanomedicine.

Figure 2 shows the mobile app development flow diagram to ensure the public can easily understand the complex knowledge.

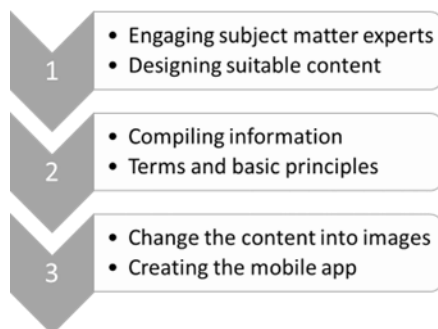


Figure 2. Process of developing mobile apps for understanding nanomedicine.

Developing the mobile app started with the engagement with subject matter experts, including chemists, biologists, material scientists and medical scientists. This step is needed to ensure that the contents are related, starting from understanding the basic principles of nanotechnology and its application for cancer treatment. Afterwards, each subject matter expert gathered and drafted the information based on the topics. At this stage, the experts used their results from previous research related to nanomaterials.

The developer needs to collate and revise the information and materials from the subject matter experts in the second stage to ensure it is appropriate for the mobile app. The info consists of basic principles of nanotechnology and nanomedicine, examples of research done by the subject matter experts, the application of nanotechnology, the definition of the term and other helpful information. For the user to comprehend the text more naturally based on the illustration, the written information must finally transform into appropriate images and infographics. The expert and developer design and compile the images to create interactive content for mobile apps.

The mobile app MyNanoRia was developed using the Unity platform, specifically for the Android operating system. The development process extensively involved programming with the C# language through Microsoft Visual Studio. The interface (UI) and user experience (UX) were designed using CorelDRAW, ensuring a visually appealing and intuitive design. The choice of Unity as the development platform provided a range of robust features and functionalities for creating a dynamic app. Considerable attention was given to the UI/UX aspects of MyNanoRia. CorelDRAW, a comprehensive graphic design software, meticulously designed UI elements, including buttons, menus, icons, and backgrounds. The goal was to ensure visual coherence and a seamless user experience, maintaining consistency with the overall theme and purpose of the app. Careful consideration was given to the app's flow and interaction patterns to enhance the user experience. Emphasis was placed on intuitive navigation, logical information hierarchy, and user-friendly interactions. By prioritizing usability and accessibility, the aim was to create an app that users could effortlessly navigate and readily understand its functionalities.

The implementation of core features and gameplay mechanics was achieved through the utilization of the C# programming language. Microsoft Visual Studio was an effective development environment, facilitating seamless integration with Unity. This enabled efficient code management, optimization, and the implementation of complex algorithms to ensure the smooth and responsive functionality of the app. Extensive testing and debugging were carried out throughout the development process to ensure the stability and reliability of MyNanoRia. Various testing methodologies were employed to identify and address issues or bugs, including functional, performance, and compatibility. Testing involved running the app on different Android devices with varying screen sizes and resolutions to ensure optimal performance across various devices.

The content of the MyNanoRia app was validated by the subject-matter experts who represent the important and related fields in nanotechnology and nanomedicine, including experts in inorganic chemistry, physical chemistry, material science, biology, biomedical science and cancer. In addition, an expert in the education field validated the content of the MyNanoRia that is suitable for secondary school students.

### 3. FEATURES OF MOBILE APPS

The mobile app, naming as MyNanoRia, encompasses three elements which are "My", referring to Malaysia, "Nano", referring to nanotechnology, nanoscience and nanomedicine and lastly, "Ria", meaning happiness or joy in this mobile app. The symbol and initial pages of the MyNanoRia can be seen in Figure 3. It was designed so that it can be interesting to be used for secondary school students and also the public. The contents of MyNanoRia are divided into two sections: information and definition. Because of the complex knowledge of nanotechnology applications in medicine, it is crucial to understand the description of each term in the information section.



Figure 3. Symbol and initial section of mobile app MyNanoRia.

Figure 4 shows the page for the definition section and its example. The terms include nanotechnology, surface area, thin film, nanomaterial, nanostructure, liposome, nanomedicine, transmission electron microscopy (TEM), dendrimer, cancer, field emission scanning electron microscopy (FESEM), and chemotherapy. The definition is given in two languages which are English and Malay. The app users can go to each definition if the users do not understand a term that appears in the information section.

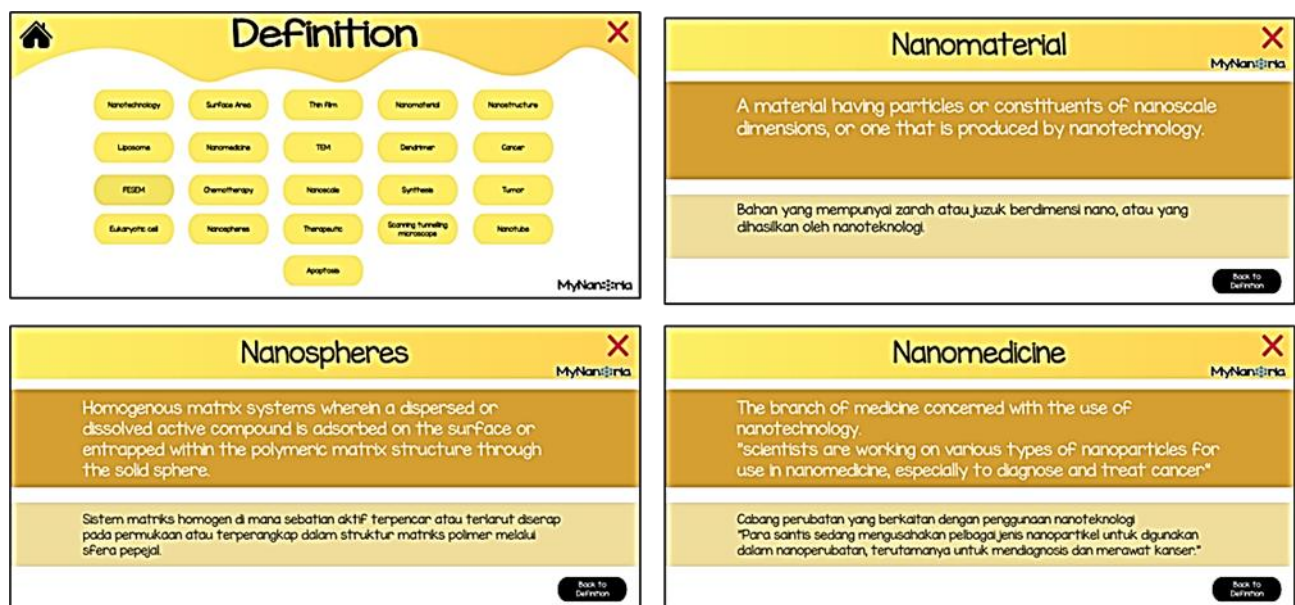


Figure 4. Section for definition of related terms to nanotechnology and nanomedicine.

The information section (Menu) has four main sections: nanotechnology, nanomaterials, nanomedicine and cancer (Figure 5). Since this mobile app is used specifically for cancer treatment using nanotechnology and nanomaterials, the user must understand the basic principles of each discipline. Nanomaterial is one specific part of nanotechnology, encompassing various materials useful for medical applications. An example of the data from the subject matter expert's research is given in Figure 6. The figure shows the image of silver nanoparticles and silica aerogels nanoparticles prepared in the laboratory. The image clearly shows that the particles are nanosized (less than 100 nm) and helpful for biomedical applications. i.e. antimicrobial agent (silver nanoparticles) and bone-implant (silica aerogels). This example is important to increase the awareness of the user on future prospect of the nanomaterials in medicine design.

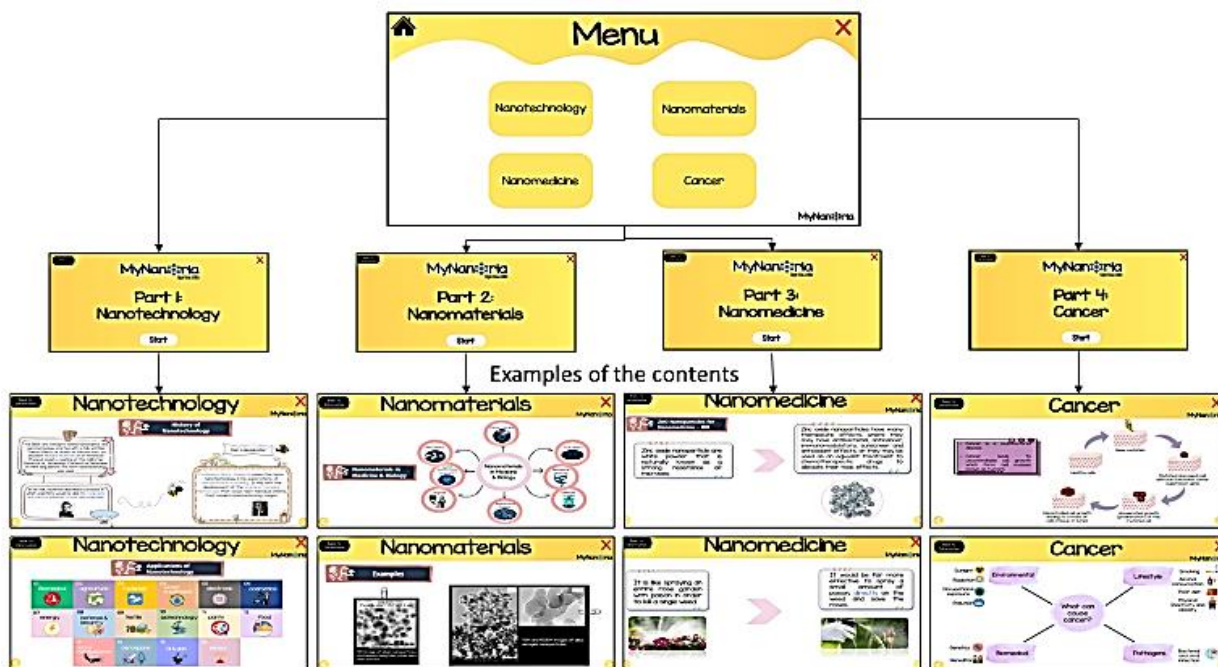


Figure 5. Section for main menu and primary information.



Figure 6. Example of results reported on subject matter expert's research.

It is expected that MyNanoRia can be a valuable tool for the target audience, students from secondary schools, to understand the basic concepts of nanotechnology and its application in medicine. Although science students learned the nanotechnology topic in the syllabus, the content does not relate to nanotechnology applications in medicine. However, the application of this app needs to be assisted by science teachers and subject matter experts because some of the contents need to be comprehensively explained in scientific ways. This is also important so that there is a correlation between nanotechnology and nanomaterials topic with cancer treatment. For example, the nanomaterial can be used as a drug delivery system for cancer treatment. In this case, the nanomaterials need a high surface area and pore with the suitable size of the cancer drug to accommodate the drug molecules and then release it into the affected area in the patient body.

The development of MyNanoRia is quite challenging since it involves several scientific fields, including chemistry, physics, biology, material and medicine. The information must be connected, and hence, the basic principles of all related topics must be clearly understood. The current MyNanoRia is at the preliminary stage, and many improvements must be made to ensure the app is exciting and easily understood by the user. Additional improvements on the contents, feedback and other suitable tools are needed to improve this mobile app. Interactive quizzes and gamification elements should also be added to this app. These elements enhance user engagement, motivation, learning, social interaction, behaviour change, and personalization. By incorporating game elements like challenges, rewards, and leaderboards, mobile apps can captivate users, keep them engaged, and encourage them to spend more time interacting with the app. These elements elevate the app experience, driving user retention and achieving desired objectives. It is hoped that the public can understand nanotechnology for medical applications in the future through this MyNanoRia app.

Understanding nanomedicine for cancer treatment is crucial for the public, school teachers and students, and medical doctors. For the public, awareness of nanomedicine enables informed decision-making and fosters hope while dispelling fears and promoting support for emerging technologies. School teachers and students benefit from incorporating nanomedicine into education, as it encourages critical thinking and interdisciplinary exploration and inspires future scientific

innovators. Understanding nanomedicine empowers medical doctors to provide personalized, effective care, utilizing targeted therapies, advanced diagnostics, and real-time monitoring. Overall, promoting understanding of nanomedicine among these groups facilitates decision-making, inspires future scientists, and enhances patient outcomes in the fight against cancer. As stated by Pautler and Brenner (21) in their review paper regarding the promises and challenges of nanomedicine for the future public health, various innovations in nanomedicine, such as the treatment of heart disease and cancer demonstrate excellent potential to reduce rates of morbidity and mortality.

#### 4. CONCLUSION

MyNanoRia, a mobile app, has been successfully developed by various subject matter experts, including chemists, biologists, material scientists and medical scientists, to share basic information about the application of nanotechnology in medicine. The MyNanoRia encompasses relevant information about nanotechnology, nanomaterial, nanomedicine and cancer. It is expected that the MyNanoRia can be used by secondary school students and the public to comprehend the basic knowledge of nanomedicine.

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#### CONFLICT OF INTEREST

Authors have no conflict of interest to declare.

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