CSCanada
Canadian Social Science
Vol. 21, No. 2, 2025, pp. 33-41
DOI:10.3968/13792

ISSN 1712-8056[Print]
ISSN 1923-6697[Online]
www.cscanada.net
www.cscanada.org

Research on the Development Path of School-based Textbooks for Elderly Universities on the Basis of Mobile Augmented Reality

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Supported by the Scientific Research Fund of Zhejiang Provincial Education Department (Grant No. Y202249321).

Received 5 March 2025; accepted 18 April 2025
Published online 26 April 2025

Abstract

The development and application of high-quality school-based textbooks for elderly universities are of crucial significance for enhancing the effectiveness of elderly education and facilitating the implementation of the active aging strategies. Currently, the development of school-based textbooks for elderly universities has made certain progress. But in the context of the rapid development of digitalization and technology, there are still many deficiencies in aspects such as content design, application practice, and management support. Innovative solutions are urgently needed. Mobile augmented reality (MAR) has the features of virtual-real fusion, multi-sensory interaction, and scenario creation. On the basis of the solid theoretical basis of multi-sensory learning theory, situated learning theory, and extended technology acceptance model (ETAM), MAR was used to provide new perspectives and feasible paths for the innovative development of school-based textbooks for elderly universities. A development and optimization path integrating MAR technology was systematically constructed and validated to address the existing problems of school-based textbooks for elderly universities. The path fully utilizes the technical advantages of MAR to effectively enhance the attractiveness, usability, and learning effectiveness of the textbooks, and can provide useful references for subsequent theoretical deepening and practical exploration in related fields.

Key words: Mobile augmented reality (MAR); Elderly university; School-based textbook; Textbook development

Tao, J. F. (2025). Research on the Development Path of School-based Textbooks for Elderly Universities on the Basis of Mobile Augmented Reality. *Canadian Social Science, 21*(2), 33-41. Available from: http://www.cscanada.net/index.php/css/article/view/13792
DOI: http://dx.doi.org/10.3968/13792

1. INTRODUCTION

In recent years, the aging population in China has continued to increase. According to the data of the Seventh National Census, the proportion of people aged 65 and above reached 13.50%. It was an increase by 4.63 percentage, compared to 2010 (National Bureau of Statistics. Bulletin of the Seventh National Census, 2021), and the society has been approaching a society in deep aging. At the same time, the elderly population in the digital era has shown increasingly diverse learning needs. Therefore, innovating and developing elderly education has become an important measure to actively respond to population aging. In educational practice, as the core carrier of knowledge and skills transmission, textbooks have become a consensus in the academic community. Elderly education also relies on the basic teaching function of textbooks. So, the development of school-based textbooks is of vital importance for elderly universities in the process of developing elderly education. The traditional paper-based textbooks have limitations in content presentation and interactivity, and need digital innovation. At the national level, great attention has been paid to the integration of technologies and education. As early as the "13th Five-Year Plan", it was emphasized to explore new educational models by comprehensively utilizing internet, big data, artificial intelligence, and virtual reality. (State Coucil, 2017) In the recently released *Master Plan on Building China into a*

Leading Country in Education (2024-2035), it was further explicitly proposed to implement the national education digitalization strategy, (Xinhua News Agency, 2025) which provides strong guidance and important support for the development of school-based textbooks for elderly universities. Mobile Augmented Reality (MAR) is a technology that superimposes computer-generated virtual information (3D models, text, audio and video, etc.) onto the real world. Its features of virtual-real fusion and multi-modality can provide innovative methods for the digital transformation of traditional school-based textbooks for elderly universities. In the research, the practical path for the development of school-based textbooks for elderly universities was specifically studied on the basis of MAR. It was aimed to improve the quality of textbooks and learning experience, and help the elderly population to engage in lifelong learning and keep pace with the times.

2. THEORETICAL BASIS AND ITS SIGNIFICANT VALUE OF EDUCATION BASED ON MAR

2.1 History of MAR

The concept of augmented reality (AR) was first proposed and applied in the aviation manufacturing industry in the 1990s. (Caudell T, Mitzell, 1992) It has three features: Real-virtual fusion, real-time interaction, and three-dimensional registration. (Azuma, 1997) The cross-application of artificial intelligence and human-computer interaction has brought revolutionary changes to many fields during its development process. In the early stage, AR systems needed to work with the help of bulky head-mounted display devices and desktop applications. Due to their technical features such as intuitive and vivid stereoscopic visual impacts, they had been mostly used in engineering and medical fields. In 2008, the iPhone 3G was released, and achieved a breakthrough in mobile computing capabilities. Since 2010, smart phones have rose to prominence, and MAR began to be commercially popularized, involving various industries such as games, tourism, and retail. The Pokemon GO in 2016 was a milestone of MAR. It marked that the technology entered the stage of extensive application. Benefiting from the productivity upgrade of mobile phone accessory manufacturers nowadays, components such as gyroscopes, accelerometers, and high-resolution screens equipped in smart phones have formed the necessary architecture of AR devices. With the rapid progress of the mobile internet technology and the significant increase in mobile bandwidth, MAR has begun to demonstrate its huge potential value and also provides new opportunities for in-depth exploration in the field of elderly education.

2.2 Theoretical basis of education based on MAR

2.2.1 Multi-sensory learning theory

Multi-sensory learning was derived from the Visual-Auditory-Kinesthetic-Tactile (VAKT) strategy proposed by an American scholar, Funa, which is based on the concept of whole-brain learning. It utilizes the brain's natural and efficient information processing mechanism to activate different brain regions to work collaboratively. According to previous research results, it can address cognitive decline and significantly reduce the learning burden of the elderly by organically integrating visual reinforcement, auditory assistance, and tactile feedback to mobilize multiple senses to construct a multimodal interactive experience. (Tu and Luo, 2024) The multimodal characteristics of MAR demonstrate unique advantages in this regard, and can optimize the learning process and enhance the learning efficiency of school-based textbooks in elderly universities.

2.2.2 Situated learning theory

It was proposed by two American educationalists, Jean Lave and Etienne Wenger. (Lave and Wenger, 1991) The theory emphasizes the close integration of knowledge with practical situations. It holds that the best way to learn is to incorporate knowledge into real-life situations, allowing learning to occur naturally in the process. Knowledge acquired through this method is more likely to be retained and applied flexibly. With its characteristic of integrating the virtual and the real, MAR can effectively create a deeply integrated learning environment of the virtual and the real. By combining learning and application, it can stimulate learning motivation and interest through such specific situations and optimize the cognitive process of school-based textbooks in elderly universities.

2.2.3 Extended technology acceptance model (ETAM)

Whether a technology can be successfully applied largely depends on the acceptance level of the target users. Although the MAR has great potential, if the users lack the willingness or encounter difficulties in operation, its value will be difficult to be fully exerted. The extended technology acceptance model (ETAM) clearly states that the two core variables for users to adopt new technologies are perceived ease of use and perceived usefulness, and another frequent extension variable is perceived enjoyment. According to existing research results; it is confirmed that the acceptance of technologies is a key constraint factor affecting the application effectiveness of AR resources in the education field. (Graser and Böhm, 2024) Given that the elderly group generally has a relatively weak technical foundation, the formulation of the implementation plan should be guided by the ETAM framework to ensure that elderly learners believe that this technology can effectively improve learning efficiency and effectiveness (usefulness), the operation process is simple and does not require additional effort (ease of use), and it can bring positive emotional experiences and enjoyment to the learning process (enjoyment).

The above theories provide research guidance for the practice path of developing school-based textbooks for elderly universities based on MAR. They reveal the improvement direction of such traditional textbooks, and serve as an important basis for the subsequent design strategies and technical solution implementation.

2.3 Value of school-based textbooks for elderly universities

In 1983, the first elderly university was established in China to offer courses in sports, culture and art. The initial goal was to help the elderly enrich and enjoy their later years. The "learning for the elderly" objective was more oriented towards "enjoyment for the elderly". During the several decades of development of elderly education, research in this field has gradually deepened, and the understanding of its essence and connotation has become increasingly profound. When the *Law of the People's Republic of China on the Protection of the Rights and Interests of the Elderly* was revised in 2012, it clearly stipulated that "the state develops elderly education and incorporates it into the lifelong education system". Thus, the educational attribute of elderly education has been emphasized by legislation. In 2019, the Central Committee of the Communist Party of China and the State Council issued the *National Long/Mid-Term Plan for Actively Responding to Population Aging*. The Plan elevating the response to aging to a national strategy. "Older people being able to contribute" has become one of the core elements of active aging strategies. Elderly education should be responsible for imparting modern knowledge and skills, and serve as an important channel to safeguard and enhance the dignity of the elderly's lives. It should be constantly innovated and adjusted to promote the social participation of the elderly and realize their self-worth, which thereby promotes sustainable social development.

The formation of the digital divide among the elderly is essentially a gap caused by the technological cognition. The unfamiliarity of the elderly with technologies significantly affects their acceptance of technologies, which in turn leads to anxiety in using technology and difficulties in adaptation. In the field of elderly education, MAR can serve as an effective cognitive extension tool to eliminate the technological cognitive boundaries of elderly individuals. At the same time, MAR can also be used as a powerful cognitive assistance tool, to provide multi-sensory, interactive, and situated learning experiences. It can significantly enhance the expressiveness and enjoyment of the content of school-based textbooks for the elderly, and effectively improve their learning outcomes. For example, we can construct vivid MAR teaching scenarios for classroom teaching; provide personalized MAR content to support ubiquitous and autonomous learning; apply MAR in experimental and demonstration courses to enhance safety and efficiency; present MAR resources through intelligent devices to enhance the visual intuitiveness and teaching interactivity of the textbook content. Its unique virtual-real fusion perception scenario can lower the threshold of knowledge understanding, stimulate the learning interest and motivation of elderly students, promote their transformation from passive learning to active exploration, and make the learning process more efficient and interesting. It indicates that this technology has important research value and wide practical application potential, and is in line with the future development trend of elderly education technology. It is expected to revolutionize the current elderly education teaching model and provide innovative solutions for the development of school-based textbook for elderly universities.

3. CURRENT SITUATIONS AND EXISTING PROBLEMS OF SCHOOL-BASED TEXTBOOK DEVELOPMENT FOR ELDERLY UNIVERSITIES

3.1 Current situations of school-based textbook development for elderly universities

With the continuous growth of the economy and the significant improvement of social civilization in China, as well as the country's advocacy and support for elderly education, the demand for elderly education has entered a period of rapid growth. The elderly group's desire for lifelong learning and improvement of the education qualities has been continuously increasing, and they have shown higher self-expectations. These facts pose new challenges to the teaching capability and level of elderly education professionals, and also impose higher requirements on the quality of school-based textbooks for elderly universities. Traditional school-based textbooks for elderly universities are originated from local studies. They were compiled by organizing and transforming teachers' practical experience, oral records, and lecture notes, and were for internal use only. They generally used paper as the only carrier. This knowledge transmission mode conforms to the inherent learning preferences of the elderly group, but its drawback is that the content presentation is limited to static text and images, keeping learners in a passive receiving state throughout the reading process. The aging of the elderly's physiological functions leads to natural decline in their cognitive abilities, including the attenuation of attention persistence, the reduction of working memory capacity, and the weakening of information processing speed. The one-dimensional and flat content form is relatively dull and difficult to stimulate the enthusiasm of the elderly for active exploration, resulting in low efficiency in internalizing knowledge. Therefore, the innovation and upgrading of traditional school-based textbooks for elderly universities is imperative.

In the *Plan for the Development of Elderly Education (2016-2020)*, it was emphasized that the focus of the increase in elderly education should be placed at the grassroots level and in rural areas. It focused on exploring the establishment of elderly open universities as the main body based on open universities and radio and television universities, and promoted the integration of IT into the entire process of elderly education. (General Office of the State Council, 2016) The integration of IT with elderly education is of crucial significance for driving the modernization transformation and adaptive reshaping of the cognitive system of the elderly population. This learning process conveys specific knowledge and enhances the elderly population's understanding of emerging technologies. Textbooks serve as the carrier of knowledge, the guide for teaching, and the tool for learning, and assume multiple roles. They are the core link connecting the course content with teachers and students. In recent years, various elderly universities have increasingly attached importance to textbook development and actively attempted to provide audio and video resources for school-based textbooks. Elderly students have also shown an active attitude towards such resources. Both policy guidance and practical exploration have highlighted that the development model of integrating textbooks and technologies is gradually becoming the mainstream trend.

3.2 Existing problems of school-based textbook development for elderly universities

School-based textbook development for elderly universities is a systematic project. Although such textbooks have shown a positive trend in recent years, there are still some key issues that restrict their further development.

Firstly, they are content and design. The existing technology integration solutions need to be improved in terms of scientificity, rationality, and compatibility. It is mainly reflected in the lack of adaptability for the elderly, such as the content being either too specialized or poorly simplified, which fails to effectively grasp the appropriate difficulty level of teaching. There is also a phenomenon of simply copying the educational model from academic education, which reduces the attractiveness of the technology to elderly learners. In terms of presentation logic, case selection, and language style, they fail to align with the cognitive habits and life experiences of the elderly population, and thereby weaken the enabling value that the technology is supposed to have.

Secondly, they are the practicality and application aspect. Currently, the connection between some school-based textbooks and practical teaching is not strong. The content is disconnected from actual applications or there is a lag in updates. The utilization rate is low. The main problem lies in the uneven quality of some textbooks, which fail to fully reflect the practicality of knowledge and the operability of skills. They lack close connection with the daily lives of the elderly and may lack necessary practical operations and case guidance contents. Even some may have a tendency of being developed merely for development purposes, deviating from the concept of "learning centered on learners" in elderly education. As a result, it is difficult to stimulate the learning interest and application enthusiasm of elderly students, and the learning fails to achieve the expected results.

Thirdly, they are the management and support. For the school-based textbooks for the elderly university, from the content arrangement design, adaptation to the elderly population, development of supporting resources, to the subsequent application promotion, effect evaluation, and iterative update, all key links in the entire life cycle management have exposed systematic deficiencies. The fundamental reason lies in the lack of professional team building and efficient collaboration mechanisms, and the failure to form a complete set of process management norms. For instance, the authoritative review and certification system is absent, and the closed-loop mechanism for continuous improvement has not been effectively established. In terms of personnel allocation, there is a shortage of compound talents with both experience in elderly education and modern educational technology capabilities. The overall strength of teachers and technical support is lacking, and at the same time, the sustainable funding input and effective incentive mechanisms are also insufficient. These problems jointly restrict the in-depth exploration and wide application of new forms of textbooks such as rich media and interactive ones, hindering the full play of their potential.

In view of the deficiencies in the development of school-based textbooks for elderly universities in the aforementioned aspects, the knowledge system carried by the paper-based content is effectively integrated with the dynamic presentation capabilities of MAR resources to enhance the expressiveness and interest of the school-based textbooks for elderly universities, providing multi-sensory, interactive and contextualized learning experiences, which is conducive to optimizing the cognitive process of senior students and improving learning efficiency. This measure can inject new vitality and value into the school-based textbooks for elderly universities, and also provides important enlightenment for exploring the development process and continuous optimization path of new textbooks, making it an important direction worth exploring in the current field of elderly education.

4. DEVELOPMENT PATH FOR SCHOOL-BASED TEXTBOOKS FOR ELDERLY UNIVERSITIES BASED ON MAR

On the basis of the aforementioned theoretical guidance and the necessity of applying MAR, it was aimed to establish and verify a development practice path for optimizing the school-based textbooks for elderly

universities through MAR in this section. It elaborates on the development design strategies, technical implementation plans, the development process and implementation of specific applications, as well as other precautions, respectively.

4.1 Development design strategies

In order to stimulate the learning interest of elderly students, promote a deeper understanding of the learned knowledge, and enhance their technical awareness and digital literacy, when integrating MAR resources based on the school-based textbooks for the elderly university, the following specific design strategies should be followed when creating an immersive learning environment.

Firstly, the operation of accessing MAR resources in the school-based textbooks should be user-friendly by lowering the usage threshold, avoiding the switching of multiple tasks, and ensuring that elderly students can easily apply them. It is to prevent complex operations from undermining their confidence in trying new technologies. In this regard, priority should be given to the needs of elderly students, and various factors such as maturity, stability, and compatibility should be considered instead of pursuing technological cutting-edge.

Secondly, the content presentation of MAR resources should be diversified and targeted. In the textbooks, the use of multimedia elements in the form of MAR to assist understanding can adopt presentation methods such as 3D models, animations, audio and video, etc. For example, in skills courses, the understanding of intelligent devices can be presented using gesture-operated 3D models, and the usage methods can be vividly demonstrated through audio and video to show the operation process. Some abstract concepts can be understood through animation demonstrations.

Finally, the content of MAR resources should have cognitive friendliness for the elderly, including simple interfaces, intuitive design, and easy understanding, to reduce the cognitive load that elderly students may face when using it. Thereby, it can maintain their positive learning intention; ensure the accessibility of the interaction process to optimize the usage experience of elderly students and promote the formation of learning motivation, reduce redundant information and potential audio-visual interference, allow the attention of elderly students to focus on the core content, and thereby enhance the internalization effect of learning and improving learning efficiency.

On basis of the above design strategies, an elderly-friendly MAR teaching ecosystem can be effectively constructed in the school-based textbooks for the elderly university. While it increases the learning participation of elderly students, it enhances their trust in new technologies and promote their better integration into the modern technological society.

4.2 Technical implementation plans

The core principle of the MAR lies in the real-time perception and identification of elements in the real environment, and the precise superimposition of digital virtual information onto this real scene. Then, it is presented to the users through display devices. The implementation plan of the technology is based on the ETAM evaluation framework. After comprehensively considering the key factors regarding technology acceptance in this framework, it was finalized to adopt the marker-based AR for the usage scenarios integrated with the school-based textbooks for the elderly university. The experience process is as follows: Students use smart devices to scan specific images in the textbooks, activate and display the corresponding MAR resources on the pages.

The above operation can be carried out via smartphones. It can avoid the introduction of new devices which would bring additional learning costs and adaptation challenges to elderly learners. In recent years, with the continuous evolution of core technologies such as MAR in recognition, tracking, and rendering, as well as the improvement of smartphone hardware performance, the realization of MAR on mobile devices has gradually formed three main technical approaches. The first approach is to develop native apps, such as the ARKit framework launched by Apple in 2017, which is suitable for iOS device development, and the ARCore platform released by Google in 2018, which supports Android device development. The second approach is to use WebAR (Web Augmented Reality), which allows users to directly access MAR content in the browser without the need to install additional apps. The third approach is based on in-platform embedded AR. The AR capabilities of existing large application platforms (such as mini-programs and social media) are used for content distribution and experience. By comparing and analyzing these three approaches, it can be found that they each have significant advantages and disadvantages. Native apps can provide the most optimized performance and the richest feature set, but they require users to download and install, which has certain limitations on universality. WebAR has natural cross-platform capabilities, is easy to share, and supports real-time interaction, but there are compatibility and performance consistency issues in different browser environments. Platform-intrinsic AR is limited in development freedom and function depth by the host platform, but it can utilize the cross-platform distribution capabilities of the platform and to a certain extent avoid compatibility issues across browsers. Such platforms are often pre-installed software of mobile device manufacturers, with WeChat being particularly representative, and it has a high penetration rate among the elderly group. Therefore, this paper proposes a technical implementation solution using a client-server (Client-Server) architecture as follows:

Mini-programs based on the WeChat platform are developed for the client end. It is also possible to modify and adapt it based on templates or open-source projects. It is aimed to implement the overall user interface (UI) and user experience (UX) process, capture images from the school-based textbooks for the elderly university by using the mobile phone camera, and communicate with the server, and achieve the final presentation of the MAR resources.

The server is responsible for handling the core image recognition function. The mini-program client captures the static image data and securely transmits it to the back-end server via the API. After receiving the image data, the server recognition service calls the image recognition engine (such as a third-party cloud service or a self-developed model) to compare and match the received image with the target image (Target Image) that has been pre-stored in the feature vector database (such as a cloud service or an open-source deployment). Once the recognition is completed, the results are returned to the mini-program's client end.

The production and acquisition strategies for MAR resources are determined on the basis of specific needs. 3D content can be created and exported using modeling software such as Blender. Video content can be generated according to teaching requirements through live-action shooting or animation production. At the same time, integrating shared libraries and obtaining commercial licenses are also important ways to enrich these resources.

The storage of all MAR resources can be selected from cloud object storage services, which are characterized by high availability, scalability, CDN acceleration, etc. They can also be deployed on local storage servers, which are characterized by data autonomy control, extremely low latency in the internal network, and customizability, etc.

After the mini-program client receives the identified data from the server, it requests and loads the corresponding MAR resources from the storage location based on the identifier in the result, and renders and displays them on the learner's screen. All communication between the client and the server should be conducted through secure protocols such as HTTPS.

Figure 1 shows the architecture flowchart of the recognition system for the school-based textbook for elderly universities based on MAR. It includes the main components (client, back-end recognition service, MAR resource sources and data storage layer) and their interaction relationships, and the data flow and processing procedures across the components are indicated.

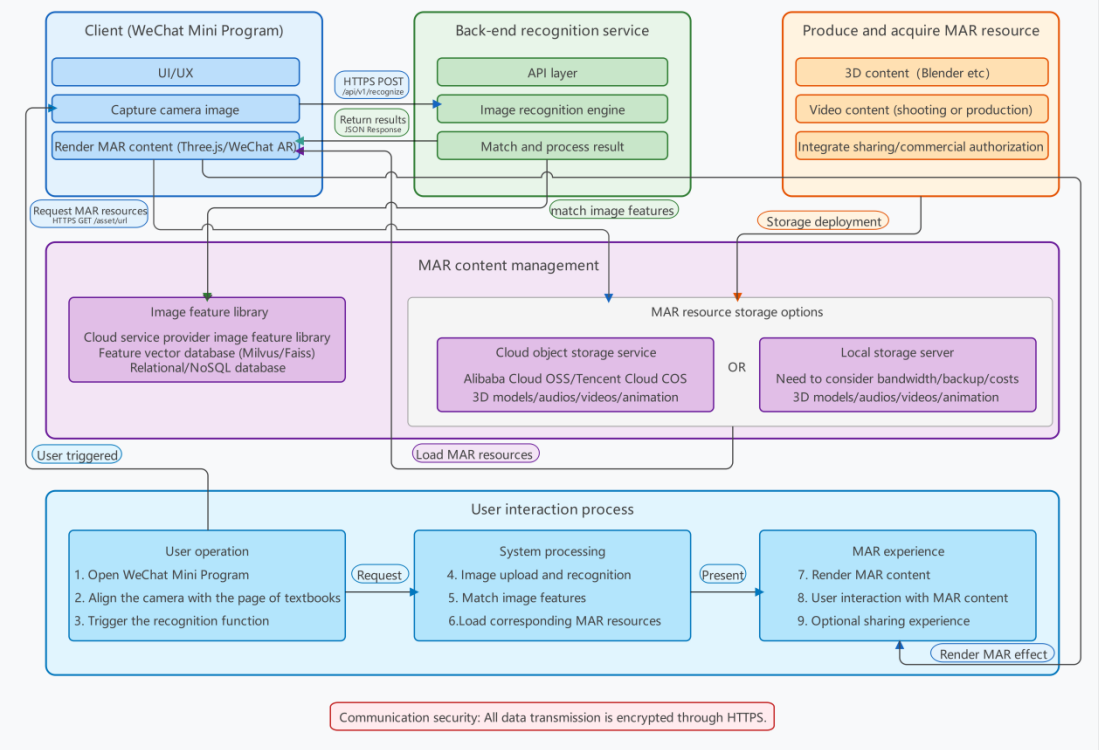

Figure 1
Architecture flowchart of the recognition system for the school-based textbook for elderly universities based on MAR

4.3 Development process and implementation of specific application practices

An application practice in grassroots elderly universities was conducted on the basis of the above design strategies and technical implementation plans. The school-based textbooks are effectively digitally enhanced by leveraging the rich media features of MAR, such as its three-dimensional, multi-form, and multi-sensory presentation. It can provide intuitive and easy-to-understand learning aids for the students.

Taking into account the project cost and related constraints, the following key implementation points have been determined.

In terms of MAR resource storage, it is deployed on the basis of the server infrastructure of the school network center. All MAR resources are stored on local servers, and persistent URLs based on the existing social education resource platform are provided for clients to download as needed. MAR resources include video content types such as 3D models, real scenes, and animations. To enhance data compatibility and interoperability and optimize the user experience, a unified data format is required. Common 3D model formats include .obj, .fbx, .glTF, and .glb. Among them, GLB is a standardized binary file format for sharing 3D data, which can contain information such as models, scenes, light sources, materials, node hierarchies, and animations, and is lightweight, high-performance, and highly compatible, making it more suitable for mobile environments. Common video formats include.mov,.avi,.mp4,.wmv,.mkv, etc. Among them, MP4 format has wide compatibility, high compression ratio, and high quality, can contain rich metadata, support digital rights management (DRM), streaming media, and hardware acceleration, and has obvious advantages in mobile environments. After evaluating the existing formats, it was decided to use the GLB format for 3D model resources and the MP4 format for video resources.

In terms of the back-end recognition mechanism, an EasyAR cloud recognition management service was adopted to build the recognition library. This service supports uploading target images, extracting feature points for each recognition target, configuring metadata (including URL and other related additional information), and associating and storing the two. Additionally, when the image is successfully recognized, the cloud service will return this metadata to guide the subsequent processing procedures.

In terms of client-side integration, the WeChat Developer was used and a technical stack that supports remote resource loading and 3D content rendering was selected. The core of this approach is the WeChat Mini Program XR-Frame framework. This framework combined with its accompanying CLI tools, and can effectively utilize the native AR capabilities of devices such as ARKit and ARCore. The development of business logic was customized on the basis of the EasyAR Mini Program template, and device-side debugging was conducted by using VConsole. The core function is to, after image recognition, trigger the operation of loading corresponding MAR resources from the server based on the metadata returned from the cloud. After completing the function development and thorough testing, the mini program was released and launched.

Figure 2 shows the UML activity diagram of the recognition system for the school-based textbook for elderly universities based on MAR. It uses Swimlanes to divide the responsibility areas of different participants, including developer activities (server deployment, WeChat mini-program development, and MAR resource production) and user activities (using the mini-program to recognize images and experience MAR content). It also demonstrates the interaction methods of the client, cloud recognition service, and local deployment server in the modeling process.

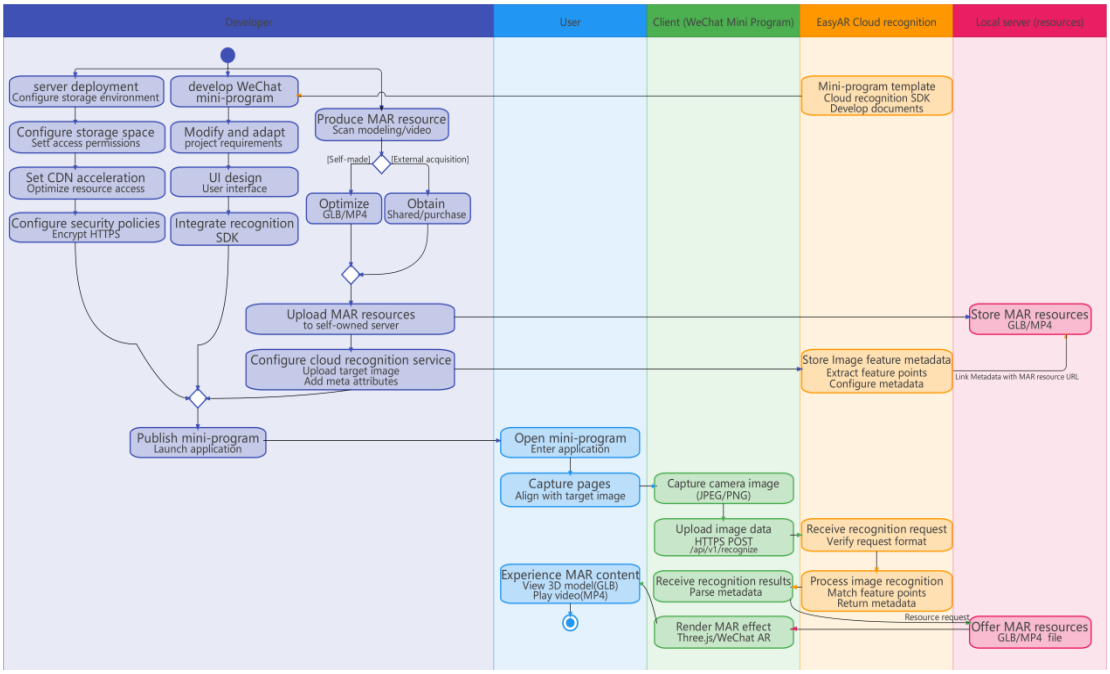

Figure 2
UML activity diagram of the recognition system for the school-based textbook for elderly universities based on MAR

To ensure the ease of use for elderly students, the mini-program has deeply simplified the interaction and content presentation. This low-barrier technology usage model aligns with the operation habits of elderly learners, can be easily adopted, and is effectively integrated into the learning process. The operation of the application meets expectations, has a significant positive effect on improving learning effectiveness and achieving teaching goals, and the satisfaction of elderly learners is generally high. Their operational skills and technical knowledge levels have also improved.

4.4 Other cautions

Based on the practical experience of this research, the following three important matters should be considered in the development work:

Firstly, a "feedback-iteration" closed-loop mechanism centered on elderly learners should be established to drive the continuous optimization of content and interaction. To establish the mechanism, we should establish diversified and systematic feedback channels, conduct in-depth analysis of the collected learner experience information, and promptly apply the results to content adjustments and design optimization to ensure the continuous improvement of the textbooks. The MAR resource library should be strategically expanded at the content resource level by following this feedback-iteration mechanism and on the basis of learner feedback. It includes developing new, suitable knowledge resources for technology presentation, as well as redeveloping and integrating existing digital resources to enhance resource reuse rate and overall development efficiency, ensuring that resources precisely meet the needs of elderly learners. At the interaction design level, according to the evolution of the digital literacy of elderly learners, the interactivity should be dynamically adjusted. In the initial stage, immediate positive responses (such as visual prompts, auditory encouragement, and textual praise) can be strengthened, and subsequently, more challenging task-driven operation processes can be gradually introduced, so as to achieve the optimal matching of technical complexity with the cognitive and skill readiness of elderly learners, thereby effectively promoting their ability development and experience improvement.

Secondly, it is necessary to strengthen the supporting and enabling system for the development to ensure the efficient operation of the "feedback-iteration" closed loop. The construction of this system involves key aspects such as content planning, 3D modeling, software development, and platform maintenance. And it should be guaranteed by professional teams, sufficient resources, clear norms and standards. Given the high threshold of MAR, it is necessary to pay attention to cultivating and introducing multi-skilled talents who possess both technical capabilities and experience in elderly education, and actively explore cooperation with other elderly universities or institutions to form joint teams to share costs, resources, and promote the circulation of technology, equipment, and courses. This process requires a careful balance of technical feasibility, operation and maintenance costs, human resource investment, and equipment support, while actively seeking policy preferences and financial support. Standardization construction is the key to ensuring the effective operation of the system. It is necessary to actively promote the standardization and normalization of the entire development process, establish clear development processes, version management mechanisms, code norms, and document standards. When the school-based textbooks for elderly universities based on MAR pass the inspection and are found to be suitable and effective for teaching, and are planned for large-scale promotion or publication, the bottleneck of missing standardization will become prominent. Currently, our country lacks national-level content and technical standards and a unified review and supervision system for AR-type textbooks, especially elderly AR-type textbooks. This leads to the quality of the textbooks being highly dependent on the self-discipline of developers, and it is necessary to draw on existing relevant industry standards, such as the *Specifications for AR Technology Application of Publications (CY/T 178-2019)* in the basic education field, and for the elderly education field, it can be combined with the characteristics of the students as a reference.

Thirdly, the scope of practice should be strategically expanded and the cognition deepened. With the support of the supporting and enabling system, the efficiency of the development model should be maximized, and continuous learning and iterative improvement should be achieved. Expanding the application and practice in stages and in a planned manner can obtain more extensive and in-depth feedback, which can be used to test the universality of the content and design, thereby improving the overall utilization rate and influence of resources. The process can also effectively test the capability of the existing supporting and enabling system to cope with large-scale challenges, and help discover new optimization points and potential demands. The experience accumulated through practice will drive the upgrading of cognition, thereby feeding back and continuously optimizing the overall development strategy and model of the school-based textbooks for elderly universities.

5. CONCLUSION

Elderly universities have a wide coverage and are a key force in promoting the sustainable development of elderly education. In the current context of rapid technological iteration, the lightweight development practice path of integrating MAR into the school-based textbooks for elderly universities, as discussed in this article, under

the guidance of multi-sensory learning theory, situated learning theory, and ETAM, provides a crucial entry point for elderly education. This path not only demonstrates substantive effectiveness in improving teaching quality and enhancing the technical literacy of students, but also has the potential to become an important digital approach for popularizing elderly education. However, the development of school-based textbooks based on MAR is not a one-time process; it is a continuous iterative and optimizing process. With the upgrading of related hardware equipment and the evolution of this technology, its application in the school-based textbooks for elderly universities also needs to be dynamically adapted and continuously developed. In the future, when the technical acceptance and operational ability of elderly learners reach the corresponding level, we can cautiously explore promising directions such as MAR gamification teaching, AI-driven personalized MAR resource push, and IoT integrated immersive virtual reality learning environments. During this process, it is necessary to scientifically select and apply those MAR features that are truly applicable to elderly education scenarios and have stable and mature technologies. We should avoid the emergence of new learning barriers and digital divides due to excessive pursuit of novelty.

To ensure the healthy development and wide application of MAR in the field of elderly education, a scientific evaluation system should be established. It can be achieved through multi-dimensional indicators and diversified methods to guide the optimization and upgrading. At the same time, efforts should be focused on the cultivation and introduction of interdisciplinary talents, the establishment of interdisciplinary teams, and the organization of professional training. A close cooperative relationship and multi-party collaboration system among schools, enterprises, and research institutions should also be constructed. Additionally, the operational mechanism should be improved and forward-looking top-level design should be carried out. For instance, a national or regional-level public service platform can be established to promote resource integration and cross-regional sharing. Unified content, technical standards, and industry norms should be formulated and implemented. The review, assessment, certification, and management mechanisms should be improved. Through the continuous practice of these measures, a complete MAR elderly education resource ecosystem can be gradually constructed. It will effectively promote the modernization process of elderly education and provide useful references for exploring the digital transformation path of elderly education.

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