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Developing an Augmented Reality–Based Multimedia E-Book (mE-Book) for Arabic Teachers in Indonesia's Teacher Professional Education Program

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Abstract

Arabic courses in Indonesia's Teacher Professional Education Program (*Pendidikan Profesi Guru*, PPG) still rely largely on two-dimensional text media such as PDF files, slides and printed books, which give little visual and contextual experience of vocabulary, sentence structure and Arab culture. Augmented reality (AR) can place three-dimensional virtual objects in the real environment, yet its use in Arabic learning for PPG teachers, particularly within a systematically designed electronic book, remains limited. This study developed an AR-based multimedia electronic book (mE-Book) for Arabic PPG teachers and examined its feasibility. It adapted the Holistic 4D model (Define, Design, Develop, Deploy) and was carried out up to the Develop stage. Data were collected through questionnaires, observation, interviews, document analysis, a literature review and expert validation, and were analysed descriptively. The Define stage produced a SWOT analysis and a system requirement specification. The Design stage produced a system blueprint and a draft mE-Book, *Bahasa Arab Qur'ani: Berdasarkan Kisah-Kisah dalam Al-Qur'an*, organised by lessons (*dars*) and language skills. In the Develop stage, the content, media and technology experts gave scores of 95, 90 and 90 (mean 91.67), all in the very feasible category. The mE-Book is therefore judged feasible by experts; its effectiveness has not been tested and remains a task for later field trials.

Keywords Augmented reality; Multimedia e-book; Arabic language teaching; Teacher professional education; Holistic 4D model

مستخلص البحث

تعتمد مقررات اللغة العربية في برنامج التربية المهنية للمعلمين (PPG) بإندونيسيا اعتمادًا كبيرًا على الوسائط النصية ثنائية الأبعاد، مثل ملفات PDF والشرائح والكتب المطبوعة، وهي وسائط لا تقدّم خبرة بصرية وسياقية كافية بالمفردات وتراكيب الجمل والثقافة العربية. ويتيح الواقع المعزّز دمج أجسام افتراضية ثلاثية الأبعاد في البيئة الحقيقية، غير أن توظيفه في تعليم اللغة العربية لمعلمي هذا البرنامج، ولا سيما في صورة كتاب إلكتروني مصمَّم تصميمًا منهجيًا، ما زال محدودًا. يهدف هذا البحث إلى تطوير كتاب إلكتروني متعدد الوسائط قائم على الواقع المعزّز لمعلمي اللغة العربية في البرنامج، وإلى معرفة مدى صلاحيته. واعتمد البحث نموذج التطوير الشمولي 4D (التعريف، والتصميم، والتطوير، والنشر)، ونُفِّذ حتى مرحلة التطوير. وجُمعت البيانات بالاستبانة والملاحظة والمقابلة وتحليل الوثائق ومراجعة الأدبيات وتحكيم الخبراء، وحُلِّلت تحليلًا وصفيًا. وأسفرت مرحلة التعريف عن تحليل SWOT ومواصفات النظام، وأسفرت مرحلة التصميم عن مخطط النظام ومسودة الكتاب الإلكتروني «اللغة العربية القرآنية

على أساس قصص القرآن الكريم» المنظَّمة حسب الدروس والمهارات اللغوية. وفي مرحلة التطوير منح خبير المادة الكتابَ 95 درجة، وخبير الوسائط 90 درجة، وخبير التكنولوجيا 90 درجة، بمتوسط 91.67، وكلها في فئة «صالح جدًّا». ولم تُختبر فاعلية الكتاب بعدُ، ويبقى ذلك مهمةً للتجارب الميدانية اللاحقة.

كلمات أساسية

الواقع المعزّز؛ الكتاب الإلكتروني متعدد الوسائط؛ تعليم اللغة العربية؛ التربية المهنية للمعلمين؛ نموذج 4D الشمولي

1. Introduction

1.1. Background and significance

The digital transformation of education in the twenty-first century calls for immersive and interactive technology in the design of teachers' professional learning (Dimyati, 2025; Mansori et al., 2024). In Indonesia's Teacher Professional Education Program (*Pendidikan Profesi Guru*, PPG), strengthening pedagogical and professional competence depends not only on mastery of subject matter but also on the ability to use innovative media that suit the characteristics of a digital generation (Anton et al., 2024; Sari, 2019; Zis et al., 2021). The challenge is sharper in Arabic, whose phonological, morphological and syntactic complexity differs markedly from Indonesian (Khitam, 2020; Khusniya, 2024; Nurfauzan et al., 2026; Sukamta, 2012).

Arabic learning in PPG still relies mostly on conventional two-dimensional text media, such as PDF files, slides and printed books. These media give little visual and contextual experience of vocabulary, sentence structure and Arab culture as the context of the language (Huda et al., 2023; Prihartini et al., 2021; Tugino et al., 2023). As a result, learning tends to centre on the transfer of grammatical knowledge and seldom offers a multimodal experience that brings text, audio, visuals and interaction together.

1.2. Previous studies

Augmented reality (AR) opens a new possibility for experience-based multimedia learning. It integrates three-dimensional virtual objects into the real environment in real time, so that learners can interact with visual representations of vocabulary, dialogue and cultural context in a more concrete way (Al-Ansi et al., 2023; Dargan et al., 2023; Devagiri et al., 2022; Geroimenko, 2020). Reviews have described the trends, tools and challenges of AR (Devagiri et al., 2022), surveyed the technology comprehensively (Dargan et al., 2023) and traced the development of AR and virtual reality in education (Al-Ansi et al., 2023; Geroimenko, 2020).

Arabic-specific studies have developed interactive multimedia for Arabic learning (Prihartini et al., 2021), applied digital technology in Islamic education and Arabic classes (Tugino et al., 2023) and proposed applicative Arabic learning media for university lecturers (Huda et al., 2023). Studies of teachers have examined competence and instructional design in classroom practice (Aryzona et al., 2023) and validated a scale of teacher competency perception in Indonesia (Arikunto et al., 2023). For the development process itself, the Holistic 4D model merges the instructional design process with learner-centred theory (Reigeluth & An, 2020), integrates formative design within its stages (Reigeluth, 2023) and has been reviewed as a usable model for designers (Roman, 2022).

1.3. Gap and contribution

Taken together, these strands leave a gap in three respects. Pedagogically, no AR-based Arabic medium has been designed around the competence needs of PPG teachers; most studies address primary or secondary school students rather than teachers as designers of learning (Aryzona et al., 2023). Technologically, AR has rarely been integrated into an interactive e-book that is easy to access, scalable and adaptive. Methodologically, few research-and-development studies in this context have been validated empirically. This article contributes (a) a documented design and specification of an AR-based multimedia electronic book (mE-Book) for Arabic PPG teachers and (b) expert-validation evidence of its feasibility from content, media and technology perspectives. It does not report evidence of effectiveness.

1.4. Research questions and article organization

The study addresses two questions. (RQ1) What are the design and specification of an AR-based mE-Book as a medium for Arabic PPG teachers? (RQ2) How feasible is the mE-Book according to content, media and technology experts? Section 2 describes the development procedure and data analysis. Section 3 presents the results of the Define, Design and Develop stages. Section 4 discusses them, Section 5 states strengths, limitations and research integrity, and Section 6 concludes.

2. Methods

2.1. Research design

The study used a research-and-development design adapted from the Holistic 4D model, Define, Design, Develop and Deploy (Reigeluth, 2023; Reigeluth & An, 2020), chosen because it integrates formative design into the development of learning media. A sequential mixed-methods approach combined qualitative and quantitative data: needs were explored first (Define), and the product was then designed, developed and formatively validated (Design and Develop). The study focused on developing the product and establishing its feasibility, so it was carried out up to the Develop stage; field trials and effectiveness testing in the Deploy stage were not conducted. Figure 1 summarises the procedure.

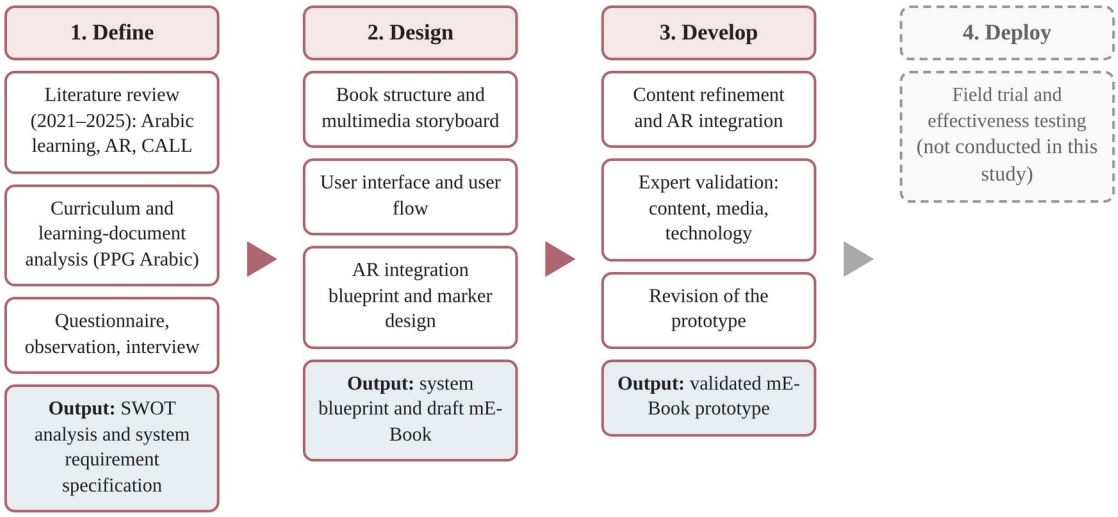


Figure 1. Development procedure adapted from the Holistic 4D model. The study was carried out up to the Develop stage; the Deploy stage (dashed) was not conducted.

2.2. Define stage

The Define stage identified and analysed needs in order to formulate an initial system specification. It covered (a) problems of Arabic learning in the digital era, particularly in relation to the progress of AR; (b) the content and learning scenarios that are relevant for simulation in an AR environment; (c) technological readiness and the choice of adaptive technology; and (d) indicators and criteria for selecting the research setting and subjects according to pedagogical readiness and digital infrastructure. Questionnaires and observation were administered by the student team, while the lecturers conducted in-depth interviews and analysed learning documents and instructional materials. A literature review covered studies published between 2021 and 2025 on Arabic language learning, AR and computer-assisted language learning (CALL), with selection following the identification, screening, eligibility and inclusion steps of PRISMA 2020 (Page et al., 2021) and quality appraisal with the Mixed Methods Appraisal Tool (MMAT) version 2018 (Hong et al., 2018). The results were synthesised in a SWOT analysis and a system requirement specification.

2.3. Design stage

The Design stage translated the specification into a conceptual and technical blueprint: (1) system architecture and AR integration, (2) the user flow in the immersive environment, (3) the Arabic learning modules and scenarios, (4) learning evaluation instruments and (5) the layout and navigation of the system. An iterative Analysis–Design–Evaluation cycle was applied to keep pedagogical and technological aspects aligned, taking into account experiential learning, immersive learning and AR interaction. The design was evaluated through a conceptual expert review (paper review of design) before development.

2.4. Develop stage and expert validation

The Develop stage turned the design into a prototype: development of the mE-Book content, the user interface and navigation, and the AR components, followed by expert validation of the beta product and revision. Three experts validated the product: a content expert, a media expert and a technology expert. The instruments covered content, instructional design, media display, ease of use and the quality of the AR implementation. Each expert's assessment was expressed as a score on a 0–100 scale.

2.5. Data analysis

Needs-analysis data and experts' qualitative comments were analysed descriptively and qualitatively. Validation scores were analysed with descriptive statistics and converted into feasibility categories using the criteria in Table 1.

Table 1. Criteria for product feasibility categories

Score	Category
81–100	Very feasible
61–80	Feasible
41–60	Fairly feasible
21–40	Less feasible
0–20	Not feasible

Scores are on a 0–100 scale.

3. Results

3.1. Define stage: needs analysis and specification

The data from the Define stage were synthesised in a SWOT analysis to formulate a development strategy (Table 2).

Table 2. SWOT analysis for developing the AR-based mE-Book

Strengths	Weaknesses	Opportunities	Threats
Contextual and grounded in local culture	Few earlier innovations	Growing need for innovative media	Unequal access to technology
Integrates several immersive technologies	High technological complexity	Strengthening local wisdom globally	Sustainability challenges
Supported by learning theory	Lack of specific studies	Support from the digital era	Competition with global media
Responds to community needs	Potential user resistance	Cross-disciplinary collaboration	Cultural sensitivity issues
Prior studies available as references			

Synthesised by the research team from the Define-stage data.

The review of studies published between 2021 and 2025 indicated that AR in foreign language learning can increase motivation, engagement, conceptual understanding and vocabulary retention. Its use in Arabic learning, however, remains limited: most studies developed simple applications or media built around a single object, and few integrated AR into a systematically designed e-book for teachers. The needs analysis also showed that PPG teachers need a medium that combines text, images, audio, video, exercises and three-dimensional visualisation in one package that is easy to open on a mobile device.

On this basis the study produced a system requirement specification. The mE-Book is a digital learning medium that can be opened on a computer or a smartphone and is supported by marker-based AR. It contains learning outcomes, Arabic material, visual illustrations, exercises, evaluation and integrated multimedia, while AR visualises selected learning objects in three dimensions. Four development principles were set: usability; integration of Arabic content and AR technology; compatibility with various digital devices; and suitability for the characteristics of Arabic learning in PPG.

3.2. Design stage: blueprint and draft mE-Book

The Design stage produced the book structure, a multimedia storyboard, the user interface, the user flow and a blueprint for AR integration. Each lesson can be opened independently through a simple navigation menu, and the material moves from presentation of concepts to examples of language use, exercises and evaluation. Selected parts carry AR markers that, when scanned with an application, display three-dimensional objects, animations or supporting multimedia. Marker design, identification of the three-dimensional objects and the user interaction mechanism were completed in this stage.

The main output is a draft mE-Book entitled *Bahasa Arab Qur'ani: Berdasarkan Kisah-Kisah dalam Al-Qur'an* (Qur'anic Arabic: Based on Stories in the Qur'an), laid out in A5 format. Table 3 summarises its components and Figure 3 shows sample pages.

Table 3. Structure and components of the draft mE-Book

Component	Description in the draft
Organisation	Lessons (*al-dars*) grouped into units (*al-wahdah*), e.g. lesson 1 *al-Ta'aruf bi al-Nafs wa bi al-Akharin* and lesson 3 *al-Bi'ah al-Madrasiyyah* in the unit *al-Hayah al-Madrasiyyah*
Vocabulary and expressions	*Al-mufradat wa al-'ibarat*: vocabulary and expression tables with Indonesian equivalents
Skill activities	*Al-istima' wa al-kalam*, *al-qira'ah wa al-kitabah* and *al-istima' wa al-kitabah*: illustrated dialogues and activities (*nashat*)
Qur'anic recitation	Learning the *nagham* of *murattal* recitation of Surah al-Fil (Bayyati, Nahawand, Hijaz, Sika, Jiharka, Rast, Shaba) and a space for a short film on Surah al-Fil
Evaluation	Final test (*al-imtihan al-niha'i*) in multiple-choice format
Language of instruction	Arabic content with activity instructions in Indonesian
AR integration	Markers on selected pages that display three-dimensional objects, animations or supporting multimedia

Based on the draft mE-Book, which was still being completed at the time of writing.

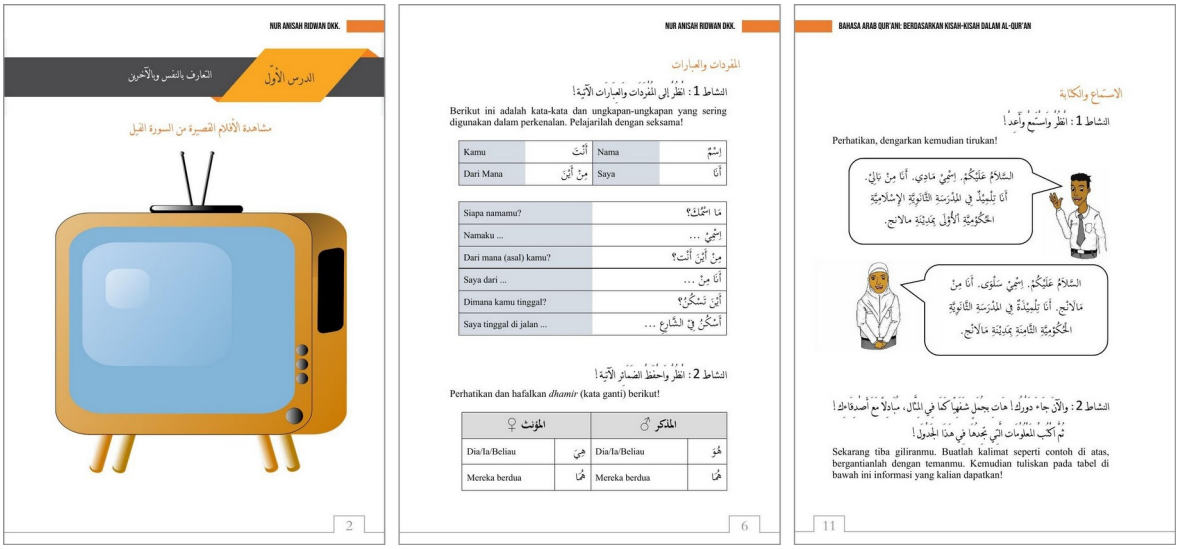


Figure 3. Sample pages of the draft mE-Book: (a) opening of lesson 1 with a space for a short film on Surah al-Fil; (b) vocabulary and expressions; (c) listening and writing activity.

3.3. Develop stage: expert validation

The Develop stage refined the mE-Book, integrated the AR components and interactive features, and revised the prototype after validation. Table 4 and Figure 2 present the validation results.

Table 4. Expert validation of the AR-based mE-Book

No.	Validator	Score	Category
1.	Content expert	95	Very feasible
2.	Media expert	90	Very feasible
3.	Technology expert	90	Very feasible
	Mean	91.67	Very feasible

Categories follow Table 1.

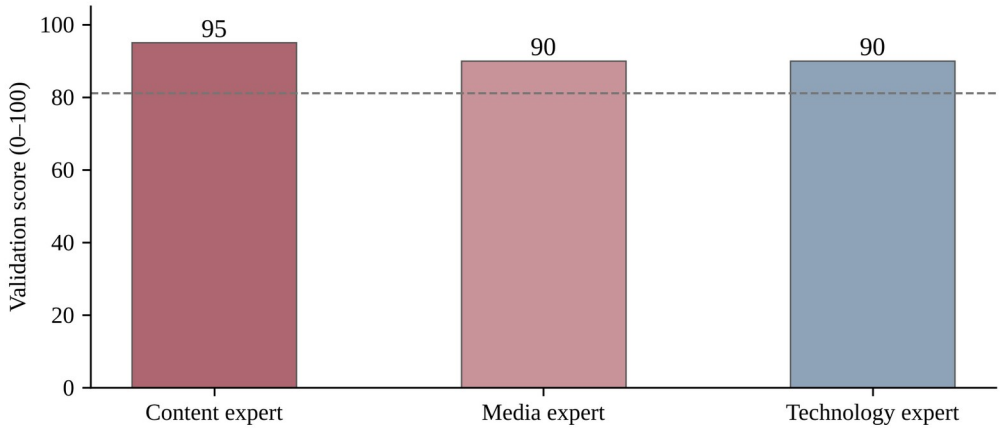


Figure 2. Expert validation scores of the AR-based mE-Book. The dashed line marks 81, the lower bound of the very feasible category.

The content expert gave the highest score (95), and the media and technology experts each gave 90, for a mean of 91.67. All scores fall within the 81–100 range, so the mE-Book is categorised as very feasible from the content, media and technology perspectives.

4. Discussion

4.1. Responding to the needs of Arabic PPG teachers

The needs analysis showed that PPG teachers want a single medium that combines text, images, audio, video, exercises and three-dimensional visualisation and that can be opened on a mobile device. This need is consistent with the call to integrate immersive and interactive technology into teachers' professional learning (Dimyati, 2025; Mansori et al., 2024) and with the importance of media that suit a digital generation (Anton et al., 2024; Sari, 2019; Zis et al., 2021). The SWOT analysis adds a practical caution: the contextual character of the product, its integration of immersive technologies and its theoretical support are strengths, but technological complexity and possible user resistance must be anticipated.

The phonological, morphological and syntactic complexity of Arabic (Khitam, 2020; Khusniya, 2024; Sukamta, 2012) makes visual and contextual representation important, and conventional two-dimensional media offer little of it (Huda et al., 2023; Prihartini et al., 2021; Tugino et al., 2023). The draft therefore organises each lesson around vocabulary, illustrated dialogues and skill-based activities, and reserves selected pages for AR markers, so that Arabic material can be presented multimodally.

4.2. AR within a structured e-book

Marker-based AR in the mE-Book draws on the capacity of AR to bring three-dimensional virtual objects into the learner's real environment in real time (Al-Ansi et al., 2023; Dargan et al., 2023; Geroimenko, 2020). Placing AR inside a structured e-book, rather than in a stand-alone application built around one object, responds to the gap identified in the review. It also addresses teachers as designers of learning (Aryzona et al., 2023): the book gives PPG teachers a sequence of lessons, activities and evaluation into which AR is embedded, and not only an isolated visual effect.

4.3. Expert feasibility and formative design

The validation scores of 95, 90 and 90 indicate that the experts judged the mE-Book very feasible in content, media and technology. The higher score from the content expert suggests that the material is regarded as suitable for Arabic learning in PPG, while the media and technology scores indicate that the display and the integration of technology are also judged feasible. The cycle of validation and revision reflects the formative design integrated in the Holistic 4D model (Reigeluth, 2023; Reigeluth & An, 2020). Expert judgement, however, concerns the quality of the product, not its effect on teachers' competence.

4.4. Implications for teacher education and further research

For PPG, the mE-Book offers lecturers and student teachers a medium that links Arabic material with visual and contextual experience on mobile devices. For research, the next step is to complete the draft and its AR components and then to test the product in the Deploy stage, with field trials that measure the pedagogical and professional competence of PPG teachers. Instruments that capture teacher competence, such as validated perception scales (Arikunto et al., 2023), could serve as outcome measures in such trials.

5. Strengths, Limitations, and Research Integrity

The strengths of the study are a product grounded in a documented needs analysis, an explicit system specification and validation from three expert perspectives. The main limitation is that the study stopped at the Develop stage: the mE-Book has not been tried out with PPG teachers, and no claim is made about its effectiveness. Each aspect was judged by a single expert, so the feasibility scores reflect individual expert judgement. The mE-Book was still a draft being completed at the time of writing, and the sample pages in Figure 3 come from that draft.

As for integrity, the validation scores are reported as given by the experts and converted to categories with the criteria stated in Table 1. The description of the product is based on the draft itself and on the research documents of the team. The authors developed the product they evaluate, so the results reflect the perspective of the development team and should be confirmed by independent trials.

6. Conclusion

This study developed an AR-based multimedia electronic book for Arabic PPG teachers through the Define, Design and Develop stages of the Holistic 4D model. The Define stage produced a SWOT analysis and a system requirement specification for a digital book that runs on computers and smartphones with marker-based AR. The Design stage produced a system blueprint and the draft *Bahasa Arab Qur'ani: Berdasarkan Kisah-Kisah dalam Al-Qur'an*, organised by lessons, vocabulary, skill activities, Qur'anic recitation and a final test. In the Develop stage, the content, media and technology experts gave scores of 95, 90 and 90 (mean 91.67), all in the very feasible category. The mE-Book is therefore feasible according to experts. Its effectiveness in improving the pedagogical and professional competence of PPG teachers has not been tested and should be examined in field trials after the product is completed.

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