Evaluation and Empirical Study on the Application Effects of App Systems in Mobile Environments: Postprint

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Abstract

[Objective/Significance] To explore evaluation approaches for App effectiveness in mobile environments and construct an evaluation index system for English learning mobile Apps. [Method/Process] An evaluation index system for English learning mobile Apps was developed across three dimensions: "content resources, human-computer interaction, and user experience". The Analytic Hierarchy Process (AHP) and dichotomy method were employed to determine index weights, and empirical research was conducted on eight representative English learning Apps. [Results/Conclusions] The constructed mobile App evaluation index system possesses certain practical value and can effectively evaluate Apps. Through App evaluation and analysis, recommendations are provided for App development and construction at the levels of content, technology, and user experience effectiveness.

Full Text

Preamble

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Abstract: [Purpose/Significance] This study explores methods for evaluating the application effects of mobile Apps in mobile environments and constructs an evaluation index system for English learning mobile Apps. [Method/Process] The evaluation index system for English learning mobile Apps was constructed from three dimensions: "content resources, human-computer interaction, and user experience." The Analytic Hierarchy Process (AHP) and bisection method were used to determine index weights, and an empirical study was conducted on eight representative English learning Apps. [Result/Conclusion] The constructed mobile App evaluation index system has certain application value and can effectively evaluate Apps. Through App evaluation analysis, this study provides countermeasures and suggestions for App development and construction at the levels of content, technology, and user experience effects.

Keywords: mobile App; application effect; evaluation system
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With the advent of the mobile internet era, mobile intelligent terminals represented by smartphones and tablet devices have transformed people's daily learning and lifestyles [1]. Apps are a type of internet application. Mobile Apps are third-party applications based on mobile intelligent terminals and serve as effective channels for obtaining information and knowledge. The 39th "Statistical Report on Internet Development in China" released by the China Internet Network Information Center (CNNIC) shows that as of December 2016, China's internet user population reached 731 million, with an internet penetration rate of 53.2%, exceeding the global average by 3.1%. Among them, mobile internet users numbered 695 million, accounting for 95.1% of the total [2]. Meanwhile, the number of Apps has also surged dramatically. Relevant data indicates that educational Apps in Apple's App Store have become the second-largest application category after games [3]. In the education sector, the portability and mobility, intelligence and personalization, strong 趣味性, and high interactivity of mobile Apps are particularly prominent [4-6]. With the vast variety and quantity of Apps, the development, promotion, and application of educational Apps that are "fast, efficient, convenient, and user-demand-oriented" have become urgent issues to address.

With the development of diversification and globalization, English, as a language connecting countries worldwide, plays an increasingly prominent role. In the education field, greater emphasis is placed on English education, yet tra-

ditional teaching models can no longer meet students' information acquisition needs. Mobile Apps enable the close integration of English learning and information technology, breaking through existing learning models and resource limitations and facilitating autonomous and personalized learning. English language learning Apps have become the choice of numerous users. Research on the evaluation of English Apps helps develop high-quality English learning Apps, provides users with appropriate recommendations for App selection, and explores effective English learning pathways.

Although mobile App applications have increasingly attracted scholars' attention both domestically and internationally in recent years, existing research shows that foreign scholars' research on mobile learning Apps mainly focuses on App development and utilization, influencing factors, and usability studies. Domestic scholars' research primarily concentrates on the design and development of mobile learning Apps and applied research on integrating mobile learning Apps with curricula. Relatively few studies address the evaluation of mobile learning Apps, which represents a major concern for users in the current mobile App field. In today's mobile environment, various types of Apps emerge endlessly, with massive numbers of Apps of the same type. The rapid popularization of Apps has brought great convenience to people's lives, work, and learning, while also providing enterprises and institutions with promising marketing channels. However, can users obtain the information resources or services they need as desired? Faced with numerous App options, how should users choose the Apps that suit them? How should developers and operators design, develop, and operate Apps to meet user needs? The development of Apps has become an urgent problem for users, App developers, and operators to solve. Effective evaluation of App system application effects can help address these issues, provide users with high-quality information content and convenient access methods, and improve user satisfaction with Apps.

2 Related Research

2.1 Mobile Learning Apps

Foreign scholars such as E.S. Georgieva et al. evaluated the mobile learning application system FLAGMAN developed by the University of Ruse, Bulgaria, from aspects including technical feasibility, teaching efficiency, cost-effectiveness, user-friendliness, equipment, courseware used, and evaluation [7]. N. Pindeh et al. explored influencing factors of the Kadazandusun language App from perspectives of perceived usefulness, perceived ease of use, content richness, user satisfaction, and perceived entertainment [8]. R.C. Shih et al. integrated mobile learning into a blended teaching method for English spelling courses, analyzed the effectiveness of the LINE App English spelling learning experience, and evaluated the effectiveness of learners using smartphone Apps for learning [9]. Quan Feng investigated users' mobile learning content, duration, scenarios, terminals, and purchasing habits from a user demand perspective, studied college students' use of English mobile

learning Apps, and provided development strategies for publishers of college English mobile applications [10]. Li Lijie proposed integration strategies for incorporating mobile learning into higher vocational curriculum teaching by analyzing factors influencing the intention to use smart mobile devices and constraints on mobile learning, including a blended teaching model combining traditional teaching with App-based learning [11]. Li Wu and Zhao Xing constructed a conceptual model of users' continuous usage intention for social reading Apps, analyzing the influence of variables such as expectation confirmation, satisfaction, perceived usefulness of reading, and subjective norms on continuous usage intention [12].

2.2 Mobile App Evaluation

In terms of evaluation research, some foreign institutions and researchers have proposed partial evaluation models and scales for Apps. For example, the "Mobilary" project team of the Chicago Public Schools Library Department designed an iPad App evaluation scale in 2011 based on three aspects: learning support, ease of use, and quality to assess the suitability of iPad Apps for school libraries [13]. M.A. Villar, building on e-Learning, established mobile learning App evaluation indicators from seven aspects: content, personalization, feedback, higher-order thinking skills, ease of use and technical performance, interactivity and immersion, and social interaction [14]. Domestic scholars Zhang Sumin et al. conducted user analysis and evaluated user satisfaction with current database publishers' Apps from aspects including usefulness, content depth, functional design rationality, price rationality, ease of use, availability, user experience, content module rationality, and content correctness, based on user ratings and review content of database publishers' mobile Apps [15].

The above related research shows that scholars have paid widespread attention to mobile App evaluation in recent years, with certain practicality in evaluation research targeting learning Apps. Based on previous studies, this paper attempts to conduct in-depth evaluation and empirical research on domestic mobile Apps, addressing three questions: How to select appropriate Apps for better learning in mobile environments? How to construct an evaluation index system for Apps in mobile environments? Does the constructed evaluation index system have guiding significance for App development and application? This study employs the Analytic Hierarchy Process to construct a mobile App evaluation index system from three aspects—mobile learning resources, App design and development, and users—and conducts empirical analysis on typical English learning mobile applications. This research provides relevant suggestions for the design, development, and application of educational Apps that meet user needs, enabling effective utilization of mobile learning resources and offering practical reference value for China's educational development.

3 Research Design

3.1 Construction of the Evaluation Index System

System evaluation theory analyzes the evaluation object as a system, uses systematic evaluation methods to assess system effectiveness according to predetermined goals, and selects optimal solutions [16]. An App is a multi-level and multi-factor system, and the App evaluation system as an evaluation system features hierarchical structure and diversified indicators. Overall, there is currently a lack of specialized standardized evaluation methods for mobile language learning Apps. The index system established in this paper primarily adopts the Delphi method. Based on mobile application user behavior characteristics, domestic and foreign institutions' and scholars' App evaluation scales and existing App evaluation literature, and referencing evaluation index systems for representative mobile learning resources, online education services, and learning websites, the study conducted interviews with relevant field experts and scholars, mobile application developers and maintenance personnel, and university students who frequently use English learning Apps. Integrating their viewpoints and optimizing them, several evaluation indicators were determined. Providing high-quality content resources through App services is a complex process that is also a human-system interaction process, while user experience reflects the results of interaction. Therefore, based on a system evaluation perspective, this paper constructs a mobile English learning App evaluation index system from three aspects: mobile learning resources, App design and development, and users. The system includes three first-level indicators: content resources, human-computer interaction, and user experience. The first-level indicators are subdivided into 13 second-level indicators and 29 third-level indicators, with each level refined as much as possible to highlight key indicators, as shown in Table 1 .

3.2 Index Analysis

3.2.1 Content Resources Content resources refer to the mobile learning resources that Apps provide for users, primarily manifested in the degree to which they meet learners' needs [17], and constitute the primary factor for Apps to be accepted and used long-term by users. Both domestic and foreign scholars have considered the content factor in their research on websites and Apps. Domestic scholars Bai Yin et al. summarized domestic educational website content evaluation from aspects including content accuracy, topic relevance, comprehensiveness, and timeliness [18]; Luo Chunrong and Cao Shujin suggested evaluating internet information resources from aspects such as practicality, comprehensiveness, accuracy, authority, novelty, and uniqueness; Cha Xianjin and Chen Minghong proposed evaluating network information resources from correctness, completeness, relevance, and novelty; foreign scholar A.G. Smith suggested evaluating network information from aspects including accuracy, authority, timeliness, uniqueness, and links to other resources [19]. Comprehensively reviewing the above scholars' evaluation indicators and considering the research object of

this paper, we believe that content resource indicators include six second-level indicators: accuracy, reliability, comprehensiveness, relevance, timeliness, and novelty. Accuracy requires that learning resources provided by Apps be error-free; reliability requires that content be standardized, have teaching value, and be trustworthy; comprehensiveness addresses the breadth and depth of content, requiring rich information; relevance requires that content provided and courses recommended by Apps be closely related to the App's theme; timeliness examines the speed and quality of content updates; novelty requires unique content and diverse forms.

3.2.2 Human-Computer Interaction Human-computer interaction is the link between users and content information and an effective way to reflect App usability and user satisfaction with App performance and services [20-21]. During App usage, users employ certain interaction methods to enable Apps to fulfill operational requirements and objectives, representing an important indicator of App usability and user satisfaction with App performance and services. The domestic Network Education Service Quality Management System Specification (CELT-24) includes 保障性 indicators such as integrity, security, and complaint mechanisms, and care indicators including ease of use, personalized services, and comfort [22]; the famous online teaching platform evaluation website EduTools proposes compatibility and security standards among technical system indicators [23]; instructional designer M.A. Villar's evaluation scale for mobile learning Apps based on e-Learning teaching experience includes seven indicators such as personalization, feedback, ease of use and technical performance, and interactivity [14]; Cheng Gang et al. proposed the human-computer interaction indicator in their mobile learning resource evaluation model [13]. Therefore, we believe that human-computer interaction indicators include five second-level indicators: ease of use, interface friendliness, adaptability, accessibility, and guarantee. Ease of use requires that Apps be relatively simple to operate, with fast response speeds and easy usage; interface friendliness requires aesthetically pleasing interface design, clear and reasonable navigation menus, and enjoyable user experience; adaptability emphasizes the system's personalized customization for different users; accessibility concerns App usage conditions and the convenience of resource acquisition; guarantee requires that Apps have sufficient security to protect users' personal information, serving as a guarantee for user trust.

3.2.3 User Experience User experience is the result of interaction between users or between users and the system, representing users' subjective feelings when using Apps [24-25]. User experience is an important indicator for understanding user needs and continuously improving Apps. Huang Wei et al. proposed four first-level indicators—application platform, user experience, visual front-end, and network back-end—in their study of App evaluation indicators under mobile networks, with research results showing that App user experience and functionality significantly impact App quality [26]. Fan Jiajia et al. pro-

posed in their summary of website evaluation standards that user satisfaction is an important standard reflecting system service conditions and user perception [27]. We believe that user experience indicators include two second-level indicators: participation and satisfaction. Participation includes communication between users and user feedback to the platform, reflecting the degree of user participation and interaction during App usage; satisfaction manifests in the degree to which Apps meet user expectations and users' post-use ratings.

4 Empirical Analysis

4.1 Sample Selection

To test the scientific rationality and application value of the constructed mobile English learning App evaluation index system, this study selected eight English learning Apps as research objects, as detailed in Table 2 . The reasons for selecting these eight English learning Apps are as follows: These Apps have relatively large download volumes and many users in the App Store; Data from the China Business Intelligence Network [28] shows that these Apps rank relatively high in educational foreign language learning App rankings in recent years.

4.2 Determination of Index Weights

This study employs the Analytic Hierarchy Process to calculate weights for evaluation indicators, achieving a transformation of the evaluation system from qualitative to quantitative. The specific weight determination method is as follows:

4.2.1 Constructing Judgment Matrices Using the expert assignment method and T.L. Saaty's scale table (see Table 3) with a scoring scale of 1-9 levels, we compared the relative importance of various factors to construct judgment matrices: P-An, A1-Bn, A2-Bn, A3-Bn, B1-Cn, B2-Cn, B3-Cn, B4-Cn, B5-Cn, B6-Cn, B7-Cn, B8-Cn, B9-Cn, B10-Cn, B11-Cn, B12-Cn, B13-Cn.

4.2.2 Calculating Weights For simplicity and to ensure sufficient accuracy, the sum-product method was used to calculate the maximum eigenvalue λmax and its corresponding eigenvector w, sequentially calculating the weights of indicators at each level. Taking the judgment matrix A1-Bn as an example to calculate the weight vector w, as shown in Table 4 .

4.2.3 Consistency Test Since factors in the judgment matrix are obtained based on experience, consistency testing is required to ensure accuracy. The consistency index CI = (λmax-n)/(n-1), where RI is the random consistency index, for which T.L. Saaty provided specific corresponding values. The consis-

tency ratio CR = CI/RI, where CR < 0.1 indicates passing the consistency test. The final weights of evaluation indicators at each level are shown in Table 5 .

4.3 Evaluation Process

To effectively evaluate mobile Apps, this study selected 12 relevant experts for investigation, including 4 university new media research experts, 4 university English teachers, and 4 doctoral students. They completed questionnaires using a five-point Likert scale, where the five responses of "poor," "fair," "average," "good," and "excellent" correspond to scores of 1, 2, 3, 4, and 5, respectively. During the evaluation process, every effort was made to ensure that evaluators were not disturbed by other external factors to guarantee the validity of evaluation results. By integrating evaluators' scores and indicator weights, the average of evaluators' scores was calculated, and final scores for the eight mobile English learning Apps were obtained, as shown in Table 6 .

4.4 Evaluation Results

4.4.1 Analysis of First-Level Indicator Evaluation Results Among the three first-level indicators in the constructed mobile English learning App evaluation system—"content resources, human-computer interaction, and user experience"—content resources carry the greatest weight (0.5584). Regarding content resources indicators, dictionary tool-type English Apps scored slightly lower on average (2.2439) than listening-speaking type English Apps (2.4269). Word content is relatively monotonous, while listening-speaking type Apps offer richer learning resources and more diversified forms. Regarding human-computer interaction indicators, dictionary tool-type English Apps scored higher on average (1.3990) than listening-speaking type English Apps (1.2759). Dictionary tool-type Apps have clearer interfaces, usually feature offline dictionaries, allow word lookup and memorization without network restrictions, and occupy less memory, whereas listening-speaking type Apps mostly require online usage. Regarding user experience indicators, dictionary tool-type English Apps also scored slightly higher on average (0.5268) than listening-speaking type English Apps (0.4477). Compared to listening and speaking skills, fragmented word memorization yields more obvious results, while listening and speaking improvement requires substantial time and continuous practice. Therefore, users generally show greater satisfaction with dictionary tool-type English Apps.

This demonstrates the importance of content resources. For any App, content resources are the first concern for users and a crucial factor for retaining long-term users. Content quality significantly affects user stickiness and stability. Therefore, Apps must particularly emphasize the accuracy, authenticity, scientific authority, systematic comprehensiveness, uniqueness, and personalization of their content resources. However, human-computer interaction cannot be neglected either, as it directly affects user experience effects, and good user experience represents the core competitiveness in the App market. Therefore,

greater emphasis should be placed on meeting user needs, ensuring product ease of use and usefulness, while strengthening technological innovation. Only through technological innovation and improvement can Apps achieve requirements such as easy access and use, friendly interfaces, and strong adaptability, thereby enhancing user experience effects, increasing user participation and activity, and enabling Apps to gain user favor and achieve long-term development.

4.4.2 Analysis of Second-Level Indicator Evaluation Results Regarding the six second-level indicators under content resources—accuracy, reliability, comprehensiveness, relevance, timeliness, and novelty—scores for accuracy, reliability, and relevance indicators are relatively similar. In terms of comprehensiveness, listening-speaking type English Apps perform relatively better, covering broader content including speech videos, movies, and travel guides, with richer information. Regarding novelty, listening-speaking type English Apps feature more distinctive content and richer forms. Therefore, dictionary tool-type English Apps need to first consider content resources from learners' cognitive and needs perspectives, making appropriate adjustments based on learners' learning status and abilities, and utilizing audio, video, animation, and other multimedia to complement learning content.

Regarding the five second-level indicators under human-computer interaction—ease of use, interface friendliness, adaptability, accessibility, and guarantee—ease of use and interface friendliness are generally good. In terms of adaptability, dictionary tool-type English Apps excel in personalized customization and assessment feedback, generally providing specialized word banks and training plans for different users based on postgraduate entrance exams, CET-4/6, and other needs, and timely adjusting learning content difficulty according to user assessment results. Regarding accessibility, dictionary tool-type English Apps have less stringent adaptation conditions and stronger offline capabilities, while listening-speaking type English Apps mostly require online usage. From the two second-level indicators under user experience—participation and satisfaction—most Apps perform well in user-user communication and sharing and user-platform feedback. Regarding user expectations, dictionary tool-type English Apps better meet user needs and expectations, allowing users to utilize fragmented time for word memorization and achieve relatively obvious results.

In terms of content resources, content is the primary factor attracting users for all types of Apps, particularly prominent in educational Apps. Ensuring content accuracy and reliability is the most basic requirement for App construction. On this basis, content should be as rich, comprehensive, novel, and timely as possible. Different groups' characteristics and resource needs should be considered to analyze their actual demands and provide targeted services.

Regarding human-computer interaction, App system architecture directly affects user experience effects. App ease of use and interface friendliness directly impact users' intuitive feelings, while good adaptability, easy access, and reliable security guarantees affect user satisfaction and trust. Therefore, App interface

and function development and design must balance aesthetics and practicality to the greatest extent, meeting various user needs and usage conditions, and providing sufficient guarantees for user usage. Phenomena such as application crashes, slow login, or unsmooth usage, as well as cumbersome procedures like registration, login, or account binding that likely pose security issues, directly affect user enthusiasm. Application vulnerabilities require developers to further improve technical capabilities and innovate technologically. Since some App resources require payment and most people currently resist paying, ensuring content novelty, uniqueness, and high quality is the primary factor supporting user payment. Meanwhile, marketers must carefully examine and set the most reasonable pricing. Advertising 植入 has always been disliked by users, requiring consideration of advertising quantity and frequency to maximize benefits while maintaining stable user numbers. App marketers must appropriately consider these issues in marketing strategies.

Regarding user experience, user experience is an important indicator for measuring the effects of various Apps and can serve as an important standard for users to select Apps. The development and utilization of any mobile application aim to provide services for users. To enhance user experience, any App should improve user participation and satisfaction through rational interface design, various practical function settings, perfect feedback mechanisms, and effective promotion, enabling users to have satisfactory experience effects and thereby increasing user satisfaction with the App. As people increasingly become accustomed to interactive information transmission methods, Apps should pay more attention to improving social functions, such as various communities and circles to facilitate user communication and information sharing, enabling them to obtain pleasant interactive experiences. In this era of big data, App operators should fully analyze relevant data on click-through rates, download rates, share counts, and usage frequency to accurately address users' personalized needs and improve user activity and stickiness.

4.4.3 Analysis of Overall Evaluation Results Among the eight selected English learning App samples, the highest score was obtained by the listening-speaking type App "English Fluent" (4.4300), indicating that users are gradually paying attention to improving their English speaking skills. Among dictionary tool-type English Apps, "Baicizhan" received the highest score (4.4110). Comparing the average scores of dictionary tool-type English Apps and listening-speaking type English Apps, dictionary tool-type English Apps had an average score of 4.1697, slightly higher than listening-speaking type English Apps (average 4.1505). The results show that dictionary tool-type English Apps are more favored by users.

The above evaluation also reveals common problems in current App development. Many Apps are almost identical in content resources, design effects, and functional experiences, with content and technology gradually converging, resulting in severe homogenization and particularly fierce market competition.

This necessitates improvements in both content resources and human-computer interaction to enhance user experience effects and ensure App core competitiveness. The most important aspects are providing unique content and personalized function settings. Only with unique content and function positioning and deep resource integration can Apps gain greater development space. Although Apps come in many types, many functions and design concepts are interconnected. Different types of Apps should learn from other Apps' advantages, combine them with their own field characteristics, reflect professionalism in content and function design, achieve complete functional integration on a platform basis, and develop Apps that meet public demands while having distinctive features. Simultaneously, user-centered service concepts should be established to better provide users with richer and more distinctive English learning App content. As society continues to globalize, English as a tool for external communication becomes increasingly important, and English learning receives more attention. The mobile English learning App evaluation index constructed in this study can guide the development and construction of English learning Apps, enabling users to better utilize them for English learning. This study also demonstrates that the evaluation index has practical operability and certain reference significance for evaluating and developing other Apps.

5 Research Conclusions and Limitations

Based on analyses of website evaluation and research by domestic and foreign institutions and scholars, this study designed an evaluation system for English learning Apps in the mobile internet environment, proposing three first-level indicators—"content resources, human-computer interaction, and user experience"—and 13 second-level indicators: accuracy, reliability, comprehensiveness, relevance, timeliness, novelty, ease of use, interface friendliness, adaptability, accessibility, guarantee, participation, and satisfaction. Using the Analytic Hierarchy Process, indicator weights were determined and consistency tests were conducted, laying a theoretical foundation for App evaluation. At the application level, eight representative English learning Apps were selected as research objects for empirical analysis. Data results show that dictionary tool-type English learning Apps are more popular among users, but listening-speaking type English learning Apps have richer and more distinctive content.

With the explosive development of mobile Apps, people's demands for mobile Apps are increasing, and App development faces increasingly severe challenges. For mobile App developers and operators: developers need to consider interface design and system functions from a human-computer interaction perspective, making App login and usage interfaces clearer and more beautiful, adaptable to different network conditions, and easy to access and use. System design should follow minimalist principles to occupy less running memory and avoid lag during usage, enhance security guarantee mechanisms, and improve application effects through technological advancement. Operators need to consider improvement strategies for existing Apps from a user experience perspective in

terms of marketing strategies, controlling resource charges and advertising 植入, intensifying promotion of high-quality Apps, increasing user participation, and improving user satisfaction. For users, with the vast number of Apps of varying quality, selecting suitable Apps has become a challenge. Mobile App evaluation can intuitively demonstrate user needs and expectations for Apps while revealing current App deficiencies, providing certain evaluation standards for users to select Apps. Users need to consider resource accuracy, richness, database completeness, and search convenience from a content resources perspective, while combining comfort during user-system interaction and relevant user feedback for comprehensive selection. Mobile App evaluation helps further improve mobile App quality and service capabilities, best meet public demands, and enable users to obtain Apps with satisfactory application effects. Thus, mobile App evaluation is of great importance and outstanding practical value.

This study also has certain limitations. Only eight representative English learning Apps were selected for evaluation, the research objects have particularity, and the number of evaluation participants is relatively small. In subsequent research, the study objects and scope will be expanded, and analysis of factors influencing App application effects will be refined.

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Author Contributions

Guo Yu: Experimental design, paper writing and revision;
Li Xiaotong: Experiment implementation, data collection and organization, initial draft;
Du Xingye: Experimental guidance, paper revision;
Liu Shuang: English translation of the paper.

Research on Application Effects of Mobile App Under the New Media Environment

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Abstract: [Purpose/significance] This paper explores the way to evaluate application effect of mobile App under the new media environment, and constructs mobile App evaluation system. [Method/process] This paper constructed App evaluation index system for mobile English learning from three dimensions of "content resources, human machine interaction and user experience", and used the methods of AHP and bisection to determine index weight. Then, it selected eight representative English learning Apps to make demonstrational analysis. [Result/conclusion] The mobile App evaluation index system has a certain application value, which can effectively evaluate the App. Through the analysis of App evaluation, we provide some suggestions for the development and construction of App based on content, technology and user experience.

Keywords: mobile App; application effect; evaluation system

Note: Figure translations are in progress. See original paper for figures.