



Design and Implementation of Adaptive Push APP Based on Android for Fragmented English Reading Resources

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Abstract. In the situation of mobile fragmentation learning, learning methods are becoming more and more mobile, and learning resources for English reading are becoming more and more abundant. It is difficult for learner to find the resources needed for his personalized learning quickly. This paper designs the five-dimensional characteristics of learner and the three-dimensional features of English reading resources in the fragmented learning environment. Combined with the ID3 algorithm, an auto-adaptive recommendation model for fragmented English reading resources is constructed. Based on this, and then according on the principles and methods of software engineering, an auto-adaptive recommendation APP for fragmented English reading resources based on Android is designed and implemented from three aspects: system analysis, system design and key technology implementation, to improve learner's English reading ability by pushing English reading resources that meet learner's individualized needs.

Keywords: Fragmentation learning · Adaptive push · Mobile learning APP · English reading · Design and implementation

1 Introduction

The revised edition of the College English Syllabus states: “The purpose of college English teaching is to train students to have a strong reading ability and a certain ability to listen, speak, read, write and translate, so that they can communicate in English.” [1] Under the requirements, the reading comprehension in CET-4 (abbreviate for College English Test Band 4) test always has a high rating. This not only puts higher requirements on the reading ability of candidates, but also brings severe challenges to college English teaching of reading. It can be seen that English reading plays a central role in English learning and is the main goal of English learning. English reading is also a necessary content for various examinations or daily applications.

Fragmented English learning in mobile context has become more and more important. Whether in public or in school libraries, many college students choose mobile devices for English learning. Fragmented learning is based on digital learning and is effectively combined with mobile computing technology to enable students to

learn English at any time and any place. On the one hand, it can be a reasonable use of fragmentation time, which is a trend of learning at present; on the other hand, many English learning APPs have been designed some very good functions, such as punching sign, which can promote learner to develop good study habits.

English reading resources are rich, diverse in form, and highly shared. While bringing convenience to people, it also brings about the problem of information overload. In the face of massive information, learner cannot quickly get the information that is truly valuable to him. Reading is a complex cognitive process, but the existing English reading APPs only do the plans based on learning objectives and learning needs when resources are pushed, or push English reading resources to learner according to his learning preferences, but not fully considering the change of the learner in the dynamic learning process. So it is difficult to constantly adjust the resources of the next push according to the change of the learner. When the APP-based learning method is adopted by more and more people, the problem in learning adaptability of learner in this environment is becoming more and more prominent. It is difficult for learner to achieve real online self-learning, and it is more difficult to obtain adaptive learning resources [2]. How to help student find the learning resources quickly and accurately which are suitable for his needs in the process of mobile learning? So there is personalized recommendation. It enables information consumers to get information they need quickly, moreover it can also provide predicted information to users in a targeted manner, and strive to push the information that the target users want most. The e-commerce APP and the English word APP have made a good exploration in this respect, but there are almost few English reading APPs for auto-adaptive pushing in English reading resources. Therefore, how to combine fragmented English reading with auto-adaptive push in the fragmented learning of mobile context, construct an auto-adaptive resources push model based on Android, and develop an auto-adaptive resources push APP with fragmentation features? It has become one of the research topics in the mobilization of English reading.

According to the learner's learning model in the learning process (English reading ability, cognitive style, learning target, learning situation and learning result) and the characteristics of English reading resource model (question type, theme and difficulty), Jianmin, Min and Bin [3] used machine-learning algorithms, also known as ID3 algorithm to construct a learning recommendation model for learning resources in fragmented reading. In order to test the feasibility and results of auto-adaptive resources recommendation model in fragmented English reading, this paper uses the principles of software engineering to determine the learning needs of target learners. Through functional analysis, the relationship between the functional modules included in the platform and the relationships between modules were determined. After that, a database of fragmented English reading resources was built. Finally, using the C/S architecture system, Android studio, Visual Studio, and SQL Server development tools, the learning resource adaptive recommendation APP for fragmented English reading is designed and implemented.

2 Overview of Adaptive Recommendation of Mobile Learning Resources

2.1 Fragmented English Reading

Compared to “integrated” reading, incomplete, intermittent reading patterns through new media such as mobile phones and mobile networks are referred to as fragmented reading [4]. With the help of mobile terminals such as smart phones and mobile networks, learner can receive huge amounts of information anytime and anywhere. The information and knowledge in the learning process seem to be at your fingertips, and reading is easy and easy [5]. Fragmented English reading is to learn English by means of Fragmentation Reading in a mobile fragmented environment.

2.2 Adaptive Learning System

The Adaptive Learning System (ALS) is an active learning system that is based on the “learner-centered” educational philosophy and proposes individual differences for current learner, (such as age, professional background, interest preferences, cognitive level, etc.), and dynamically provide a system for personalized learning support services. The adaptive learning system was first introduced in the field of foreign intelligent teaching systems and adaptive hypermedia systems. In recent years, it has become a hot spot in the field of E-Learning distance education [6, 7]. With the help of the adaptive learning system, learner can monitor his own learning process and choose the learning content and learning strategy that suits him best according to their actual needs [8].

At present, the English learning APP on the mobile phone is becoming more and more popular in young people. It is more common to use the fragmented learning method for English reading and learning. The goal of these APPs is to provide learner with personalized learning, that is, according to learner’s learning interests, behaviors in the learning process, learning history and learning level, and other characteristics, to push adaptive learning resources for learner through a certain algorithm. This provides a learning path that meets the learner’s individual needs.

2.3 Adaptive Push Model of Learning Resources in English Fragmented Reading

Referring to Jianmin Zhang, Min Xie and Bin Wen, an *adaptive recommendation model for learning resources in fragmented English Reading* [3] was constructed in the article Adaptive Pushing of Learning Resources in Fragmented English Reading, as shown in Fig. 1.

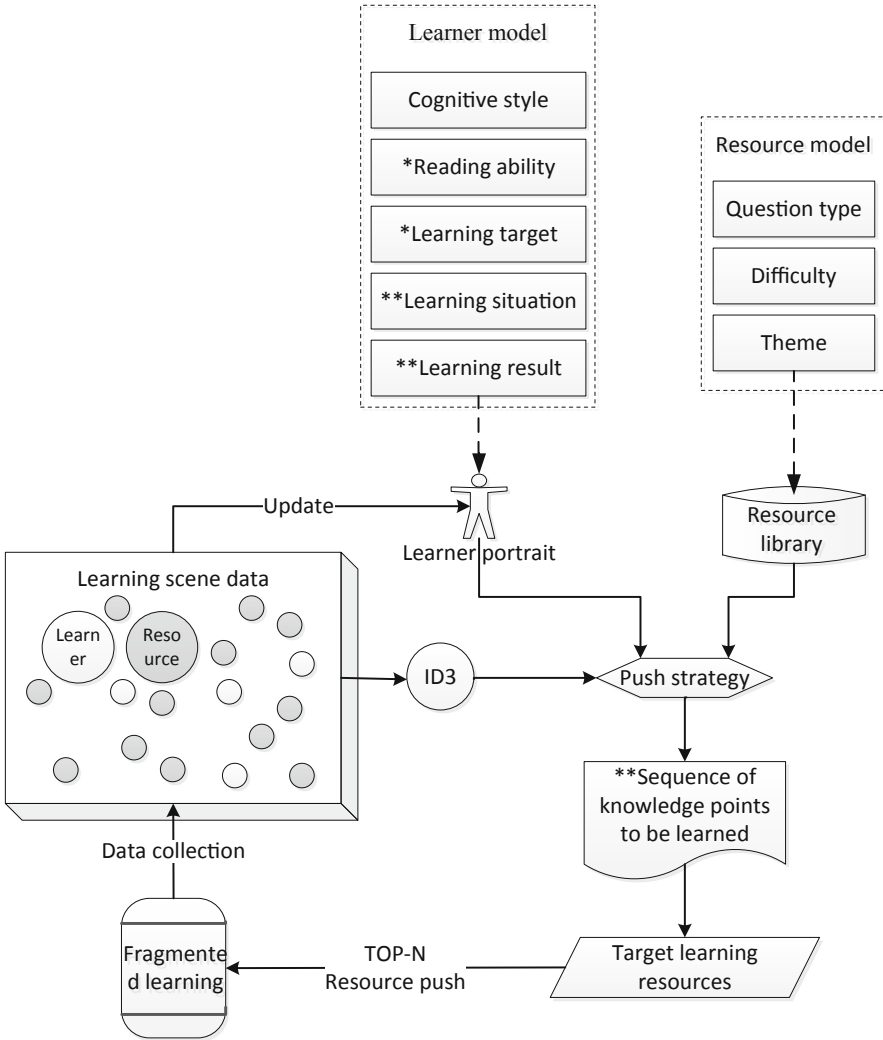


Fig. 1. Adaptive learning resources pushing model in English fragmented reading

Note: (1) In the learning scene, the white circle represents learners, and the gray circle represents the learning resources fragmented.

(2) “*” represents the relative stability of data. Items without “*” are more stable, items with “*” take a longer time to update, and items with “**” update the fastest.

On the basis of literature review, it is found that in fragmented learning environment, learner models can be established according to learner’s reading ability, cognitive style, learning target, learning situations, learning result and other information in the four-level English reading. Then extract the feature information of English reading

resources, and establish the connection between learner model and learning resources. Thereafter, based on the feature information of the learner, the sequence of knowledge points to be learned is generated. Based on this sequence, the push strategy is determined, the learning path is planned, and the learning resources are pushed.

The learner model shows that in order to realize the self-adaptive push of resources, the system needs to understand 4 aspects, that are what level the learner is at, what goals he want to achieve, where and how to learn, and how the effect is based on resource push learning. Among them, the assessment of learner's reading ability is based on CET-4 syllabus. It is mainly based on *the Chinese English Reading Ability Rating Scale* [10] and the seven factors mentioned in the article *A Study on the Structure and Development of College Students' English Reading Ability* [11]. And an assessment scale for English reading ability is developed. Cognitive styles are mainly field-dependent and field-independent. Students with different cognitive styles also have different interests in reading, thinking patterns, learning strategies and the impact of environment on them [9]. The vocabulary size and the accuracy of CET-4 are the main learning target. Learning situation mainly considers the decibels of the noise level of the current learner's geographical location in mobile debris learning environment. Learning result is mainly feedback through the correct rate of the problem of the learner in the complex learning situation.

The question types, theme, and difficulty of reading materials have a greater impact on learner. Different types of questions essentially examine different ways of thinking. Based on different growth environment, learners have different familiarity with reading materials on different subjects, and the results of the questions vary greatly. However, subjects with different degrees of difficulty require learners to be at different levels of learning. Understanding these differences in reading materials, the system can push resources more specifically for learner. This study extracts the feature information of English reading resources from the three-dimensional degree of topic type, subject matter and difficulty level of reading resources, and establishes a three-dimensional reading resource feature model. Question types are mainly considered from factual details, inference problem, semantic comprehension problem, main idea and the attitude of view problem. Theme is mainly considered from the humanities and social sciences and natural sciences. The difficulty mainly lies in people's experience of careful reading of Level 4 to decide which is difficult or easy.

On this basis, by collecting learner characteristics and resource characteristics information, the decision tree ID3 algorithm is used to establish the decision tree of resource push, from which the rules of resource push can be found. ID3 will be used to achieve the push of CET-4 careful reading resources in mobile fragmentation learning situation and meet the individual learning needs of learner.

3 Systems Analysis

3.1 Requirement Analysis

Faced with the rapid expansion and rapid renewal of knowledge, people are always eager to learn more knowledge to cope the rapidly changing times. Some developers have caught people's changes in this demand and developed a lot of learning APPs, but most of them lack in theory of teaching design, and just concentrate a large amount of resources. Seemingly very human, but it forced people to face with more multiple choices when using these APPs. It making them even more confused and do not knowing where to start. As a result, learning is like finding a needle in a haystack, and nothing is achieved.

Therefore, in the fragmented learning situation, it is urgent to solve the problem of auto-adaptive push of English reading resources. By collecting the learner's characteristics, resource characteristics, and the degree of influence of the environment (volume) on the learner in the process of the using of the APP, we can determine the learning demand based on the learning history data and adapt to push resources to help learner get the information he need quickly when the learner log in again [12]. On the other hand, the APP should also aim at the module of "Careful Reading" of CET-4, with the guide of relevant theories of fragmented learning in mobile context, and learner-centered, providing learner's needs for autonomous learning, and provides the possibility for learner to learn fragmented English reading in mobile environment. Therefore, the APP should include five core modules: login registration, context acquisition, learning resources recommendation, independent practice and learning process.

In addition to functional requirements, the APP should also have non-functional requirements. The APP should also be secure, simple to operate, and with appropriate openness to meet the future needs of users.

3.2 Target User Analysis

The main target users of App are undergraduates preparing for CET-4 and students who are willing to use App to improve their English read. Young students can quickly adapt to the popular new learning style of mobile fragmentation learning. This kind of learner has the following characteristics:

1. The frequency of using mobile devices and the willingness of mobile learning is higher. Mobile devices have become a necessity in people's daily life, and "carry-on" has become a habit of the youth. Because the purpose of this kind of learner is to obtain CET-4 certificate, most of them attach great importance to it. They often use the learning software in the intelligent terminal to study English. Therefore, they need a lot of mobile and fragmented English learning.
2. Limited learning time and easy to be interrupted. Most of these learners will make full and reasonable use of the fragmented and scattered time in their spare time for mobile fragmentation learning. Because of the short learning time and the complex

and diverse learning scenarios, it is easy to lead to the distraction of learner's learning attention. Therefore, in space-time of mobile fragmentation learning, English reading resources should be segmented reasonably and effectively.

3. Personalized demand is highly, and focuses on using experience. In the era of information explosion, it is difficult for the youth to find content that meets their personalized needs from mass information in a short time. Choosing an APP, the younger generation pays more attention to whether it can provide personalized learning services to help learner acquire learning resources quickly and accurately. In addition, there are so many learning APPs in the market, and the youth pays more attention to the UI design and user experience of APP.

3.3 Feasibility Analysis

Economic viability includes pre-investment, mid-maintenance and post-application and improvement. The pre-investment mainly includes the design, feasibility evaluation and cost of system development. In terms of software, based on the Windows operating system, with the client running on Android Studio 3.2.0, the server is deployed on IIS, and use ASP.NET WebAPI of Visual Studio 2013 to build framework. The database uses SQL Server 2008 R2. Therefore, these development tools can be easily obtained on the network. In terms of hardware, the server is deployed on personal computer through the network operation environment of the campus network (local area network), so there is no need to spend a lot of money to purchase server.

Mid-term maintenance requires only a simple back up the system regularly.

In terms of later application and harvest, for students, they only need to connect to the campus network WIFI to use this APP without logging in the account, thus saving the learning cost. Therefore, the system can bring great benefits in terms of economic feasibility.

In terms of technical feasibility, Android Studio is currently popular Android front-end development tool. Development based on Android is easier. ASP.NET has been recognized by many software manufacturers, and a large number of enterprises are using this technology for development. In addition, the SQL Server database uses the SQL language to manipulate data, which is easy to understand. ASP.NET+SQL Server as development platform on network has been quite mature, so it is feasible to use to build a Web Server. Combined with Android Studio front-end development, it is technically feasible to realize the development of an adaptive learning resource push APP for fragmented English reading.

In terms of application, more and more colleges and universities have used digital learning platforms to carry out education and teaching activities for many years, and mobile terminals are more favored by the younger generation. However, with the rapid growth of information, people's demand for personalization is getting higher and higher. At present, it is almost impossible to find resource recommendation function in mobile learning APP, in particular, there are few mobile terminals that push CET4 "carefully read" resources in the form of fragmented learning. Therefore, there is a great demand for the learning resource auto-adaptive push platform in fragmented English reading.

4 System Design

4.1 System Architecture Design

The purpose of system construction is to better help decision makers to formulate future recommendation strategies through effective data collection, so that the weak links in learning can be targeted and intensively trained. The general architecture of the adaptive push APP of English fragmented reading resources is shown in Fig. 2. The general framework of the system is divided into five levels, including the base layer, data layer, service layer, application layer and user layer.

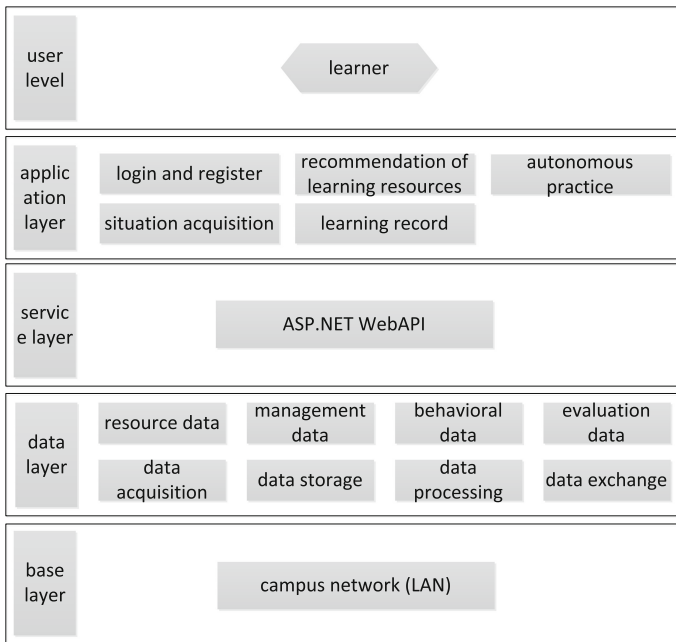


Fig. 2. General framework of system

1. Base layer

The base layer is the lowest layer of the system architecture, mainly based on the campus network (local area network) to support the network service of the auto-adaptive learning resource recommendation system to meet the requirements of network service of the system.

2. Data layer

The data layer is the second layer of the system framework, which is mainly for operating and managing system data, including resource data, management data and behavioral data. The resource data includes English reading resources, cognitive style test resources and English reading ability scale test resources. Management data includes student personal information, software information, etc. Behavioral data includes learner's behavior data, self-designed learning plan and the semester test, etc. The evaluation data includes exercise results. The data layer is mainly for collecting, processing, exchanging and storing the above data.

3. Service layer

The service layer is the middle layer of the general architecture of the system, which is used to connect the data layer and the service layer. The service layer is mainly used to support the system to provide application services for users at the application layer. The ASP.NET WebAPI framework is mainly used to quickly provide API for HTTP clients to create Web services.

4. Application layer

The application layer presents an adaptive learning service that the auto-adaptive learning resource recommendation system ultimately provides for learner. It mainly embodies the functions of login and registration, learning resources recommendation, independent practice, situation acquisition, and learning record provided by the system. Among them, login and registration are used for authentication and reading ability, and cognitive style test. Learning resource recommendation is mainly used for the system to recommend learning resources for learner. Autonomous exercises are mainly used for learner to learn according to their own learning needs, selecting the learning module and autonomous setting plans to learn. The situational acquisition is mainly to obtain the environmental volume of the current user's geographical location, thereby judging the influence of the annoyance of the geographical volume on the learning. The learning record mainly records the current learner's basic information and learning behavior.

5. User layer

The user layer is the mainly layer which the system directly contacts the users, and is the outermost layer of the system architecture. In the fragmented English reading, most of the user of the learning resources auto-adaptive push system is learners who are preparing for CET-4, and this system aims to provide learning services for them.

4.2 Function Module Design

The fragmented English reading resource auto-adaptive push APP has five main functional modules, including user center module (which include two modules of login registration and learning record), autonomous practice module, context acquisition module and auto-adaptive resource recommendation module, as shown in Fig. 3.

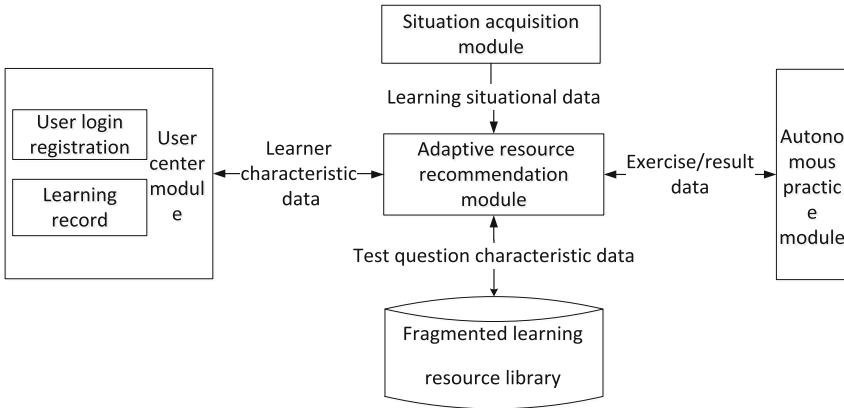


Fig. 3. System function model

The fragmented learning resource library is consisting with “carefully read” of CET-4, which is a fragmented reading resource that is reasonably segmented. In order to meet the characteristics of the fragmented learning situation, the reading materials are segmented according to the title and the dry information to meet the needs of fragmented learning when determines the length of reading resources.

The user center module includes user’s registration (cognitive style test and reading ability test), learning record (viewing the wrong title set, reading history, reading progress, and setting the learning plan), managing the basic information that the current learner learns in the APP and records of learning behaviors.

The situation acquisition module dynamically acquires the volume decibel of the current environment during the learning process of the learner, so that the system can monitor the learning dynamics of the learner in real time, which is beneficial to the system to obtain the learner’s learning data, and the recommendation strategy is more accurate and targeted.

The autonomous practice module is that the current learner chooses the learning content to train according to his needs. The APP has a selection of English reading learning resources classified according to different types, including five classification methods: test time, question type, subject matter, and by difficulty.

The auto-adaptive resource recommendation module is based on the learner model and resource model of the learner in the learning process, and comprehensively analysis the learning resources that conform to its personalized characteristics provide the possibility for learner to learn English reading in the mobile fragmentation situation [13].

5 Key Technology

In the fragmented English reading resources auto-adaptive push application, the Android-based C/S architecture system is adopted. Android Studio is used to implement the client’s functional part. Written in java language, the server is deployed on IIS.

The framework is built by ASP.NET WebAPI of Visual Studio. SQL Server is used to store the database. The server and the database are connected through the corresponding interface. And the server is deployed on the computer through the specific IP address and port number in the campus network by using the convenience of the campus network. Communication principle: after the client sends a http request to the server, the server parses the data, and then indirectly accesses the database and returns the data from the server to the client. After the client obtains the data in the JSON format from the server, the program will parse these data quickly. After the analysis is completed, the results will be displayed to users through the interface of the mobile intelligent terminal, as shown in Fig. 4.

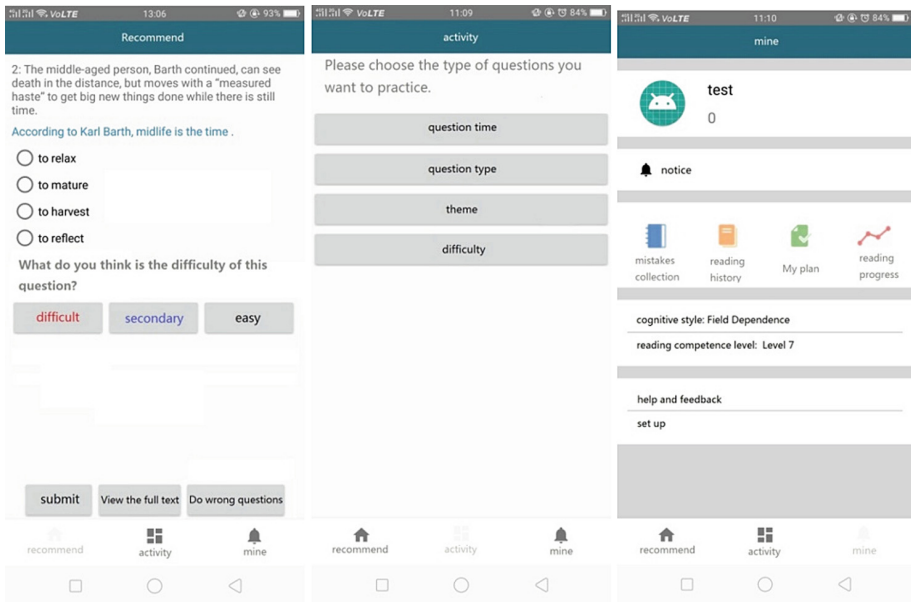


Fig. 4. Some of the system interface

5.1 Resource Push

In the process of mobile learning, it is difficult for learner to find the learning resources that are suitable for individual from massive resources quickly and accurately. This is the core problem that the auto-adaptive learning resource recommendation APP needs to solve in this paper, and is also the key technical point. By collecting the characteristic data of the learner in the learning process, and combining with the three-dimensional characteristics of the reading resources, the machine learning algorithm-ID3 decision tree algorithm is used to comprehensive analysis for auto-adaptive resource recommendation.

After the learner successfully logs in, the userId of the current learner is obtained, and the server API is accessed by GET() mode; the user information is obtained by the UserId. If the user is logged in for the first time, it is recommend based on the user's

cognitive style test and English reading ability test during the registration process. If he is an old user, it will through the ID3 decision tree algorithm for comprehensive recommendation based on the learner’s characteristics and learning behavior (cognitive style, reading ability, learning goal, learning plan, and learning result) to find matching questions in the database. Then encapsulate the relevant information of the title, options, corresponding articles, answers, etc. into an object PractisePackage, and use the JSON format to transfer to the front-end APP. The client uses the WebView control to display the returned data, which is equivalent to a browser is embedded in the client to load and display the web page. And the sliding answer effect answers of the selected questions, options, related articles which parsed by client, is achieved by ViewPager +fragment. The learning resources recommendation interface is shown in Fig. 5.

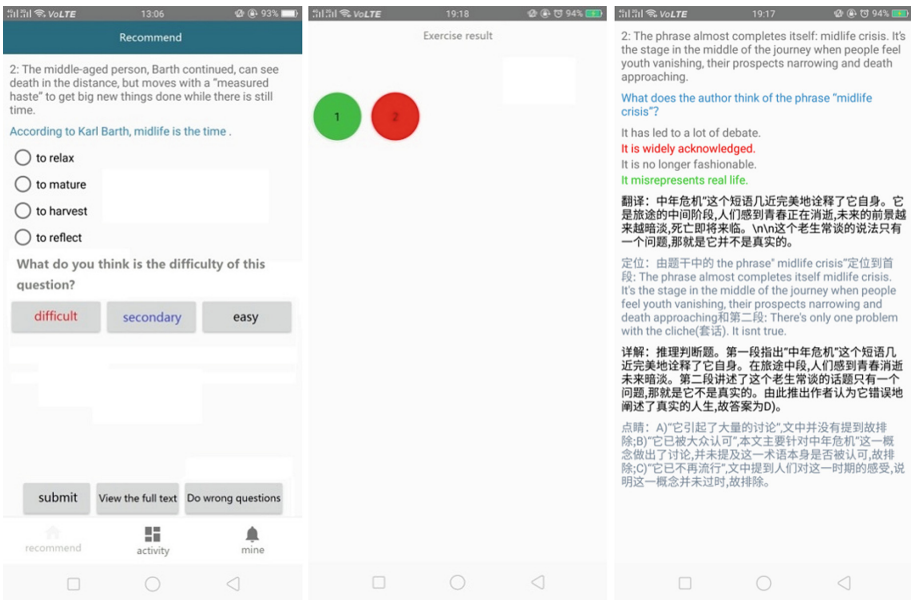


Fig. 5. Learning resource recommendation interface

The ID3 algorithm first acquires learner’s characteristics, resources features and classification properties. Then stores them in a two-dimensional array, and preprocesses the discrete data to normalize it. According to ID3 algorithm, the information gain of each attribute is calculated by the formula. Compare the information gain of these attributes, and use the attribute with the largest information gain as the test attribute of the S set, that is, the root node of the decision tree [14]. The flow chart of the algorithm design is shown in Fig. 6.

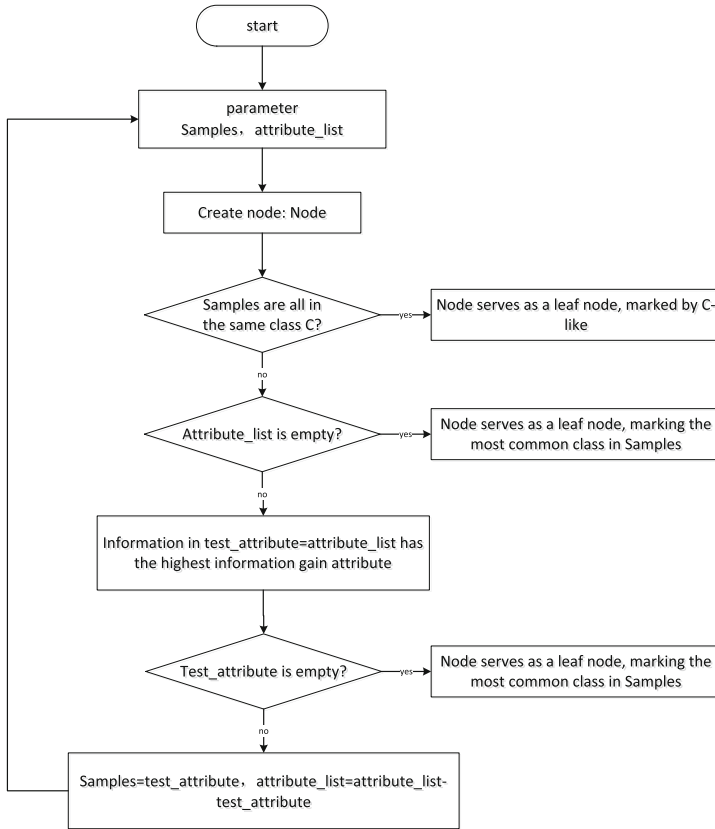


Fig. 6. Flow chart of decision tree algorithm

The algorithm is described in pseudocode as follows:

Input: training sample set; candidate attribute_list

Output: Decision Tree

Method:

Function ID3_Decision_Tree (samples, attribute-list)

{

 Create a node: **Node**;

IF samples is in the same category **C** **then**
 return Node is a node with class **C** tags;

IF attribute-list is **Null** **then**

return Node is the leaf node and is labelled as the most common class
in samples;

```

    select the highest gain attribute test-attribute from attribute-list;
    mark the attribute attribute-list as node: Node;
    known values for each test-attribute Ai;
    according to the condition test-attribute= $a_i$ , the node Node is divided
into a new branch;
    let Si be the set of test-attribute= $a_i$  samples in samples;
    IF Si is Null THEN
        add a leaf node and mark it as the most common class in samples;
    ELSE
        add a node returned by ID3_Ddecision_Tree (Si, attribute-list);
}

```

5.2 Web API Based on ASP.NET

The back-end framework of web server uses ASP.NET WebAPI to provide a new framework for HTTP services, using GET, POST and other methods to request or respond to requests or return media types, providing Web services for mobile terminals. The APP client uses the HTTP protocol to access the network. The working principle is that the client wants the server to issue an HTTP request. After receiving the request, the server will return some data to the client, and then the client parses and processes the data. Fragmented English reading auto-adaptive resource push APP accesses the network by `HttpURLConnection()` method, and uses a computer in the campus network (LAN) as a server. Therefore, in the case of acquiring `HttpURLConnection`, we only need to create a new URL object based on our computer's IP and specific port number, and pass in the target's network address, then call `openConnection ()` method to access the network. In the data interaction between the client and the server, generally we will transfer some formatted data on the network which have certain structure and semantics. When the other party receives the data message, it can parse by the same structural specifications, and get the part he wants. Therefore, this APP used the GSON open source library provided by Google to parse JSON data and implement the formatted data transmission on the network. The main advantage of JSON is its small size, which saves flow when transmitted over the network.

6 Conclusion

English reading is a complex process of cognition, and fragmented learning is characterized by fragmentation and dispersion of time and space, which inevitably leads to problems such as inattention of learner and fragmentation of knowledge construction in fragmented English reading. This study combines fragmented English reading with auto-adaptive resources push to provide learner with the possibility to learn English reading with mobile terminals in the context of fragmented learning. According to the learner characteristics and reading resources characteristics in the mobile fragmentation

learning situation, combined with the machine learning algorithm ID3, the learning resources auto-adaptive push model in fragmented English reading based on Android is constructed. The APP pushes the resources close to the learner's personalized feature requirements auto-adaptively. In order to support fragmented English reading better, this paper use Android C/S architecture system, designed the architecture and functional modules of the auto-adaptive resources push APP for fragmented English reading. Through testing, it can provide users with real-time targeted learning resources push that meets individual needs, which enables learner to make rational use of fragmented time, and learn English reading anytime anywhere. Fragmented English reading as a new way of learning can effectively supplement the lack of traditional English reading learning. If learner can rational use of this APP with normal English learning, it will definitely improve the learning effect. Subsequent research can be carried out in the following areas:

- Improvement and optimization of ID3 algorithm in fragment English reading resources recommendation algorithm. Such as reduce the perspective consumption of the classifier, improve the accuracy of the recommendation and optimize the classification process, etc., to further improve the adaptability of the algorithm.
- Auxiliary recommendation for English vocabulary learning. A certain vocabulary is the basis of reading. In the subsequent work, four-level high frequency words in the English reading resources can be extracted for the learner to learn, and the vocabulary learner felling difficult may be mined according to the learner's learning behavior records, so as to meet the learner's need for mobile fragmented learning.
- Real-time access to learning situations. The fragmented learning situation in mobile learning may change at any time, and the noisy degree of the learning context in this APP is only acquired at first log in, which may lead to recommended learning resources not better adapted to changes in the learning environment.

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