Study of the Individual English Learning and Memory based on Visualization Analysis

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Abstract—**Nowadays, with the rapid progress of computer technology, some new words like big data, visualization emerge in endlessly. Meanwhile, research of these respects is still ongoing. By using data visualization technology, we can obtain an excellent data analysis result. By using Item Response Theory (IRT) and Computerized Adaptive Testing (CAT) system, this paper is to build a method of individual adaptive English learning and memory. It will also combines the method of English learning with data visualization, aims to create a modern, visual and attracting English learning method, and creates a new learning experience.**

Keywords—English learning; visualization; learning method; IRT; CAT; individualization; adaptation

I. INTRODUCTION

With the deepening process of globalization, English has generally become an ability that people must master in modern society. However, it is not easy to learn English well for the key point that people are difficult to memorize large amounts of complex English words. For word memory, people have summarized a number of methods, such as root mnemonics, split mnemonics, etc. But most of the memory process is tedious and inefficient. With the development and application of visualization and adaptive technology, integrating English learning memory with computer science, it creates a new innovatively learning method.

II. TRADITIONAL ENGLISH MEMORY METHOD

Word learning is the most basic and important part of the whole English learning process. English word memory method will be very important, especially for the person who has problems in English learning. In other words, English word learning is the most difficult obstruction for those people. The ability of memorize vary greatly from individual to individual. Therefore, a good learning method cannot apply to every individual. Only if you find your own method of learning and memory, could get twofold results with half the effort in word learning.

The method to memorize English word can divide into three main types: rote memory, working memory and associative memory (Wang, 2011). Those memory types which as the memory module of language aptitude (language aptitude is a special part which is put in charge of language learning in general intelligence), play their own roles in English word memory (Wang, 2011) [1]. Although those memory methods are scholars' research finding, they may be a little hard for some English learners.

III. VISUAL MEMORY METHOD

Visualization is a theory, method and technology, which uses computer graphics and image processing technology to convert data into graphics or images displayed on the screen and processes in an interactive way [2].

Visualization technology enables to let people operate the visible information of graphics world directly and contact with computer promptly. It unifies human force with machine's power in an intuitive and natural way. This revolutionary change will undoubtedly improve people's working efficiency [2].

Visualization includes visualization in scientific computing (ViSC), data visualization, information visualization, and knowledge visualization. Visual English memory method is using the visualization of knowledge, and combines English learning with memory in a visual way to make English learning and memory process more attracting. It also improves learning efficiency and shortens memory time.

Nowadays, the existing visual English learning methods are word with pictures, word visualization and word splitting image, etc. Integrating visual English learning and memory method with individual adaptive method of visual English learning and memory, it not only helps learners to learn English, but also helps them to arrange learning time, improve learning efficiency, reduce the learning inertia and enhance interest in learning and many other aspects.

IV. INDIVIDUAL ENGLISH VISUAL LEARNING AND MEMORY RESEARCH

The word memory cannot separate from constantly memorize and review. No matter what methods you have used

to memorize English word, you will forget it over time. Therefore, it becomes more significant that reviewing the word that we learnt before to reinforce the memory of word. Although doing exercise is a traditional way of memory, but we have to admit that, so far, is still an effective memory way. So, the integration of exercise and visual learning method will be a brand-new English learning method.

The above learning method merely helps learners to learn how to memorize, but not supports them to memorize English word systematically. But individual English visual memory method can make a personalized learning method for leaners, help them to learn English word more systematically, and arrange time rationally and effectively. It not only improves the leaners' efficiency, but also makes learning full of fun.

A. visualization English word learning

According to learners' word memory extent, the word memory module can be divided into three levels: primary memory, secondary memory, and tertiary memory. Through three levels of word memory module to strength the memory of word.

1) Primary memory

Primary memory is using examples and pictures which are related to the word, plus "association + reasoning" mode of thinking, to guess the word's meaning, as shown in fig.1. In this way, it not only guides learners guess the true meaning of the word by association memory, but lets them have a deeper understanding due to example sentences. Whatever learners choose correct or wrong answer, the system will give a detailed explanation of the word to the learners, which can make them have a deeper understanding of the new word. But, if they cannot associate the word meaning and choose the correct answer by using of example sentences or pictures, the system will still leave the word in primary memory module. Hence, learners will memory that word again under the primary memory module. Only if they pass the primary testing, can they enter the next module. The primary memory module is a primary understanding when the learners first learn a new word.

Fig.1.   Primary Memory

2) Secondary memory

Secondary memory is a way of using the word meaning to choose correct picture, deepen the word understanding and memory. It is shown as fig.2. Only if learners pass the primary memory module testing, can they enter the secondary memory module. This module is more difficult than primary memory module. Therefore, it requires that the learners should have a certain understanding and memory of the word. This module

not only lets them have a self-texting, but also deepens their memory. If they choose a wrong answer, the system will give a detailed explanation of the word; reversely, if they answer correctly, they will enter the next module. The secondary memory module is a process of word's deepen-understanding that based on the primary memory module.
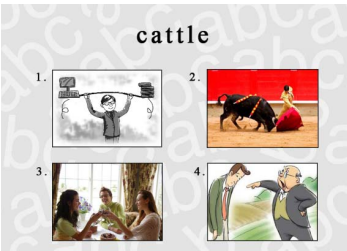

Fig.2.   Secondary Memory

3) Tertiary memory

Tertiary memory is a way of choosing word's correct meaning to make a self-texting. It is shown as fig.3. This module is more difficult than the last memory module. Only if learners pass the secondary memory module testing, can they enter the tertiary memory module. If they choose a wrong answer, the learning process will stay in this mode; reversely, the learners choose right answer, all the learning process will finish. In other words, the learners have complete word basic memory. Tertiary memory is a self-texting of word memory degree which based on the secondary memory module.

Fig.3.   Tertiary Memory

4) Memory process

Step 1: Start learning process, firstly, the leaners will enter primary memory module, and learn word by using example sentences and pictures. They can enter secondary memory module if they pass the last module texting; reversely, if they give a wrong answer, they will stay in the primary memory module to text again.

Step 2: When the learners enter secondary memory module, they can merely choose correct picture by the word meaning. This module is to texting learners' memory degree. So, it is harder than the last module. If the learners answer wrongly, the system will back to the primary memory module and let learners review the word; reversely, they will enter the next memory module if they pass this module texting.

Step 3: The tertiary memory module is the hardest module, because learners have to choose the word according to its meaning. This memory module requires learners to master the word's basic meaning. If the learners answer wrongly, the

system will back to the secondary memory module and let learners review the word; reversely, they will complete learning process if they pass this module texting.

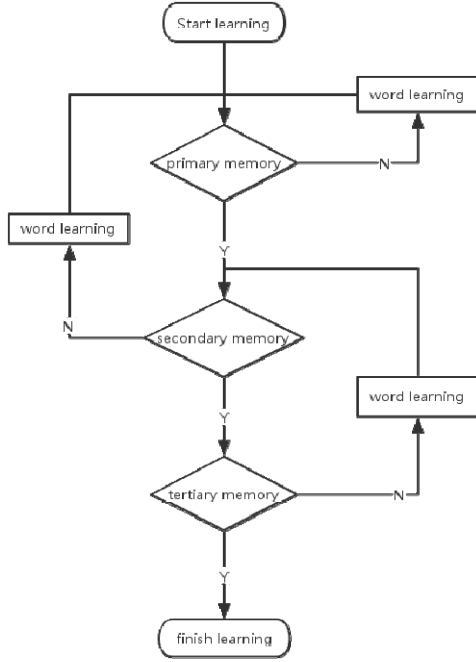It is shown as fig.4. The memory process is:

Fig.4. Memory flowchart

B. *Individual adaptive system customization*

1) Theory of adaptive design

Item response theory (IRT), is a generic term for a series of psychological statist model, and also a theory of personalized English learning and memory systems research[3,4]. IRT is using of mathematical model which let learners continue to do texting to analyze them response data. As shown in equation (1), θ represents each learner's ability; P (θ) represents the accuracy. If the learner has an outstanding English word learning ability, then P (θ) value is closer to 1. In other words, the learner selects more correct answers. Moreover, it is the most significant feature that IRT can accurately analyze the true word learning ability of learners, no matter the problem is difficult or not. For the same score leaners, IRT also can dig out their diversity according to their answer reaction, which provides a scientific effective basic data to learner's personalized visual learning [5].

$$P(\theta) = c + \frac{(1 - c)}{1 + e^{-Da(\theta - b)}} \qquad (1)$$

Computerized Adaptive Testing system (CAT), which establish in IRT, is a brand-new analyze texting method. On the basis of leaner's answer situation, CAT can calculate the ability value and information quality of the tester. Meanwhile, it will adjust levels of problem difficulty based on those parameters, and gives tester a proper evaluation [6]. Specifically, when the tester doing the testing the system will select a number of easy problems firstly. If the learner chooses a correct answer, then the system will select some more difficult problem to do the quiz; reversely, if the learner answers wrongly, the system will select some easer problem. Learners will constantly repeat this testing until they complete the whole learning process. CAT, as an individual adaptive testing, has great features in integrating tester's self-ability while selecting adaptive problems doing the test, which meets all levels of learners' need.

IRT, CAT technology is combined with English learning, which has provided a theoretical basis for visualization tertiary memory learning question bank mode. This kind of combination has provided a solution for the realization of individuation customization. Learners conduct tertiary memory learning after entering into the system. The system will increase or decrease the difficulty in a self-adaptive way based on the learner's test result. Learners try to complete the learning of English word by continuously conduct tests in order to improve their ability to finalize the study.

It is shown as fig.5. The general process of English visualization tertiary memory mode that combined with personalized adaptive technology is shown as below:
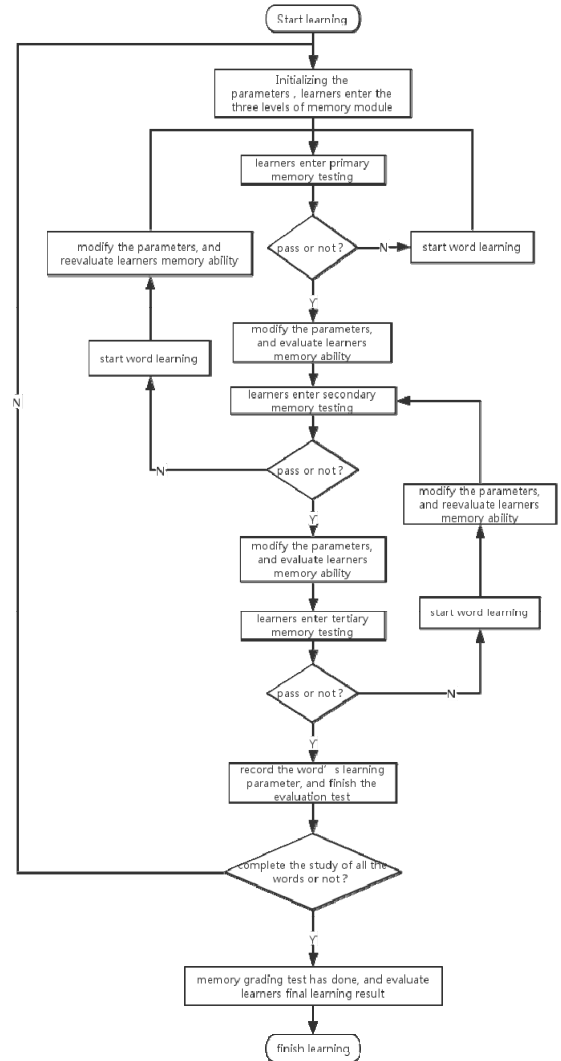

Fig.5. Process in adaptive three levels of memory module

2) The binding of individuation customization and visualization technology

Learners will produce a variety of learning and memory data, these data are all stored in the database in the form of parameters. Many seemingly useless data can effectively help learners reasonably arrange for study time, optimize learning plan more effectively to improve learning efficiency. Through the realization of useless data techniques we can help learners to analyze the state of their own learning, check their learning outcomes so as to push themselves to continue their efforts to complete the study plan.

The system can make the study accomplished through the following visualization cases:
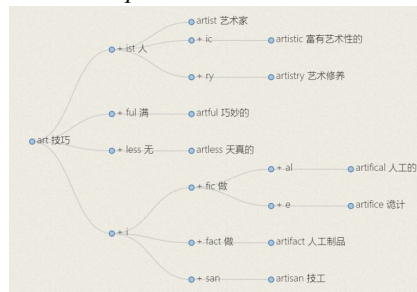
a) Root mind map

Fig.6. Word mind map

It is shown as fig.6. Mind map is created by Tony Busan the famous British "Mr. Brain of the World ". Through the use of learners' radiant thinking mode, the framework of knowledge can be divided orderly; it can make learners have a more profound and clear understanding and memory of the word. Through color and line, the mind map can organize and categorize the words that learners have learned. In this way, they will more convenience to learn and review. The mind map is like a tree, the tree trunk is the center of this kind of words, it also can be the roots, types, and keywords of this kind of words, etc. It is like the trunk can be divided into several branches, this kind of words can also be divided into several subclasses, and the subclasses can also have several subclasses. Finally it is the details of content. The biggest advantage of mind map is that it can clearly claim the related word that learners have learned in a certain time. This method can make the learners through a certain keywords and associate with the same types or the same root words. It is efficient to learn and review the same type of the words. It not only let learners learn new word, but also strengthens the memory of same type in deeply.
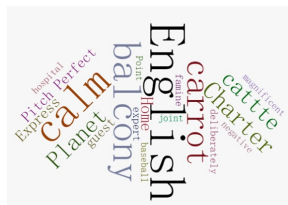
b) Wordcloud

Fig.7. Wordcloud

It is shown as fig.7. Word cloud is a kind of way of visualization through the cloud picture production tools to produce a text art processing. Word cloud can make abstract and boring English words visualize, make the learners fully mobilize the sense of visual and auditory to stimulate interest in English reading, so that at the least time, they can remember the most important and most critical text description of English knowledge [9].Word cloud has combined with the conditions of learners' learning, which shows latest words learned to learners and reminds learners to learn or to review the words that have been learned recently. Learners do not need to deliberately to see exactly what are the words in the cloud, and just need to see the record in cloud, and then recall certain word to achieve goal of reviewing. Word cloud image visual way provides learners with a new way of learning words through various artistic effect such as color, font.

c) Visual learning performance

It is shown as fig.8. Learners in the learning can produce all kinds of data, such as learned words number, new words number, forgotten word number, and reviewing word number, etc. Although this series of data is generated in the process of learning and seems useless, the data displayed through the visualization tool, can achieve unexpected result. Learners can use these data to optimize their learning plan and keep learning to achieve learning goals.

Fig.8. Visual learning records

As shown in fig.9, learners can pull the time axis to check their learning situation in a certain period of time. Learners can be known by the statistics, such as the number of words they have learned, the number of words they do not complete, and the number of words they need to review, also be known by their variation tendency. Learners can optimize their learning plan and improve the efficiency of learning according to their own learning situation.
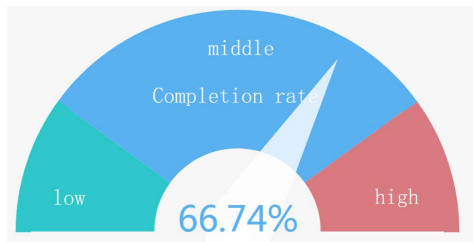
Fig.9.   Learning completion rate

As shown in fig.10, according to the assessment of learning, learners can see the completion of their own learning plan, in order to encourage themselves to adhere to the study, and to complete the learning objectives
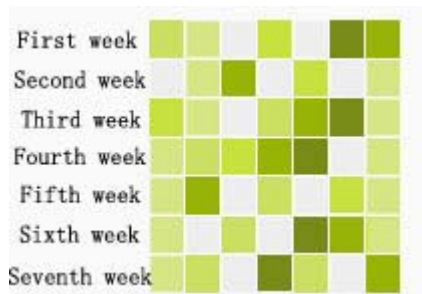

Fig.10.   Users learning login diagram

Learners can also see their own register in visualization. If learners sign in and register, then the color of the square in this day becomes the gray into the green. While the longer time they spent, the more they remember words and the darker green the color of the square. Learners can see their daily learning status and the situation in visualization, in order to encourage their daily study and review.

V.   CONCLUSION

Word learning can't be accomplished immediately; it's a process with long time accumulation, constant revision and consolidation to deepen understanding. For different learners, English learning methods vary from each other. Individual adaptive visual memory method provides a new way of thinking and memorizing for the users who have difficulties in memorizing words. It can make learning process full of fun by reasonable photocopy-able words meanwhile show the learners by visual method valuable data in the process of their memorizing through different approaches. While reducing users' learning pressure and burden, this method promotes the memorizing and understanding of words by interesting way, and also makes a personalized-learning data analysis through effective tool and technology for learners. With fun learning approaches, this method provides intuitive visual approach for learners to realize their learning conditions for better learning and memorizing.

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