The Research on the Application of Plant Identification and Mobile Learning APP based on Expert System

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Abstract: As the development of mobile internet and the improvement of software and hardware facilities, expert system expands its field in mobile applications. The identification and learning of plants is an important part of biology in middle school. Outdoor experiential teaching is an effective way to improve the students' learning effect. Based on the production rules expert systems, this study developed plant identification and learning mobile app based on Android platform. This study applied the app into the outdoor mobile learning and used the education experiment and classroom observation method to do research by the use of software, attitude of using software, learning satisfaction learning and attitude towards science four dimensions. And the analysis of the difference between the population statistics and the application of mobile learning experience, verify that the system has a positive effect on the students' learning attitude and the degree of satisfaction with the outdoor experiential teaching.

1 INTRODUCTION

The expert system is a heuristic program system which can use expert knowledge to do empirical reasoning. It contains a large number of expert level domain knowledge, which can simulate the reasoning process of a human expert to solve problems (Jia, 2009). In 1965, Fei Baum in Stanford University and chemist Lud Begg developed the first expert system DENDRAL (Shi, 2011). Since the 1980s, the expert system is gradually applied to various fields with the development of science and technology (Pandit, 2013). In the field of education, the application of expert system embodied intelligent teaching system, intelligent question answering expert system, intelligent decision system, intelligent test paper evaluation system, etc.. (Golumbic et al., 1986; Xu and Jiang, 2011; Zhu, 2012) With the popularity of smartphones and the development of mobile Internet, mobile learning has become a new field of expert system in educational application (Fu and Li, 2010).

Biology learning in middle school is the basic stage, and knowledge about plant is one of its components. The plant identification is more complex than animal identification, which is the key to biology learning, need more practice to carry out experiential learning in a real environment (Hou et al., 2012). The plant recognition and learning mobile application based on expert system can make students experiencing the process of plant knowledge learning outdoors, by which students can learn knowledge of plant genera and characteristics flexible and fully.

2 RESEARCH STATES

2.1 Limitation of Plant Identification

With the development of science, now the identification of plant can be roughly divided into three categories (Chen et al., 2014), artificial identification method, assisted artificial identification method and automatic identification method. Artificial identification method refers to the plant characteristics of knowledge investigation form of learning, such as flora and botany etc.. Corresponding to the actual life, plant identification is divided into a visual method, smell method, somatosensory method. The method requires experts to master a wide variety of plant characteristics knowledge. Experts in the field can quickly identify plants through this method, while middle school students are not competent. Assisted artificial identification method id using the existing data in

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physical or chemical methods to help people identify, such as simple tools, microscopy, spectroscopy, thermal spectroscopy and other high-precision methods. However, this method is not suitable for ordinary biology classroom or outdoor experiential teaching. Automatic identification method is using automatic identification system based on computer vision to observe leaf characteristics. Computer vision technology can automatic complete plant leaf image processing and feature extraction and classification of plants. While this method is time-consuming, can not provide instant feedback on mobile learning.

2.2 Relevant Research

Mobile applications contribute to project-based learning, problem-based learning, and other integrated practical activities, to develop students' ability to communicate, solve problems, innovation and innovation ability. Huang(Huang et al., 2010) developed a Mobile Plant Learning System (MPLS) based on the pad, which provides outdoor experience to recognize plant and learn botany knowledge in the primary school curriculum. MPLS belongs to the framework based expert system, in which stored a large number of plant leaf characteristics and detailed examples of information. Through the comparison between pre-test and post-test in the experimental group, it was found that through MPLS learning, students' ability of plant recognition was improved obviously, and the outdoor learning method was more popular.

Mobile applications based on interactive concept maps are also applied in middle school biology learning. (Hwang et al., 2011)Research shows that instant feedback of mobile application learning method is conducive to improve students' interest in learning and outdoor biological science teaching effect. The practical teaching system of campus plant scene teaching is designed (Xu et al., 2015), which includes pre-class learning and outdoor experiential learning in class and teaching feedback underclass.

Compared with the traditional classroom knowledge teaching, outdoor experiential learning is more helpful to improve students' interest in scientific knowledge and knowledge of plant knowledge. The mobile application expert system can promote the application of outdoor mobile plant identification and learning of middle school students not only need simple and easy to operate, plant information database based on large, there should be immediate feedback operation, help learners to quickly complete plant identification, and learn more knowledge about plant characteristics.

3 APPLICATION DEVELOPMENT

3.1 Expert System

The expert system based on rules also called the generative rules system, there are many examples of successful and simple and flexible development tools, can directly imitate human psychological process, and use a series of rules to express expert knowledge (Zhang et al., 2010). This study established a plant facts database of non-attribute rules, including the fact of plants, that is attribute value of the attribute refers to a "yes" or "no", which is a series statement of IF and THEN. Figure 1 is a simplified structure of the expert system which was designed for this research. Through the display of obvious plants, the system has many aspects describing the entries and simple image schematic. The learner can answer the question when observing plants, then the reasoning machine and the interpreter in the knowledge database shows the next question refers to feedback from the learner. Until the correct reasoning to plant so far, all the information about the right plant will be shown in the result page on the app (including plant number, picture, name, alias, characteristics, distribution and use value) for the learners.

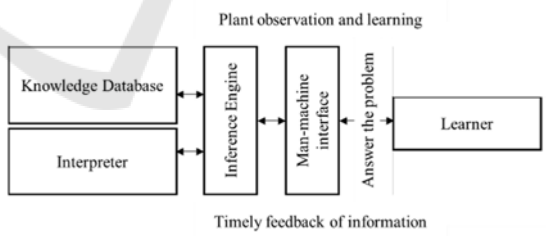

Figure 1: Simplified architecture of plant recognition and learning expert system.

3.2 System Inference and Interpreter

In this study, the inference engine design of production rule expert system can enable learners to identify plants through a variety of plant characteristics. The interpreter is the plant fact information, which combines the operation of the corresponding machine. This study designed the intermediate facts to simplify the inference process of plant identification, that is, let learners judge plant genera (herbaceous, woody and Fujimoto) first. Figure 2 structure for plant mainly adopts two query tree data, the first access node, if the user chooses "yes", then access the left subtree, or visit the right subtree, until no node is given, the plants need to query. The asterisk represents a picture prompt. Each question makes learners observe plant characteristics and make decisions, greatly the promoting learner's participation in learning and improving the frequency of learners' observing of plant characteristics.

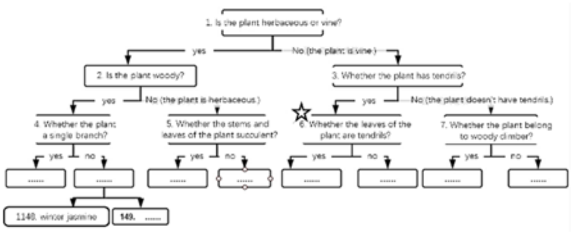

Figure 2: Sketch data structure of plant recognition and learning mobile applications.

Note: When the question number is greater than 1000, indicating that the node of binary tree has come to an end, which means the user can get the answer. The question marked with an asterisk has picture prompts.

3.3 Plant Knowledge Base

Plant knowledge base formed in this study included a total of 204 species those were common in the northern campus in China and have obvious characteristics of plants, including 78 species of woody herb, 99 species, 27 species of vines. According to "Chinese flora" (editorial board, Chinese Academy of Sciences Chinese flora 2004), this study wrote the two retrieval disambiguation table (shown in Table1).

Table 1: Plant retrieval tables (part).

1. Plants are woody or herbaceous.
2. Plants are woody plants.
3, trees, plants with a single trunk
4, leaf needle shape, scale shape, thorn shape, evergreen
5, leaves all scale flake, interactive pairs, twigs flat, arranged in a plane.......................... Platycladus orientalis
5, needle-like, rod
6, leaf type two, for scaly leaves or barbed leaves, branchlets terete................................... Sabina Chinensis
6, at least 2 gold leaf clusters
7, Ye Dansheng, spiral arrangement
8, cone upright; leaf blade back bar, two holes, spirally arranged; not a leaf... Liaodong fir
8, pendulous leaves with a prominent seat;
9, young branchlets hairy; leaves subulate tip blunt; four white hole line....................... Picea Meyer
9, young branchlets smooth; tip acuminate or acute; the stomatal band is not obvious............................. Picea wilsonii

The software knowledge database mainly includes two tables: plant retrieval table (see Table 2) to find the role of plant, provide answers; Plant information table detailed information for the storage of plants, which provide more learning content (including plant number, picture, name, alias, characteristics, distribution and use value) about the plant for learners to learn.

Table 2: Design of plant retrieval table in knowledge base.

property	has_pic	question_id	question	yes	no
Meaning	Whether there is picture tips, Picture ID	Question ID	Question Content	User select Yes, next problem number	User select "no", next question number
data type	Interger	varchar	varchar	varchar	varchar

3.4 Plant Identification and Learning Process

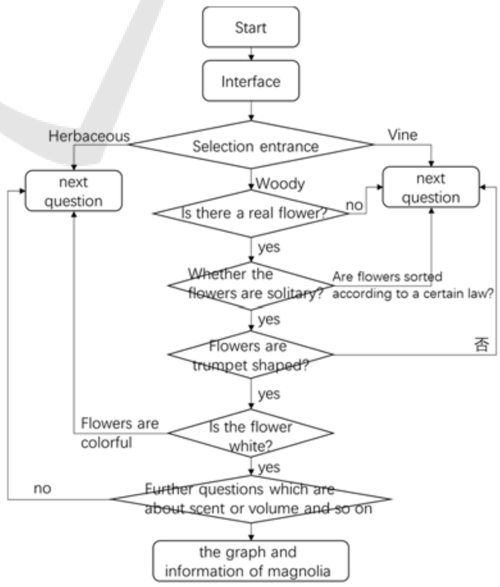

Figure 3: Plant identification and learning process (Magnolia).

The application is developed by eclipse and Android ADT, which can run in more than 2.3 versions of the Android mobile platform. In the software testing phase, and the average duration of the plant identification process is 2 minutes.

Take the identification and learning of Magnolia for example, when learners observe magnolia, and choose wood for the entrance, and then answer a series of questions by observing the features of plants as shown in Figure 3 and Figure 4. Finally, learners can obtain the graph and information of magnolia (shown in Figure 5).

Figure 4: Question interface.

4 APPLICATION RESEARCH

4.1 Research Method

4.1.1 Education Experiment Design

This study conducted two education experiments on plant identification and learning APP. The purpose of Experiment 1 is to explore the use and attitude of learners on the system based outdoor experiential teaching. The purpose of Experiment 2 is to explore the teaching extension of the system in different stages of middle school.

Figure 5: Plant presentation interface.

Experiment 1 implemented in Beijing City, Shijingshan District Yangzhuang middle school, which is greening and rich in plant species. Experimental design control group and experimental group. The experimental steps of the experimental group are as follows: (1) preview the relevant knowledge of plant characteristics before class; (2) use outdoor experience plant recognition and learning in APP; (3) study and use. The experimental steps of the control group were as follows: (1) preview the knowledge of plant characteristics before class; (2) learning knowledge of plant recognition under the traditional classroom teaching environment; (3) investigation of the learning situation.

Experiment 2 is generalized inquiry experiment. The experimental sites were selected from Taiyuan forty-eighth middle school in Shanxi province. To explore the use and attitude of the senior middle school students, we choose the were senior high school students as the experiment subjects. The experiment steps are as follows: (1) preview the plant characteristic knowledge before the experiment; (2) use the APP to carry out outdoor experience plant recognition and learning; (3) a survey of learning and use.

In addition to the application of questionnaires in educational experiments, the research method also includes classroom observation and interview. To observe the learning situation and attitude of the learners participating in the outdoor experiential plant recognition and learning, and the informal interviews after class, the software usage is analyzed comprehensively.

4.1.2 Research Tool

This study refers to the questionnaire used by Chu’s (Chu et al., 2010) plant mobile learning applications, and we combined with the cognitive characteristics of mainland Chinese students, revised the scale of each topic for translation and part of the topic of expression. "Plant identification and learning mobile APP usage questionnaire" is divided into scale part and background information part.

Scale into two parts, a total of 25 questions (see Table 3): plant identification mobile applications using the first part of the survey students learning activities, divided into three dimensions: "the use of software" 4 questions, "the use of the software attitude" 6 questions, "the use of the software to learn after the learning satisfaction" 8 questions; the second part is "to participate in the learning activities, learning attitude of natural science", namely the survey of students' attitude towards natural science learning, a total of 7 questions. The questionnaire uses the Likert five-point scoring method, the option settings from "very agree" to "very disagree", in turn, scored for 5, 4, 3, 2, 1. The overall scale of Cronbach's Alpha coefficient is 0.894, the use of software, the use of the software of attitude, learning methods and the satisfaction of natural science learning attitude of Cronbach's Alpha were 0.742, 0.793, 0.902, 0.907, indicating that the research tools have higher reliability.

Table 3: Survey scale of plant identification and learning mobile APP.

Construct	Item
Use of software	This software is easy to use
	I used a very short time to learn how to use this software
	The user interface of the software is friendly
	During the use, I did not encounter technical problems (such as click no response, etc.)
Attitude of using software	I like to use this software to learn, it provides an interesting way to learn
	I hope this way of learning can be applied to other courses.
	I will use this software to learn
	I will recommend this software to other students
	Using this software makes learning activities more interesting
	When using the software I can seriously according to the tips of each step to the next judgment
Satisfaction with learning methods after using the app for learning,	This learning activity, let me know more about the characteristics of different plants
	During my study, I have been trying to observe the differences between plants.
	I learned to identify a plant by observing the characteristics of the flower, leaf, and fruit of the plant.
	Using software to learn is more challenging and interesting than traditional learning methods.
	I learned new knowledge or new discoveries
	I try new ways of learning and thinking
	I learned how to identify a plant
	I learned how to tell the difference between plants
Learning attitude towards natural science after participating in learning activities	I am more interested in observing and exploring plants.
	I have more confidence in plant learning
	I am more interested in plant learning
	My observation of outdoor plants has increased.
	I hope to learn more about plants
	I like to learn about the real world through outdoor observation.

4.2 Result Analysis

4.2.1 Analysis of Overall Effect

In Experiment 1, the research object is middle school students from Beijing Shijingshan District Yangzhuang junior high school, including students from 1st class and 2nd class in Grade three. The students were volunteered to participate in this experiment. 1st class is the experimental group, a total of 15 people (7 boys, 8 girls), 2nd class is the control group, a total of 15 people (6 boys, 9 girls). Experimental group students after the application of plant identification fill in the questionnaire, the control group only fill in the questionnaire background information and scale fourth parts. A total of 30 questionnaires were issued, and 29 valid questionnaires were recovered.

After the experimental group of learners using the learning system, "the use of software", " attitude of using software " and "learning satisfaction" scores were in the middle level (4.883, 4.044, 3.733). It shows that the system has a higher user experience in software design, and the students in the experimental group have higher satisfaction in using the system. In the dimension of "learning attitude towards science", the experimental group was filled out after using the system, while the control group did not use the system. After independent sample T test, there was a significant difference between the experimental group and the control group, that is, the experimental group in the natural science learning attitude, far higher than the control group. This shows that the learning attitude and interest of the natural sciences were greatly improved after the outdoor activities of plant identification. The purpose of this study, to improve the students' interest in plant learning and plant characteristics and knowledge come true.

Table 4: Difference between experimental group and control group.

Dimension	gender	num	mean value	standard deviation	t-value	*p*
Learning attitude towards natural science	experimental group	15	3.990	0.360	7.619	0.000***
	control group	14	2.980	0.354		

Note: * * * represents p<0.001.

4.2.2 Analysis of Teaching Extension

The subjects of Experiment 2 were students of grade one in Taiyuan No. forty-eighth high school. A total of 45 questionnaires were distributed, and a total of 35 valid questionnaires were collected, including 10 boys and 25 girls. The differences of experimental results between students in experiment 1 and 2 were analyzed. The differences in grade analysis results are shown in Table 5, all dimensions are significantly different. Senior high school learners of the learning system, the use of software "," software attitude "and" learning satisfaction "and" natural science learning attitude scores were in the middle level, and the scores were 4.671, 4.586, 4.668, 4.535. The dimension of the use of the software is higher than that of high school students in junior high school, while high school students are higher than junior high school students in the attitude of using software, the satisfaction of learning methods, and the attitude towards learning science dimensions. Although the junior and senior high schools close in grade, but the junior high school students will face the senior high school entrance examination (Biology is not included in the examination), high school students have finished senior high school entrance examination (while the college entrance examination includes biology), and these factors on learning application will have a certain impact.

Table 5: Difference between middle school students and high school students.

Dimension	grade	num	mean value	standard deviation	t-value	*p*
the use of software	middle	15	4.883	0.229	2.431	0.019*
	high	35	4.671	0.302		
attitude of using software	middle	15	4.044	0.434	-3.501	0.001**
	high	35	4.586	0.526		
learning satisfaction	middle	15	3.733	0.398	-7.554	0.000***
	high	35	4.668	0.402		
learning attitude towards science	middle	15	3.990	0.360	-3.873	0.000***
	high	35	4.535	0.489		

Note: * represents P < 0.05, * * represents P < 0.01, * * * represents p<0.001.

Overall, the system also has higher teaching popularization value in senior high school, and it can promote the senior high school students improving the learning attitude of plant knowledge. The development of the educational application of relevant knowledge content has a higher feasibility and application value to help middle school students and high school students to conduct outdoor experiential learning.

4.2.3 Analysis of Differences in Application

The study used survey data of 50 learners to analysis differences in demographic and mobile application learning experience and other independent variables. When to use the network to study there were no significant differences in the use of software, the use of software attitude, learning methods and learning satisfaction attitude dimensions of natural science, but with the delayed network learning time, each dimension scores were increased, but the difference is not large, indicating when starting study on the use of significantly influence the recognition and application of plants using network. The average comparison shows that boys use software better than girls, while girls are better in satisfaction of learning and learning attitude towards natural science than boys.

When to start using the network to learn in the use of software, the attitude of using the software, the satisfaction of learning methods, natural science learning attitude dimensions were no significant difference. With the delay of the beginning of using the internet to learn, each dimension scores were improved, but the difference is not large, which indicating when to start to learn by the internet has no significant effect on the identification and learning of plant.

Whether has experience in using mobile applications for learning before has a significant difference in the use of software dimension, that is the scores of students who have used the mobile application to learn before were significantly higher than those who haven't. This shows that a certain mobile application learning experience has a good impact on the use of mobile applications, while there are no significant differences in other dimensions.

Table 6: Difference in mobile application learning experience.

Dimension	item	num	mean value	standard deviation	t-value	*p*
the use of software	yes	37	4.777	0.287	1.537	0.048*
	no	12	4.583	0.289		
attitude of using software	yes	37	4.356	0.593	-1.312	0.196
	no	12	4.597	0.399		
learning satisfaction	yes	37	4.307	0.625	-1.887	0.069
	no	12	4.604	0.412		
learning attitude towards science	yes	37	4.351	0.509	-0.442	0.661
	no	12	4.429	0.578		

Note: * represents $P < 0.05$, * * represents $P < 0.01$, * * * represents $p<0.001$.

There are significant differences between "0-3h", "7-15h" and "15h" group in the two dimensions of learning method satisfaction and learning attitude dimension of natural science. The longer the use of mobile learning, the higher in the score in learning satisfaction and learning attitude towards science dimensions. There are similar rules in the use of software and software attitude. It shows that if students have a mobile applications learning experience, the longer the use of mobile learning applications, the better the use and learning results.

5 CONCLUSIONS

Combined with classroom observation and informal interviews and data analysis of the above application results, the following conclusions can be drawn:

(1) Using mobile learning applications to study plant identification is popular with middle school students. The use of software, the use of software attitude, learning methods and learning satisfaction attitude dimensions of natural science are higher than traditional teaching methods, especially in the use of software dimension;

(2) Using the plant identification of mobile applications to learning knowledge outdoors can make dimensions significantly higher than that of students who haven't in the natural sciences students' learning attitude. The application of plant identification significantly improves students in science learning interest and attitude;

(3) The teaching extension of the system is quite feasible. High school students in the usage of software dimensions are lower than the junior middle school students. High school students in other dimensions is higher than the junior middle school students;

(4) Gender had no significant effect on the use of mobile learning in plant identification;

(5) When to start using the internet for learning, there is no significant impact on the use of learning in plant recognition mobile learning applications;

(6) Students who have used other mobile applications for learning have scored significantly higher on software usage dimensions than those who did not use other mobile applications before learning;

(7) Have the experience of using mobile applications to learn is helpful to use the app. The longer the use, the use of mobile learning applications and the better the learning effect.

6 DEFICIENCIES AND PROSPECTS

Although plant learning in middle school is not the emphasis part, the learners have a higher interest in using the app to learning plant identification and were enjoyable with the teaching methods. We can see that outdoor experiential learning can bring students a different experience from the traditional classroom teaching. Through plant identification and learning APP, learners can answer the system questions given by the app, meanwhile, they can observe plant characteristics, which can greatly improve the learners' learning participation and the understanding and mastery of plant knowledge. The study shows that the app can improve students' learning attitude towards natural science, stimulate the learners' interest in learning related subjects such as plants.

This study makes a general analysis on software usage and learning, but not for learners to plant-related knowledge test to value learners' mastery of the knowledge of plants. The further experimental investigation is still needed. We should expand the sample size at the same time, and add a degree of data collection for students to master relevant knowledge in the pre-test post-test. This study designs an expert system based on production rules,
It consists of the knowledge base, inference engine, and interpreter. However, the function is relatively simple, as teaching interaction is limited to the interaction between learners and teaching materials, and is a lack of interactive teaching based on mobile internet interaction and teacher-student interaction. In addition to outdoor experience learning, we should also provide plant information feedback, peer exchanges, and cooperation, teacher feedback which is equally important. The future research direction of this study is to increase the communicative function of learners, conducting peer collaborative inquiry learning mode with outdoor experiential learning under the guidance of teachers.

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