Scaffolding m-Learning Approach of Automotive Practice Courses in Senior Vocational High School

Hsiu-Yi Lin, Chun-Yu Chen, and Wen-Chin Chen
linsy@kcg.gov.tw, x2181@email.meiho.edu.tw, wcc3759@yahoo.com.tw

Abstract – In accordance with government policy, certain changes from new learning technologies would promote the economy and continuous progress. The technological and vocational engineering education must be modified and adjusted over time, especially the innovative learning activities design. Students who take automotive practice courses in vocational high school must apply principles about the automobile and use them practically. However, most of the students still cannot solve difficult problems and suffer frustration. Hence, this research uses the core phases of scaffolding theory and knowledge management to build a mobile-learning model, applied in automotive practices courses. Students can learn and practice the automobile components and manipulations according to the scaffolding knowledge structure, accompanying with mobile instruments such as laptop and PDA. This paper expects students to study independently and handle any situation they encounter about the automotive service and repair.

Index Terms - Automotive Practice Course, Mobile-Learning (m-Learning), Scaffolding Theory

INTRODUCTION

Vocational Education Training (VET) is a crucial part of educational development in Taiwan. The main goal of VET is to provide technical human resource required in economic development of the nation and to solve unemployment. The successful practice of VET in the past years in Taiwan not only makes the industries and business thrive but also creates the so-called “Taiwan Economic Miracle.” However, as time passes by, VET must be adjusted with trends to meet with current industrial structure in order to achieve economic prosperity and development. The educational goal of the department of auto mechanics in vocational schools is to train technicians for automobile-related industries. Most technicians in automobile maintenance/repair workshops graduate from the department of auto mechanics in vocational schools. In “Automotive Practice Courses,” students must apply the automobile elements to actual practice. When not solving problems, most students encounter difficulties in learning.

With the development of wireless access technologies in mobilization, ubiquity and personalization, there are also huge changes in educational technology. To increase learning efficiency, there is the use of large storage technological electronic learning device, the Internet, multimedia, interactive learning, and personalized learning portfolio. With these approaches and the advantage of Mobile-Learning (m-Learning), which is mobility, students could have Ubiquitous Learning (U-Learning) with consistency at any time and in any place, such as school, home or outside. Therefore, what they learn can be applied to a larger scale and be re-used.

We can particularly find the influence of these teaching approaches in automotive practice courses that are deeply connected with learning situation, including the situation at the time, teachers’ thinking, and the interaction of teachers and students. In the other aspect, teachers face different students every year. In their teaching, besides good knowledge that can be easily conveyed through words, there is also knowledge accumulated from practical experiences that is difficult to be put into words. By the use of m-learning models, including m-learning system and m-learning device, teachers’ precious professional knowledge and experiences can be gathered, preserved, and passed down. It is expected that the difficulties in teaching practice courses in the department of auto mechanics in vocational schools can efficiently be solved through m-learning models.

LITERATURE REVIEW

I. M-Learning Prevalence

In many countries, wireless Internet access is provided from high schools to universities, from government organizations to corporations, and from coffee shops to restaurants. Information technology and m-learning are speeding up the prevalence of wireless Internet access, and it has become an important trend of globalization. According to Moore’s Law, the price of m-learning device and Internet access will be lower and lower. Therefore, when the cost is affordable for most university students and the parents with school-age children, there will be a trend of using m-learning device at school. Such trend will prompt education institutes to emphasize on m-learning more and more.

When the expectant students gradually use information technology and m-learning device, how do teachers help students, staying at home after school, to learn extensively about what they learn at school? By “Seamless Learning Space”, which has the quality of mobility, learning could be extended in different environments. Seamless learning means that students could learn whenever they feel curious and be motivated to learn. They can easily and quickly switch from one situation to another [2]. “Seamless Learning
Space” is a combination of various learning situations built up with one-to-one technological support. Regular learning time limited to a traditional classroom can be extended to irregular time. With the extension of learning space and time, students will learn or participate in extracurricular learning opportunities, including learning projects in or outside school, interaction of on-line learning community, or learning in other spaces or occasions [3]. From the way of learning, students can gradually develop their interest and habit of learning and ultimately get the advantages of self-motivated and lifelong learning in the future as well.

From 2003 to 2007, Taiwan government launched a 5-year-long project of “National Science and Technology Program for e-Learning” [4], which includes a sub-project of “Mobile Learning Devices”. The Project goal is to create e-learning environment to improve the digital literacy level of the nation, and to lead Taiwan to have a key position in global digital learning technology. The project is to put learners in the environment where learning is available everywhere to increase the prevalence and quality of e-education. At the same time, in many countries of advanced technology, m-learning has become the focus of the whole nation, industries and education researchers. Therefore, the application of m-learning device is to make m-learning device be a part of traditional teaching and it can become an easily accessible resource or assisting learning tool [5].

II. Application of M-Learning in Learning Activities

Seppala and Alamaki [6] think that m-learning is to allow learners to enter wireless Internet when they need most or at the most appropriate timing and acquire the information and knowledge they need. It is an extremely flexible learning approach in the learning environment of high flexibility. Chen, Kao and Sheu [7] think that m-learning has these characteristics: meeting the urgency of learning need, initiative of knowledge acquisition, mobility of learning setting, interactivity of learning process, situating of instructional activity, and integration of instructional content, etc. Besides, compared with traditional approaches of books or illustrated handbooks, more multimedia forms can be supported by m-learning device, the diversity, convenience and liveliness of learning content can attract students more. Learning efficiency therefore be improved.

Many researches in different countries have started to apply m-learning to different ecological teaching situations, and these systems were applied to both indoor and outdoor learning situations. Take the research of Cornell University as an example [8], teachers store information and images of elaborately categorized campus plants in the database. With the searching interface on m-learning devices, students can search for the information and upload the gathered plant growth statistics that they measure to the database. They can also have an interactive discussion with desktop computers. In Germany, project WELCOME (Wireless E-Learning and Communication Environment) in 2001 was to use the original e-learning system of the university and integrate newly set up campus wireless Internet access. One complete wireless e-learning system was accomplished, and teachers and students could all enjoy teaching and learning with higher efficiency [9]. Another good example is DIGITAL-EE II ecological learning project in Japan [10]. The project was an on-line collaborative learning platform applied to environmental science. It adopted 3-D image techniques, and laptops installed with GPS and CCD camera to connect the virtual world with the real one. Participants from both worlds could jointly experience and care for surrounding environment. Such platforms would improve the interaction and understanding among participants.

III. Application of Scaffolding Theory to M-Learning Activities

Scaffolding Theory proposes that teachers will act as assisting roles in the learning process to provide a temporary support (scaffold) in order to assist students to construct self-learning [11]. Scaffolding Theory includes two main procedures, which are to set up the scaffold and phased removal of scaffold. The scaffold can be a teaching strategy or a teaching tool; it can be a provision of clues, a reminder, encouragement, solution, providing an example or assistance through information technology. Meanwhile the learning responsibility is gradually shifted from teachers to students and eventually students can lead their learning. That is to say, students can construct knowledge of their own and develop themselves to be independent learners.

The teaching principals of Scaffolding introduced by Greenfield [12] further propose that teachers should provide adequate learning situations in practical instructional activities to enable students’ actively participation. Scaffolding Theory can enhance students’ understanding, independent learning and application, and knowledge transmission and transferring. Among these, independent learning can help students acquire knowledge, ability, skills, value, and motivate them to learn actively. Students can then analyze learning situations and possess advanced ability by taking appropriate measures themselves [13].

In the m-learning bird-watching system [7], researchers used the PDA (Personal Digital Assistant) as the main m-learning device and combined it with Scaffolding Theory. During teaching process, the system can adjust the level of its teaching material catering to learners. The image information of birds taken with digital camera can be transmitted to back end database with a laptop worked as the server. The information can be used as testing to record students’ activity. Students can use the PDA as the interface for searching birds and their traits and take the examination. In further research of m-learning butterfly-watching system [14], these researchers made advanced application by using the PDA to take photos of butterflies and transmitted the photos via wireless Internet access. The images then can be categorized automatically with image recognition techniques to assist students to achieve independent learning in the process of natural ecology observation.

Highly computerization and automation are the trends of present automotive industry. With more concern in safety
and energy saving, it is certain that the future automotive industry will be more strongly connected with high technology to meet human being’s need in transportation. Therefore, to induct Scaffolding M-Learning in automotive practice courses can help students acquire the ability to independent learning. When the students face rapid changes or development of technology in the present and future working environment, there come new challenges. However, Scaffolding M-Learning makes students be well prepared and be able to cope with the new challenges.

SCAFFOLDING LEARNING MODEL

Teaching of automotive practice courses emphasizes on the basic operation of mechanical and electronic practice, and there are many units of courses, like engine system, chassis system, and electric system. Therefore, this research will first use engine troubleshooting as an example and make it the initiation of this m-learning model.

This paper will firstly introduce m-learning model (Figure 1), and then the application of m-learning system and m-learning device usage. At last, it will integrate them with engine practice courses. M-learning activity design will be made in the process of applying m-learning models. Also, an eight-week-long Execution Table of Learning Activity in Automotive Practice Courses (Table I) will be used as actual teaching application with process evaluation throughout the courses. In future researches, one survey will be taken and it targets at teachers and students regarding aspects of their usage, satisfaction, and recognition of learning efficiency.

I. Teaching Content of Practice Courses of the Department of Auto Mechanics in Vocational Schools

The content of practice course of the department of auto mechanics in vocational schools is decided regarding to students’ ability. According to the course standards of the department of auto mechanics promulgated by Education Bureau [15], one of the main educational goals of the department of auto mechanics in vocational schools is to cultivate technical human resource for vehicle assembly, inspection, and maintenance. To achieve the goal, the professional courses are mainly as follows:

- Automobile Maintenance/Repair: students must be able to perform fault diagnosis and troubleshooting in accordance with maintenance manual.
- Automotive Related industry: including automobile sales, used car sales, tire industry, automobile audio industry, and automotive electric engineering, etc. From all these educational goals, we can find that students graduate from the department of auto mechanics should have basic knowledge and practical techniques of automobile. Therefore, to extend the fields of students' professional knowledge and have them prepare for the rapidly changing automotive industry, besides providing basic theories, and practice courses, schools can also arrange activities like workshop internship, factory visit, and collaboration projects to make up the insufficiency of basic courses. Students can also put theories into their practice to acquire ability to solve problems independently.

Therefore, the key point of teaching is to have the students acquire the ability to practice work. It is also emphasized on cumulate experience of practice from practice learning, to enhance students’ ability to integrate system and solve problems in the future.

II. M-Learning Model

In the engine unit of automotive practice, key teaching points of the educational goal are to assist students to understand principals of how engines work and maintenance methods. Students are expected to be able to understand maintenance manuals, parts manuals, circuit diagrams, and to acquire the ability to maintenance, such as changing, assembling, adjusting, and testing engine. They also need to have protection concepts of working environment. Therefore, main teaching contents include knowledge of engine body and subsidiary system parts, inspection, removal/assembly, testing, and adjusting. Also, teachers should emphasize the instruction of basic concepts and use related theories to help students have correct concepts about automotive engines.

Therefore, this research proposes that when applying scaffolding theory in the m-learning models of automotive practice courses, teachers provide learning scaffolds for different levels by using m-learning technology. The teaching principal is that teachers explain the theories, demonstrate real cases or examples, and students do the practice. In practice courses, there are also learning situations to work as simulation of workshops, factories or other places where students intern. Students can be in ideal learning situations to practice with actual objects and interact by using m-learning device, like Laptop, PDA, WAP phone, and Smart phone, etc. Students can use m-learning devices to videotape teaching as well as the intern process of their own or other classmates with good performance. The video files can be reviewed on-line afterwards at any time and any place. Such a review can help learners to get self-reflection to construct the meaning or insight of automotive engine knowledge step by step. Ultimately, students can successfully achieve different levels of learning. That is to say, sharing their own or groups’ practice work on-line can enhance students’ interest in learning and increase the efficiency of both teaching and learning.

One of the characteristics of automotive practice courses is that learning combines intern situations, teachers’ thinking and the interaction of students. It also involves the reaction from actual situations. By embodying the abstract concept of automotive theories through teachers’ demonstrating teaching in automotive practice, the vagueness and complexity of teaching could be decreased.
Putting such practice into actual environment, students can understand more about the structure, connection and combination among actual automotive components and body. Sharing and transmitting of teachers’ knowledge can also be improved. Therefore, in order to help students to put what they learn into practice and solve problems of separation between theory and practice, this research make use of further core knowledge management steps which are: creation, categorization, storage, sharing, updating, and value [16]. Moreover, scaffolding learning model of m-learning applied in automotive practice courses is illustrated as Figure 1, and is also explained as follows:

- **Knowledge Creation**: Constructing automotive engine principal courses (database, on-line courses, on-line bullet-in board)
- **Knowledge Categorization**: Courses are categorized according to the theme of units (text searching, web page search engine)
- **Knowledge Storage**: Develop and set up m-learning system (system operation structure)
- **Knowledge Creation**: Teachers demonstrate and instruct students to learn and discuss interactively (on-line discussion, discussion forum, on-line group report, upload electronic assignment file, e-mail, text message)
- **Knowledge Categorization**: Courses are categorized according to the theme of units (text searching, web page search engine)
- **Knowledge Storage**: Develop and set up m-learning system (system operation structure)
- **Knowledge Value**: Develop students’ keen observation, critical thinking, and independent learning (on-line teachers’ comments, on-line evaluation among students)

III. Design of M-Learning Activity

In the practice courses of automotive engine troubleshooting, teachers will firstly explain the theories of automotive engine (starting to set up learning scaffold), and then raise the questions to instruct learning, “The engine cannot be started” since breaking down of automobile is a very

<table>
<thead>
<tr>
<th>Database (Educational Content)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASP.NET Web Server</td>
</tr>
<tr>
<td>GPRS</td>
</tr>
<tr>
<td>Internet / Wireless</td>
</tr>
<tr>
<td>Laptop / PDA</td>
</tr>
</tbody>
</table>

**FIGURE 2**

**SYSTEM OPERATION STRUCTURE.**

- In Knowledge Sharing, teachers and students can interactively share their learning content by following methods of using m-learning device: text messages, e-mail, graphs/table making, self-made multimedia files: audio/video, on-line discussion, discussion forum, uploading electronic files of assignment, and on-line group report, etc. Students can be encouraged to discuss, raise questions, and gather related information.
- In Knowledge Updating, by on-line discussion, discuss forum, on-line group reports, and evaluation of electronic files of students’ assignment, teachers can have better understanding of students’ learning schedule and efficiency. Teachers can then update on-line courses when it is necessary. Meanwhile, students can get the evaluation of group report and assignment, and they can make reflection, adjustment, and improvement in time.
- In Knowledge Value, by teaching evaluation and the reflection of group cooperation, students’ learning efficiency can be measured. Teachers and students can have sufficient interaction by setting up the function of commenting between teachers and students. Evaluation includes process evaluation, and summative evaluation. Process evaluation emphasizes on overall performance of the students during the intern process and their learning attitude while summative evaluation at the end of each intern unit includes overall performance like products, intern reports, and oral test or written test, etc.

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common situation. Assuming that one set of engine doesn’t start in the factory where you intern, so what exactly are the reasons and how to solve the problem? This research uses question-oriented model in the automotive practice courses learning activities [16]. M-learning devices on above activities are managed as illustrated in Table I. In the fifth week of learning activity in automotive practice courses, one question from another unit is studied, “The engine can not be started, but it doesn’t operate.” In the process of solving this problem, teachers can use the process evaluation resulted from the fourth weeks to collaboratively remove learning scaffold in the steps depending on students’ learning efficiency. Students are expected to minimize learning scaffold in steps in the following intern process, and eventually remove the learning scaffold. They can have thorough understanding of completely teaching content, and complete the teaching goal of independent learning.

<table>
<thead>
<tr>
<th>Week</th>
<th>Steps of Activity</th>
<th>Content</th>
<th>m-Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Explain activities and preparation</td>
<td>Divide students into groups, explain the notes of class, and introduce the usage of devices (multimedia and m-learning)</td>
<td>A, B, C, D</td>
</tr>
<tr>
<td></td>
<td>Define and analyze questions</td>
<td>Teachers raise the question, “The engine can not be started” before classes</td>
<td>A, B</td>
</tr>
<tr>
<td></td>
<td>Arrange and develop the solution</td>
<td>Analyze the known and unknown knowledge before learning, know how to solve unknown questions, plan the analysis diagram/ graph of question structure, assign group work, and how to gather information after classes</td>
<td>A, B, C, D, E, F, G, H, I, M</td>
</tr>
<tr>
<td></td>
<td>(1st) Share information</td>
<td>Students discuss the information gathered, manage question to sum up record, propose new thinking direction, study newly found questions, and set what further information to gather</td>
<td>A, B, C, D, E, F, G, H, I, M</td>
</tr>
<tr>
<td>2</td>
<td>Face questions again</td>
<td>Analyze the information gathered regarding new questions, and make management and preparations</td>
<td>A, B, C, D, E, F, G, H, I, M</td>
</tr>
<tr>
<td></td>
<td>(2nd) Share information gathered</td>
<td>Internship</td>
<td>A, B, C, D, E, F, G, H, I, M</td>
</tr>
<tr>
<td></td>
<td>Face questions again</td>
<td>Analyze the information gathered regarding new questions, and prepare for presenting group report</td>
<td>A, B, C, D, E, F, G, H, I, M</td>
</tr>
<tr>
<td></td>
<td>(3rd) Share information</td>
<td>Internship</td>
<td>A, B, C, D, E, F, G, H, I, M</td>
</tr>
<tr>
<td></td>
<td>(1st) Group report</td>
<td>Reports from each group</td>
<td>A, B, C, D, E, F, G, H, I, M</td>
</tr>
<tr>
<td>3</td>
<td>Face questions again</td>
<td>Analyze the information gathered regarding new questions, and prepare for presenting group report</td>
<td>A, B, C, D, E, F, G, H, I, M</td>
</tr>
<tr>
<td></td>
<td>(2nd) Group report</td>
<td>Reports from each group</td>
<td>A, B, C, D, E, F, G, H, I, M</td>
</tr>
<tr>
<td></td>
<td>Combined analysis</td>
<td>Internship</td>
<td>A, B, C, D, E, F, G, H, I, M</td>
</tr>
<tr>
<td></td>
<td>(1st) Group report</td>
<td>Reports from each group</td>
<td>A, B, C, D, E, F, G, H, I, M</td>
</tr>
<tr>
<td>4</td>
<td>Reflection evaluation</td>
<td>Have interactive learning and reflection on the experience of group cooperation</td>
<td>A, B, C, D, E, F, G, H, I, M</td>
</tr>
<tr>
<td></td>
<td>Define and analyze questions</td>
<td>Another unit, teachers raise the question, “The engine can be started, but it doesn’t operate”</td>
<td>A, B, C, D, E, F, G, H, I, M</td>
</tr>
<tr>
<td></td>
<td>(2nd) Group report</td>
<td>Reports from each group</td>
<td>A, B, C, D, E, F, G, H, I, M</td>
</tr>
<tr>
<td></td>
<td>Combined analysis</td>
<td>Internship</td>
<td>A, B, C, D, E, F, G, H, I, M</td>
</tr>
</tbody>
</table>

| Session F1H |
|-------------|-----------------------------------------------|
| Arrange and develop the solution | Analyze the known and unknown knowledge before learning, know how to solve unknown questions, plan the analysis diagram/ graph of question structure, assign group work, decide the order of how activities proceed, and instruct students to gather information |
| 6 (1st Share information) | Students discuss the information gathered, manage question to sum up record, propose new thinking direction, study newly found questions, and set what further information to gather |
| 7 (1st Group report) | Reports from each group |
| 8 (2nd Group report) | Reports from each group |

**Note:** m-Learning techniques used in Table I are detailed as follows:

- A: Laptop,
- B: PDA,
- C: On-line bulletin board,
- D: Discussion forum,
- E: On-line courses,
- F: Web-page search engine,
- G: On-line discussion,
- H: Text message,
- I: Upload electronic files of assignment,
- J: On-line group report,
- K: On-line teacher commenting,
- L: On-line evaluation among students,
- M: E-mail

**CONCLUSION**

Due to major advantages of portability and mobility of m-learning, it is especially appropriate for automotive practice courses that require learning to not be limited to time and space. By proposing this research of scaffolding m-learning models and applying it to the automobile professionalism and maintenance techniques, it is expected to help teachers have full understanding of m-learning and make complete preparation for teaching. Teachers can make before-class work and after-class arrangement, inclusive of question-designing and evaluating teaching material arrangement. In teaching, questionizing techniques should be adopted to bring about creativity and provide necessary guidance at any time. After courses, teachers can evaluate themselves about the pros and cons of teaching to make improvements to the operation models of the next teaching.

M-learning is not the panacea for teaching and learning. Teachers must alter their teaching strategies and assess different aspects according to courses content and students’ necessity. M-learning can be applied more often, and the support of m-learning technology can not only largely increase students’ learning interest but also motivate students to combine technology with automobile. For the students of the department of auto mechanics, they can also
adjust better to ever-lasting changing technology in automotive industry.

Ubiquitous learning environment is an unstoppable trend. This research is expected to apply m-learning in the learning models of the automotive practice courses of the department of auto mechanics in vocational schools. Scaffolding m-learning models are also expected to be introduced into practice. By developing and executing substantiated systems and applying it to the situations of students’ internship, we expect to help students have ability of independent learning. Students of the department of auto mechanics in vocational schools can therefore practice independent learning in their working environment after leaving school, and they can cope with constant challenges of automotive practices.

In future researches, research scale can be extensively applied to other course units of automotive practice. M-learning models and m-learning systems proposed in this research can be integrated into teaching application. By the evaluation of hand-on teaching and the survey of aspects like teachers’ and students’ usage, satisfaction, and learning efficiency, the credibility test and statistics of the survey can be used to have further understanding and testify the feasibility and practice of this research. This research is then able to contribute to academic field and teaching practice.

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AUTHOR INFORMATION

Hsiu-Yi Lin, Department of Industrial Technology Education, National Kaohsiung Normal University, linsy@kcg.gov.tw

Chun-Yu Chen, Department of Business Administration, Meiho Institute of Technology, x2181@email.meiho.edu.tw

Wen-Chin Chen, Department of Industrial Technology Education, National Kaohsiung Normal University, wcc3759@yahoo.com.tw