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Mobile Learning Practices in Manufacturing Environment

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Abstract: The most common method used for staff development in an organisation is through the traditional face-to-face training. The training conducted by a trainer or a facilitator faced a lot of challenges in terms of engagements, logistics and flexibility. Hence, traditional training approach has not been very effective in delivering the learning objectives. This research proposes an alternative self-learning method using mobile technology to provide on-site learning to the factory staff. It helps to resolve the shortcomings faced by the traditional training approach. Mobile learning (m-learning) is referred to learning using mobile devices, which enable users to move freely as they like. This is a collaborative project between Wawasan Open University, Universiti Sains Malaysia and Motorola Solutions Malaysia. The project demonstrates the process of using mobile technology for self-guided learning to overcome the constraints in a factory environment. The scope includes learning material creation, learning practices, and learning material management. Specifically, this paper looks at the use of short video clips as learning objects, combined with the flexibility provided by mobile technology, to create effective "on-demand" self-learning practices for manufacturing operations.

1.0 Introduction

The idea of using mobile devices for education and learning purposes have grown in recent year due to the rapid development of the mobile technology. Mobile Learning, or m-learning has evolved from distance learning and electronic learning (e-learning) to become the next mainstream learning delivery medium. Mobile technology is one the most quickly adopted technologies in history. Compared to two billion TVs and one billion PCs, there were five billion mobile phones (Wain, 2011). Hence, m-learning has the best chance to reach large number of people in the world. According to Cherian and Williams (2008), barriers to the distribution of digitized content for m-learning, content

hosting, network infrastructures, and media devices are diminishing. It is now up to the organisations to put efforts to adopt new learning approach using multimedia instructional design methodologies.

1.1 M-Learning

M-learning is generally considered as a learning approach using mobile devices such as, but not limited to, mobile phones, smart phones, personal digital assistant (PDAs), MP3 players, tablets and laptops. However, Traxler (2005) pointed out that the definition of m-learning based in hardware devices was flawed and too techno centric. He suggested that core characteristics that define m-learning should include: spontaneous, private, portable, situated, informal, bite-sized, light-weight, context aware, connected, personalised, and interactive. There has never been a specific definition for m-learning. Ismail et al. (2010) summarized various definition and taxonomy of m-learning.

Based on the definition provided by David et al. (2009), there are four essential characteristics are proposed to describe m-learning situations, i.e. devices, mobility, context, and location. According to Nash (2007), m-learning provides the learner's with "constantly changing physical environment with the concepts to be understood and processed". In other words, the learner can move out of the classroom and learn in the actual environment that defines the context and location of the learning content.

According to David et al. (2009), m-learning can be divided into two categories in relation with the context and location. The learning activities may be totally independent from the location and context of the learner; or the learning could be context sensitive, where the system will decide the best content to be presented to the learner. It is now possible to provide context-based learning by using sensory technology to detect the context or location appropriate to the learner. In our research, we will not focus on sensory devices, but will consider the most basic form of interface between the learner and computer to provide both context independent and context sensitive learning experience.

M-learning can be applied to many areas, including education, instructional learning and corporate training. In this paper, we will explore m-learning in a corporation, specifically in the area of staff training. By taking advantage of the m-learning approach, this research aims to promote self-learning in contrast to the traditional instructor-led training in a classroom.

1.2 Motivation

Training is an essential part of staff development in any organization. The most common training method is face-to-face training conducted by a trainer or a facilitator to many participants in a classroom environment. The disadvantage of classroom training is that the participants will be disconnected from the real-life environment during the training. Sometime, on-job-trainings for technicians and operators are arranged in the factory floor. However, the effectiveness of the training can be affected because of the unfavourable conditions such as too many people gathering around a trainer during the training, noise level, space constraint, and various disturbances due to the production activities. The level of attention provided to each trainee will be very limited, and usually the trainee will not have too many chances to request for repeated training. In addition, due to time and location constraints, to arrange for training for the production staffs is always a challenge.

According to Alonso and Norman (1996), there were several types of learning systems, i.e. conventional (face-to-face) learning, instructional learning, electronic learning (e-learning) and m-learning. However, only m-learning has the potential to be applied at any time and at any place without constraints.

Hence, this research proposes an alternative training through m-learning. Devices such as mobile phone or tablet PC are used to show specific training content. Training via fixed computers in the production line at the actual working location is also considered as a type of m-learning for practical reason.

2.0 Scope and Objectives

This project demonstrates the process of using mobile technology in developing on-demand learning materials, self and guided learning to overcome the constraints of learning in a factory environment. It will also free the trainers from routine training tasks and focus on creating quality learning materials for the benefit of a large pool of trainees.

The current targeted groups for this study are the workers involved in procedural routine jobs, i.e. the operators who are learning a new production process, and new technicians performing maintenance tasks on machines. The study into the content (or information objects) will be planned in the next phase of the project.

The objective of this paper is to discuss a preliminary study to evaluate the effectiveness

of the mobile learning approach against the traditional face-to-face training. The paper focuses on two elements in m-learning process, namely:

M-learning material development process; and
Effectiveness of the learning process

In this research, m-learning is defined as an on-demand learning using multi-media, slides and text on mobile devices or fixed computer terminal, at the actual location in the production floor.

3.0 Method

M-learning can be applied to many areas in a manufacturing organisation. The current applications concentrate in two areas:

Production processes; and
Machine maintenance processes

3.1 M-Learning Material Development Process

Motorola has a group of dedicated trainers that in-charge of operators' training. While for technicians, there is a group of experienced technicians that are responsible to provide on-job training to the new technicians.

At the initial stage, these trainers were given two tablet PCs and a camera. The objective of the study was conveyed to the trainers. Instead of giving specific instructions to the trainers to create the training content, the trainers were given the free hand to explore and decide how they use the devices to fulfill the requirements of m-learning.

The trainers have taken one week to create the first training content. As a result, the trainers came out with a diagram of production process according to the existing Work Instruction (WI). The process for learning material creation is as follows:
Videos are first taken for the full processes.

The videos are edited and cut into short video clips according to the production process steps.

These video clips act as the learning objects for the on demand learning material in the mobile tablet.

Captions were added into the video clip to clarify certain points that were difficult to be shown clearly in a video clip.

Sound narration was not used, as the environment in the factory was too noisy for

the voice instruction to be heard clearly.

The operators are given the access to the tablet and refer to specific process steps wherever and whenever needed.

Similarly, for technicians' maintenance training, procedures in the standard maintenance procedures are translated into video clips as learning objects inside the mobile tablet. The only difference is that the technician groups have already initiated video training before our proposal. They have carried out training to their new staff on fixed computer in the maintenance lab. The tablet provides them with additional mobility. With video clips organized according to processes in the tablet, the technicians were able to perform their tasks in any location and position, at any time when they needed refer to specific steps in the learning material.

3.2 Effectiveness of the Learning Process

The effectiveness of the m-learning was compared to the traditional training using process cycle time as the measurement index. Cycle time was the easiest way to gauge the performance of an individual in performing a certain task. A cycle time measurement is defined as the time needed to complete one cycle of a repeated process, and it is measured in second(s). The measurement was also backed up by quality remarks to ensure that the tasks were carried out properly. These measurements were applicable for both operator's and technician's tasks.

3.2.1 Planned activities for Operators

The following activities have been carried out on the production floor on newly hired operators:

(a) A trainer was assigned to the line to perform data collection. Two operators who were new to the targeted process were selected. Considerations were made to ensure that the two operators possessed similar background, i.e. nationality, command of language, working experience and skill sets. The assumption made was that the pair operators selected has almost similar learning ability.

(b) A video was created for the targeted process and stored in the tablet. Captions were added on necessary scenes to ensure that new operators were able to understand the training content without trainer's assistance.

(c) The first operator learned the production process with a tablet without assistance. The performance was measured in terms of cycle time. The measurements were

repeated for 10 cycles. The trainer observed the quality of the outputs to ensure that the operator has performed the task correctly.

(d) The second operator being trained by the trainer. The same data collection process was repeated with the second operator.

(e) The above method has been repeated using another production process with the same pair of operators switching their roles. The first operator being trained by the trainer, while the second operator performed via m-learning.

(f) The whole process would then be repeated from (c) to (e) for other pair of operators.

3.2.2 Planned activities for Technicians

Eight new technicians were observed by the trainer to compare their performance in terms of cycle time to complete a given task. Due to the job nature of a technician, it was not practical to ask the technician to perform the task repeatedly.

Two new technicians were selected to learn and perform a task, one using m-learning, and the other with the traditional approach. The cycle time and quality of the job was observed.

The process was repeated with the second process, with both technicians switching the training approach similar to the method for the operators. The same observations were done for all eight technicians for the processes.

4.0 Results

The initial plan for data collection was intended for statistical analysis, which requires at least 30 sets of data for each process. However, due to the limited time to conduct the data collection in the busy production lines, only 10 cycles were repeated for each of the operators. Hence, the data was only suitable to be use as indications about the likely performance of m-learning as compared to the traditional approach.

4.1 Results for Operators

The observation showed that not all operators were comfortable with m-learning. A few operators require human assistant in training rather than be on their own. Some operators appeared lost when they were given the tablet. They were not exposed to computer and tablet. Hence, they required more time to learn the new technology before they could go through the m-learning process. Explanation was still needed to ensure that the operators

know how to use the tablet and the video clips provided. However, for most operators who have had experience of using a computer, the training with m-learning appeared to be faster than the face-to-face training. The results are as shown in Figure 1. Note that the cycle time is given by the average of the 10 cycles for each process.

Out of the eight processes measured, five processes showed that operators trained by m-learning approach were faster in completing the task, whereas three processes indicated that the traditional face-to-face training were faster.

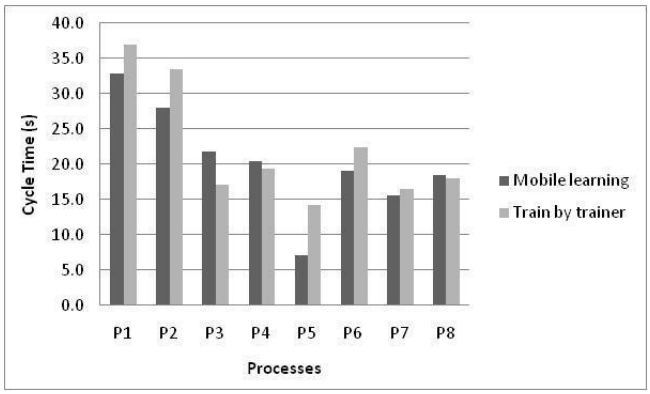

Figure 1 Cycle time comparison between task trained with traditional approach and m-learning for operators

4.2 Results for Technicians

As the data collected from the technician were even limited, no statistical analysis could be conducted. Just by observations, it was found that neither of the two approaches has shown significant better performance than the other. The result is as shown in Figure 2.

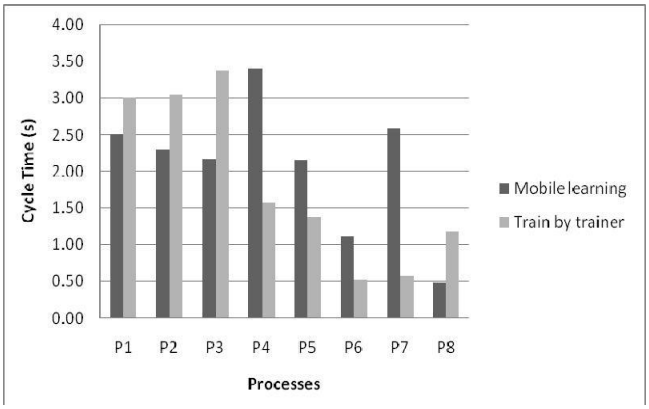

Figure 2 Cycle time comparison between task trained with traditional approach and

Process P4, P5, P6 and P7 showed m-learning took longer time than the traditional approach. They were due to mistakes made by the technician while going through M-learning. However, the technicians were quick to realise and correct their mistakes. The trainer led training did not have such problem, as the trainer corrected them immediately when mistakes were made.

The technician's performance is very much depending on their individual skills prior to learning the new task. It did not seem to be affected by the approach of learning. In addition, all technicians were used to computer, hence they did not have much problem with learning from the tablet as compared to the operators.

5.0 Discussion

The above data was collected based on the assumption that selected operators and technicians were identical in terms of their initial skills and learning ability. Special care has been made to ensure that the selected people were similar in terms of background and language ability. Another measure that might help to normalised the data was by switching the methods used to training the same person. However, the result can only be used as a likely indication that m-learning is comparable to the traditional face-to-face training approach.

It is worth pointing out that the above study was based on the comparison of m-learning against one-to-one traditional face-to-face training. In the actual condition, the trainees are trained in groups, i.e. with one trainer to many trainees. Hence, the effectiveness of the group training is expected to be lower as compared to one-to-one training. M-learning has the advantage of "duplicating" a trainer to serve many trainees at any time, or simultaneously.

The above method showed that users could perform relatively well using m-learning approach. However, the implementation of new technology needs to be accepted by the users in order to be successful. One of the most popular approaches to gauge the acceptance of technology is survey carried out using the Technology Acceptance Model (TAM) (Kim et al., 2009). According to Davis (1993), a user's overall attitude towards a given technology is the main factor determines whether or not he or she will use it. This method can serve as another indicator about m-learning implementation.

6.0 Immediate & Future Plan

Based on the current limitations in the factory to collect actual cycle time data, the team is considering setting up an offline process for data collection. The next plan is to study the acceptance of m-learning in the factory using TAM survey method.

The next phases of research include:

To focus on creating and organising learning content suitable for mobile learning. Study will be made to find the effective ways to create and present the learning content. The learning material can be categorized according to the reusable information objects: concept, fact, procedure, process and principle (Barritt et al., 1999).

To look into the organisation of the learning content for ease of learning and reuse in a large organization. The learning content can be organised according to processes and product structures. Web based repository system may be use to facilitate the content creation frameworks.

To revisit the study on the effectiveness of m-learning after implementation of the facilities provided in the previous two phases.

7.0 Conclusion

M-learning can be used to further enhance the well known e-learning, by providing mobility and flexibility in terms of where and when learning can be carried out. In a manufacturing environment, m-learning can help to improve the effectiveness of training programmes, and free the trainers from routine trainings, at the same time to serve more trainees as though the training is carried out on one-to-one basis. Although there were limitations in the factory to collect data to evaluate the effectiveness of m-learning, the data has shed the light about the feasibility of using m-learning as an alternative to traditional face-to-face training.

Further studies will be carried out to gauge the acceptance level of the factory users to m-learning, to determine the types of content and frameworks to organise and manage the content in the manufacturing environment.

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