The Initiative of Distance E-Training System for Advanced Military Education in Taiwan

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Abstract

The military advanced education can prepare officers to become skillful in war tactics for future combats. Traditionally, this is done through on-campus and correspondence courses. The on-campus education is impossible for line-officer whereas the correspondence program is known to be inefficiency. This paper aims to content the learning purposes of the correspondence program with the learning efficiency of the on-campus education. This paper presents an alternative distance learning architecture, called Distance Learning for Advanced Military Education (DL4AME), to offer the advantages of on-campus education (immediate interaction) be available in the correspondence program (asynchronous learning). The major contribution of this integrated platform is that instructors and learners are no longer constrained by geographical and temporal barriers; they can teach and learn more effectively.

Key Words: Advanced Military Education, Collaborative Learning, E-Learning, Distance Learning, Petri Net

1. Introduction

In behalf of cost and accessibility, the military has a growing need for training on an "anywhere and anytime" basis through distance learning technologies [1]. As the military education and training becomes increasingly distributed through the Internet and intranets, it is advantageous to improve learning efficiency and learning result by utilizing web-enabled instructional approaches [2–4]. Key research reports on applying distance learning technology in military education were presented by Bonk & Wisher [2] and DUSD of U.S. DoD [5]. These reports advocate the importance of developing online learning system to improve military education performance. Following this trend, Taiwan military is currently transforming its legacy training courses and classrooms to cope with the concept of distance learning. Furthermore, the instructional technologies that support such a transformation must also be tailored to the E-learning environment. This paper presents an architecture to transform the legacy advanced military training into an e-training courses. This architecture focuses on specialized skill training for military officers in Taiwan. It combines advanced E-learning operation tools, simulation technology, and web technology to satisfy a set of military training subjects.

In Taiwan, military education includes a series of training programs which are starting from preparatory fundamental education, in-service education to advanced education. Upon the completion the fundamental education, a military officer must receive short-term specialized training at a number of military-branch schools,

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such as the infantry, the armor or the artillery branch schools of the Army. In addition, candidates for colonel and major general must complete the advanced military education before they are promoted [6].

The goal of advance military education is to educate commanding officers with the ability to perform joint operation with thorough war tactic knowledge. However, due to the limited defense budget and military reform in the recent years, the number of instructors in War College is cutback consequently and has become short in supply. Furthermore, since there is also a significant downsizing in military personnel, military officer cannot leave his post to attend residential education for a long period of time. Correspondence program in advance military education is presently one of the proposed solutions to resolve this problem. Under this program, officer students use their leisure time to read course material and complete their assignments. Their learning progresses are then reported to their instructor during the monthly faculty meeting. For courses such as "National Security" and "War Theory", which do not demand interaction, this method of teaching is practicable. However, for courses, such as "Joint Operation", that require frequent interactivities, this asynchronous teaching method would not work well. To overcome the deficiencies in correspondence program, this paper presents an e-training architecture to assist military officers in advanced education program.

2. The Advanced Military Education in Taiwan

Taiwan military has made a commitment to use distance learning as an alternative to train and to educate geographically distributed line officers. As the complexity of military technologies increased, the need for extended technical training also increased. The cost of dispatch officers to distant facilities for on-campus training is significantly expensive in terms of monetary terms and manpower. The only solution currently available besides on campus training is the correspondence program. In order to reserve manpower and save cost, this paper presented the web based distance E-learning system called DL4AME.

There are two types of advanced military training courses in Taiwan, which are the basic tactic courses and the advanced strategy courses. The basic tactic courses introduce operational art, but focuses primarily on tactics at the Division level. The advanced strategy courses focus on national security policy-making and war tactics. The advanced strategy courses are aimed to develop leadership skills in commanding, research, and defense resource management. Candidates for colonel or major general in Taiwan must complete advanced military education before they can advance to the next rank level [6]. The attendees of military advanced education are referred as officer students and this term will be used throughout this paper.

3. Distance Learning for Advanced Military Education

3.1 Advanced Military Education Course Overview

The core of Taiwan's advanced military education focuses on "Military Force Construction" along with war readiness courses as supplementary. The training curriculum includes subjects such as "National Security", "Enemy Research", "International Relations", "War Theory", "National Defense Decision Making and Management" and "Joint Operations". These courses prepare officer students to become more skillful in joint operations and field exercises. Upon the completion of training, these officers have become masters of anticipating future military establishment plans and various combat operations.

Except the "Joint Operation" course, the rest of the courses mentioned above are lecture courses, which constitute two-thirds of the training program. The "Joint Operation" course is a practical course that focuses heavily on interactivities and communications among officer students. This course requires officer students to cooperatively set up repeated war game simulations until they become experts of commanding and dispatching troops for joint operations. These courses are offered through either on-campus training or a correspondence program. On-campus training offers officer students the opportunity to work as a team and collaboratively to demonstrate their learned results, whereas, in the correspondence course, officer students go through the same theoretical and doctrine courses by self-review, they lack live team operation experiences in joint operations. The main contribution of DL4AME is to provide a platform for correspondence officer students to collaboratively set up war game simulations over the Internet to resolve this issue. The joint operation course flow for on-campus is as shown in Figure 1.

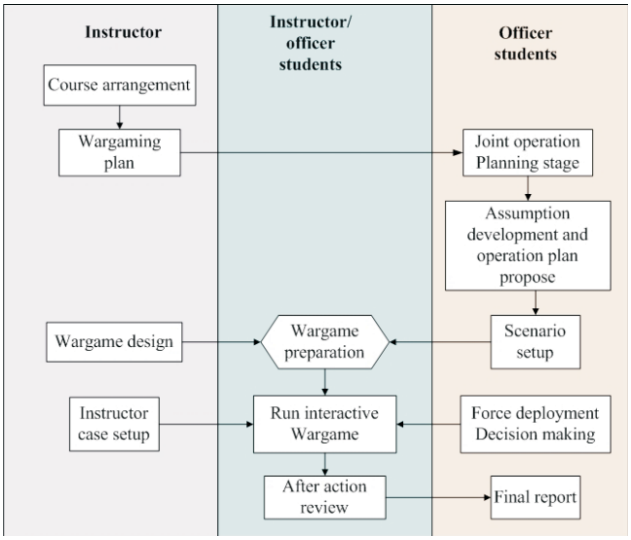

Figure 1. Joint operation course flow on campus program.

3.2 The Different between on Campus and Correspondence Program

The comparison between on-campus course and the correspondence courses is below:

(1) The on-campus course conducts joint operations through interactive war games; however, in the correspondence courses, the learners cannot participate in the courses interactive war game.

(2) After interactive games, review of joint operations of on-campus course is conducted; however, in correspondence courses, e-mail is the only communication between the instructors and the learners.

(3) In the war games of the on-campus course, the instructors play the roles of the commanders and directors. The learners must be well prepared for this interactive war game. In the correspondence courses, since the learners are not able to attend the school, there is no interactive war game.

(4) The instructors have different curriculum designs. On-campus course is based on interactive war games, whereas the correspondence courses are based on the introduction of a decision support model without practical application.

3.3 DL4AME Joint Operation Course

According to the above comparison, it is found that in order to fulfill the learning purposes of the correspondence courses as those of on-campus course, the disadvantages of the correspondence courses need to be supplemented with distance learning. This section aims to propose a system that can solve the problems of the correspondence courses, and remain as advantageous as the on-campus course (immediate interaction) and the correspondence courses (non-simultaneous learning). In Figure 2 DL4AME joint operation course, the operation of distant learning is described by using the joint operation course as an example.

3.4 Joint Operation Course Flow Analysis with Petri Net

DL4AME is the system designed to solve the differences between on-campus and correspondence courses, this section will describe the system by Petri Net with the example of joint operation course.

The Petri Net model is a graphical and mathematical modeling tool, which is especially useful to capture the synchronization characteristic among modules of a system. With the help of the netted representation by Petri Net, the researcher can easily discover the potential problems of a running system, and then adjust its design to maintain the validity of this system.

A Petri Net model can be formally denoted as a 5-tuple, PN = (P, T, F, Mo) where:

- $P = \{p_1, p_2, \ldots, p_m\}$ is a finite set of places.
- $T = \{t_1, t_2, ..., t_n\}$ is a finite set of transitions. Most importantly, P and T must satisfy the properties of $P \cap T = \varnothing$ and $P \cup T \neq \varnothing$. That is, at least one of these two sets P and T must be nonempty.

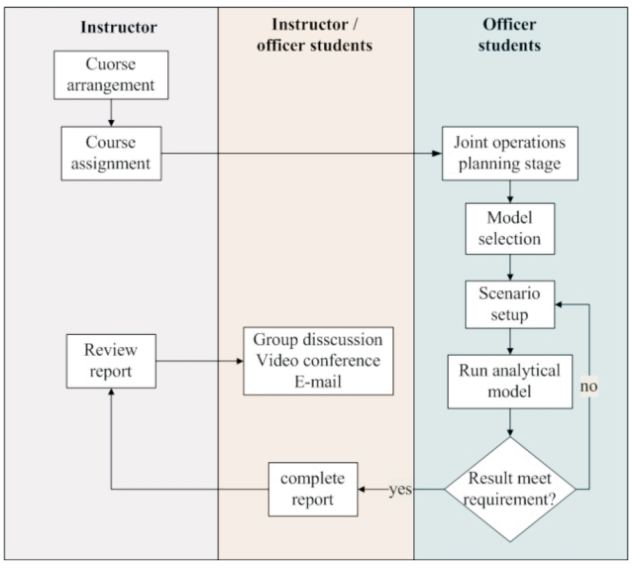

Figure 2. DL4AME joint operation course.

- $F \subseteq (P \times T) \cup (T \times P)$ is a set of arcs (flow relation) of network places and transitions. That is, $(P \times T)$ represents the set of arcs that flow from places to transitions, whereas $(T \times P)$ is the set of arcs flowing in opposite directions.
- Mo: P-> $\{m_0, m_1, m_2, \ldots, m_m\}$ is the set of initial marking of each place. For the definition of the Petri Net model, m_{ij} represents the token number on place p_j, at time *i*, and a token can be a resource of a system, or the control of a program [7,8].

According to the definition of Petri Net, this section will define place as stages of the courses, and transition as the actual learning process. Using Figure 3 of the joint operation on-campus course as an example, the instructors implement the joint operation course from T1, and they must first plan the course arrangement on P1 and after fulfilling all course arrangements on T2. They can describe the course schedule and assignments required by course assignment on P2, and formally assign the course assignments from the learners on T3. At the same time, the instructors start the war game design on P4, and design the environment and framework of a computer war game of joint operations. After receiving course assignments on T3, the learners can begin assumption development on P3, according to the instructors' requirements, then make their decisions on T4 and implement operation planning on P5. They fulfill war game environments and framework design according to the instructors' requirements by accessing the scenario setup on P6 from T5. The instructors and learners then prepare for the scenario before the war game, and accomplish the related parameter settings of T6. They then each run the interactive war game on P7 to start conducting computer interactive joint operations. During the process, the instructors can properly assign the learners on instructor case initiate p8 to increase the reality. The learners can implement military force arrangements, occasions, and commands on force deployment and decision-making on P9. After T7, the learners complete an exercise report on P10 and submit it to the instructors. The instructors convene all personnel on T8, and after action review on P11, reinforce the learners' understanding on the joint operation course.

In addition, Petri Net of DL4AME joint operation is shown in Figure 4. The flow from T1 to T3 is the same as that of the on-campus course. The difference is that after accomplishing course assignment on P2, the instructors do not need to make war game designs, and the learners develop assumption based on course planning on P3 and operation planning proposed on P4. After operation planning proposed on T5, the learners have model selection on P5 to select the proper model through the model manager. After T6, they continue to scenario setup on P6, and then, after fulfilling scenario setup on T7, they run the analytical model on P7, and start implementing the proposed setting. After fulfilling

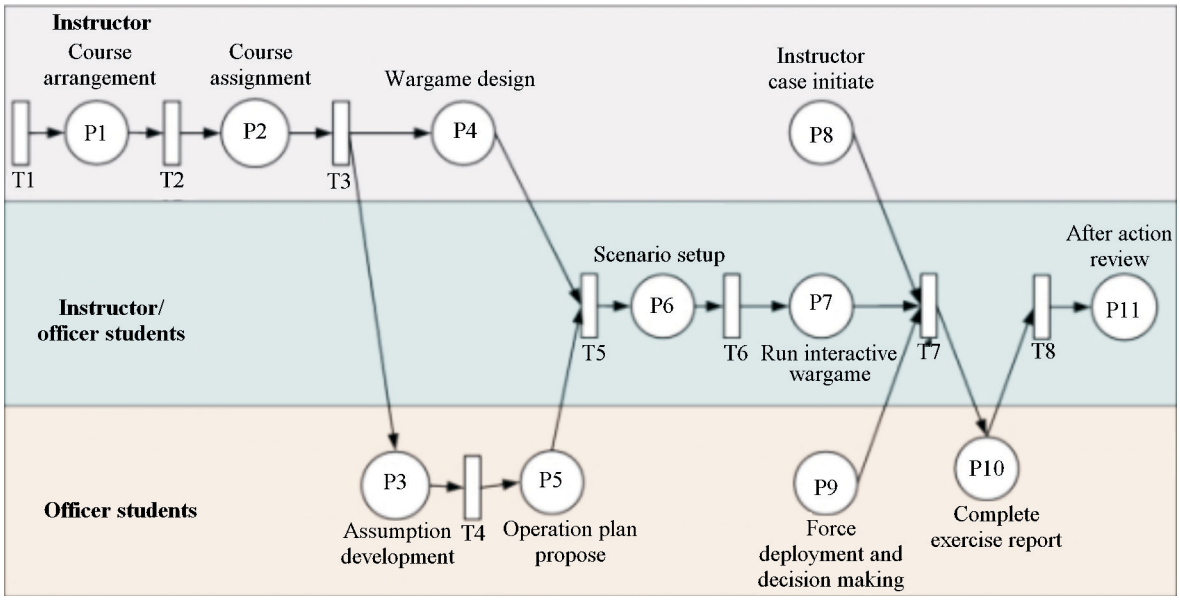

Figure 3. Petri Net for on-campus joint operation course.

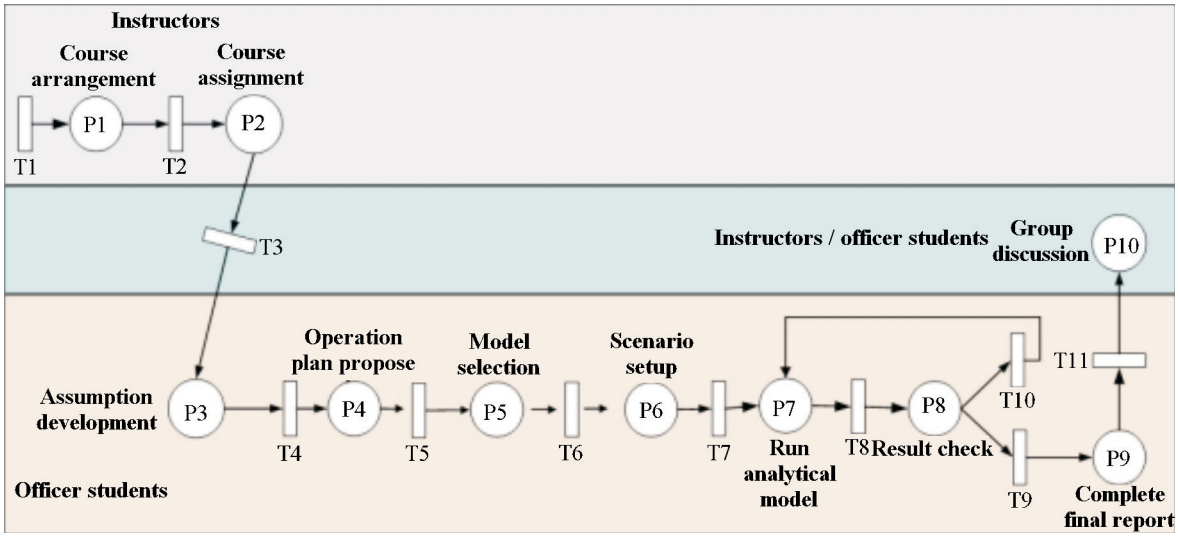

Figure 4. The Petri net for DL4AME joint operations course.

requirements of T8, they must have their results checked on P8 and distinguish the following two situations: after fulfilling the operation requirement on T9, they reach the complete final report on P9, and according to the results, the learners write their report, finish it on T11 and submit it to the instructors by e-mail. The instructors will arrange a group discussion on P10, which is conducted on line with all learners through video conference. When the simulation result does not match the requirement, the learners return to scenario setup on P6 through T10, and repeat the operation until the results meet the requirements.

3.5 The DL4AME Joint Operation Course Function Architecture

According to Figure 4, the Petri Net for DL4AME joint operation course, it can be concluded that to construct the DL4AME distant learning system, the following functions are required:

(1) An interface for the learners' registration and identification;
(2) Learning management system, with the functions of course arrangement and assignment;
(3) An interface for the learners to select different courses;
(4) An interface for the learners' to propose operation planning;
(5) An interface with varied models for the learners' model database and parameters of related operation;
(6) A virtual environment for the learners' distance operations;
(7) A communication platform between the instructors and the learners, and a group discussion video conference system.

According to above requirements, this study designed the DL4AME joint operation course function architecture, as depicted in Figure 5. This system is designed to achieve the learning objectives for an advanced military education, while providing a low-cost, customizable, interoperable, and easily accessible training environment, the architecture is a three tier structure, including Front-End Web Tier, Application Tier, and Database Tier. The Front-End Web Tier contains all of the interfaces for users. The Application Tier is the core of the DL4AME system and all course administrating tasks, such as parameter updating/querying, database updating, assumption developing, and scenario settings are executed in this tier. The Database Tier is constituted by a set of database servers. In this tier, databases are specifically designed for advanced military education (i.e., doctrine, assumption, scenario, parameter, and model are included).

3.6 The Petri Net for DL4AME Joint Operation Course

According to the definition of Petri Net, this study defined place as the modules of functions, and transition as the process of implementation. This section will describe the flow of different stages of Petri Net. Figure 6 is the Petri Net for the DL4AME function architecture. Be-

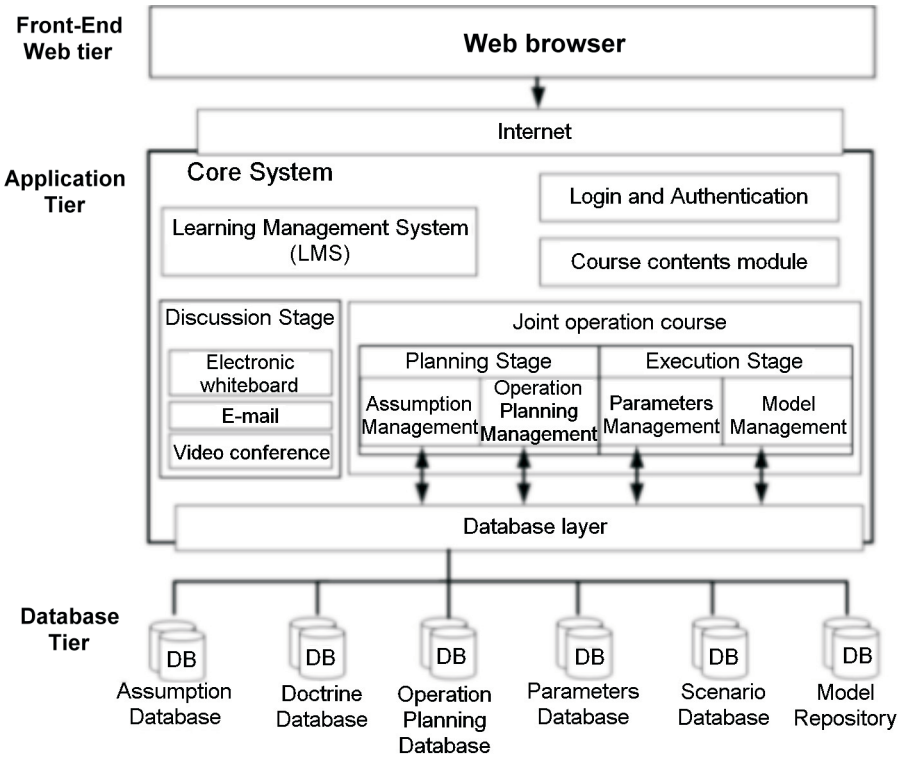

Figure 5. The function architecture of DL4AME joint operation course.

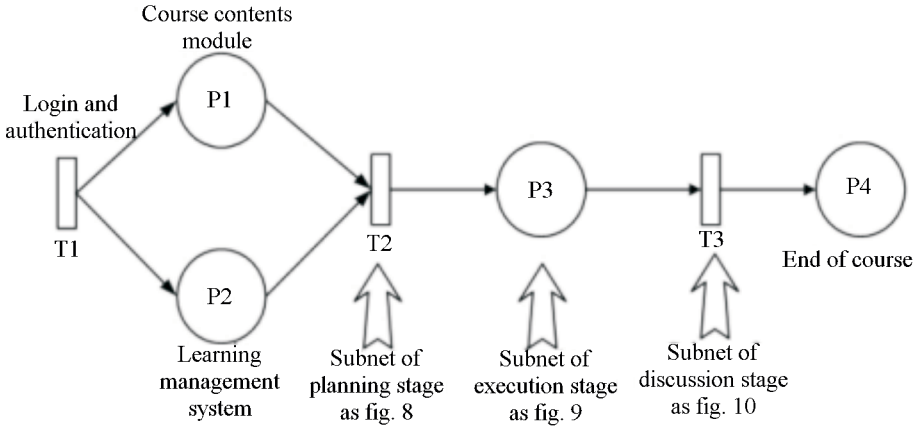

Figure 6. Petri Net for DL4AME function architecture.

sides the principal flow, there are also three sub-flows (planning stage, execution stage, and discussion stage), as depicted below:

Main workflow: after fulfilling browser login and identification on T1 through the internet, the officer students receive course assignments by LMS on P2, and they select the courses assigned by the instructors on course contents module on P1. The sub-process is shown below:

Planning stage: the planning stage of Petri Net is shown in Figure 7. The learners select a joint operation course from T1 course selection, and then reach the assumption manager on Pl. They select the assumption from the assumption database on P2, and fulfill the purpose as assigned, and edit according to the requirements on T2. They then select the proper war assumption through the operation-planning manager on P3 and operation-planning database on P5, examine the related principles from the doctrine database on P4, and then rapidly accomplish war game planning on T3.

Execution stage: the execution stage of Petri Net is

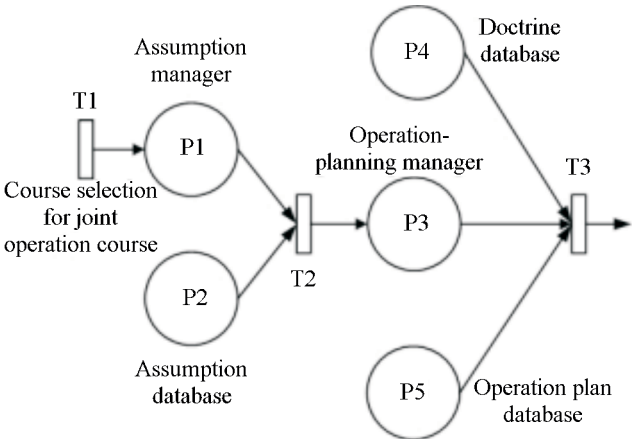

Figure 7. Planning stage.

shown in Figure 8. The learners implement the simulation process after the planning stage operations and are ready for execution on P1. First, the learners must comply with the above war planning requirements and select the proper model from the model manager on P2 and model repository on P3. After T2, they are ready for parameter manager in P4 for scenario settings, and then accomplish the settings on T3 from the parameter database on P5, as well as the scenario database on P6 for further implementation of the operation. In the run analytical model on P7, the learners can repeat the operation until it matches the requirements. They confirm the results through the result check in P8. If it matches the requirements, they are ready to write the report from the final report on P9 from T6; otherwise, they return to place P4 from T5 to re-set the parameters and repeat the operation until it matches the requirements.

Discussion stage: Discussion stage is shown in Figure 9. After finishing the course report, the learners must upload it to the instructors on T1 by e-mail, and the instructors collect the reports before the deadline and review them in instructor review on P1. Upon the accomplishment on T2, the instructors can inform the learners through e-mail on P3, which registers DL4AME on the assigned date and at the assigned time. They have a group discussion videoconference on P2 and interactive review on the operation of the course.

4. Experiment and Results

4.1 The Workflow for Joint Operation Course

To further explore the execution of DL4AME, this paper uses one of supported courses to discuss the workflow of DL4AME. Since the course of Joint Operation is a core course for advanced military education, the workflow of this course provided by DL4AME is fully discussed in this section.

The purpose of the Joint Operation course is to help officer students to become ready for unpredictable com-

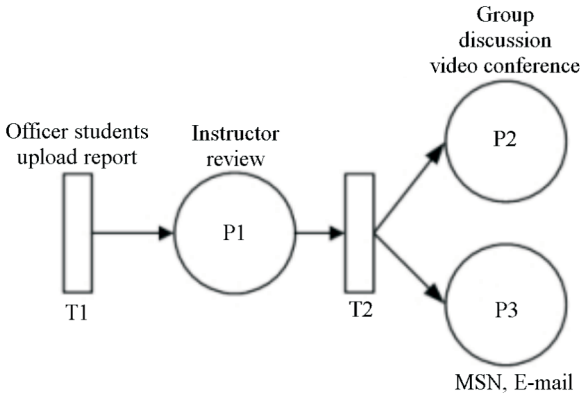

Figure 9. Discussion stage.

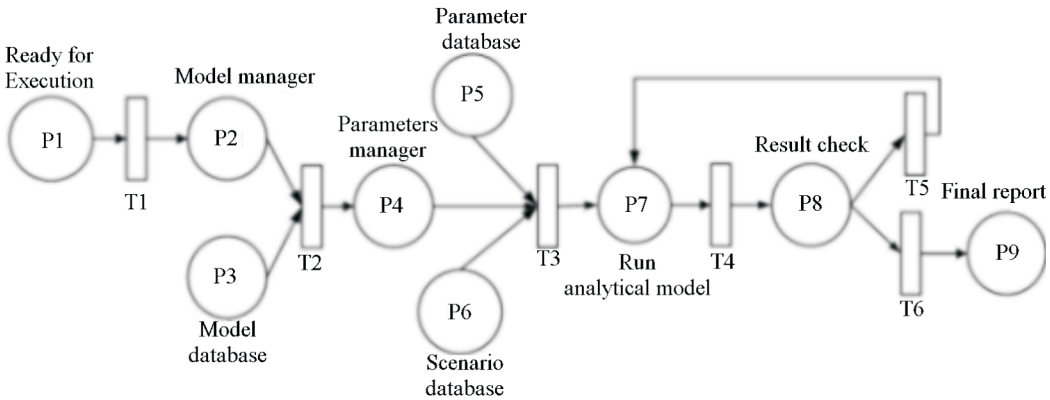

Figure 8. Execution stage.

bat situations, and to have the ability to make precise decisions on various battlegrounds. In this course, officer students are asked to first set up different joint operation scenarios, and then design appropriate operation-planning based on the particular scenario and assumptions. Once these operation-planning are completed, simulations are then performed to verify the feasibility of these plans. This course is conducted systematically, with diverse group discussion topics supervised by the instructor.

The workflow of the Joint operation course in DL4AME is illustrated in Figure 10. There are three types of users in this Joint operation course, which are the course manager, the instructor, and officer students. The course manager uses the functions provided by SharePoint Learning Kit (SLK) to input curriculum related data such as: semester duration, orientation date, instructor profile, etc.

Similarly, the instructor input course requirement, assignment guide, and reading material, etc. through SLK. Furthermore, the instructor can use SLK to assign officer students into different teams and monitor/control the progress of these assignments as the course proceeds. Base on the course content, the instructor then uses Assumption manager and Operation-planning manager, which trigger ECM to access and manage data in the Database tier to apply appropriate assumption and scenario to the assignment.

The workflow for officer students is more complicated. After login and selection of course through SLK, based on the course and assignment requirement, their workflow can be divided into three stages, which are Planning stage, Execution stage, and Discussion stage.

Planning Stage: As illustrated by dotted line with label ①, officer students use the Assumption manager first to activate ECM to select and edit suitable assumptions for the course requirements. Based on the assumptions, officer students then either develop their own operational plans or select and edit existing plans from the Operation-planning database using the operation-planning manager, as shown by dotted line with label ②. Notice that, officer students also need to check the Doctrine database to ensure that their operation-planning strictly follow compulsory doctrines.

Execution Stage: At this stage, as shown by dotted line with label ③, officer students are required to choose the proper synopsis from the model repository using the Model manager. For example, if the spreadsheet simulation mode is chosen, they can manipulate spreadsheet model, which is based on different combat scenarios, to satisfy and improve the accuracy of a simulation. A scenario simulation setting is completed by combining appropriate assumptions and operational plans. Hence, as illustrated by dotted line ④, officer students use the Parameter manager to extract data from the parameter and scenario databases to complete the setup process. Once all the preparations are done, officer students use a web browser to execute the simulation and present the simulation results to the instructor. The simulation is done by officer students through the Internet. They can repeatedly adjust parameter data and execute the simulation until the result is consistent and reliable.

Discussion Stage: After officer students complete their simulations and have written their reports, they can upload their assignments for the instructor to review. The instructor has the option to conduct group discussions and provide feedbacks using the Communication server and Exchange server in the form of video conferencing, MSN Messenger, or Windows Live Mail.

4.2 Experimental Evaluation of Learning Effectiveness

The goal of this study was to develop a Petri-Net approach for analyzing and designing a distance learning system for advanced military education. With the aid of the Petri-Net model, the designer can easily spot the

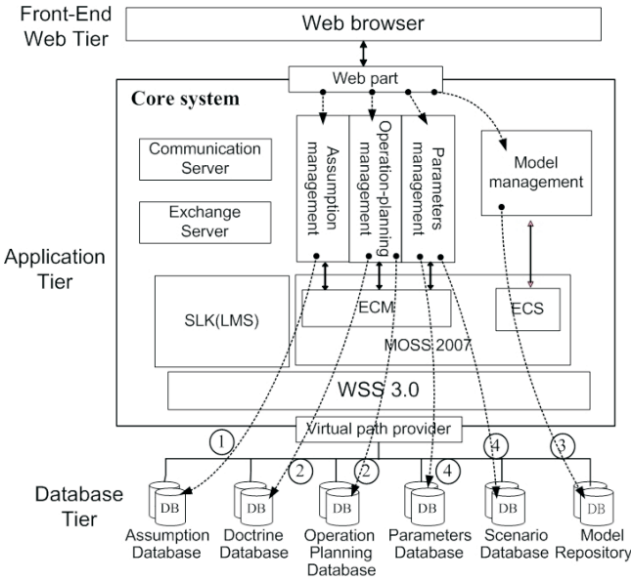

Figure 10. Joint operations course workflow.

learning curve of this course and design an appropriate e-learning system. To further verify this point, an experiment was conducted to determine whether the Petri-Net analysis was consistent with actual conditions.

Hence, the following five learning effectiveness measurements were chosen for validity testing of the DL4AME:

- **Impact on engagement planning:** This indicator evaluates the ease with which the officer student completes the assumption development and operation planning stage. With the aid of assumption management, the officer student can easily adapt an existing assumption from the Assumption database to reduce setup time.
- **Battle reaction and decision-making capability:** This indicator represents the effectiveness of the student in battle reaction and decision-making. However, given the asynchronous nature of distance learning, the interactive war game system is replaced by an analytical model. Through the process of setting different parameters in repeated simulations, officer students can acquire the expected decision making capability.
- **Case studies**: This indicator measures the practicability of the simulation models selected by officer students. The model repository provided by DL4AME can easily provide examples from previous exercises. Meanwhile, the reiteration characteristics of the model enable officer students to accumulate combat/operation experience under varying engagement scenarios and parameter settings.
- **Sharing learning experiences:** This indicator evaluates the usefulness of group discussions. The DL4AME integrates communication systems that enable online group discussions among officer students. The after-action review meeting is an important activity that can significantly enhance the learning achievement of the officer students. The DL4AME uses a combination of various network communication tools to conduct this activity via Internet.
- **Overall learning effectiveness:** This indicator requires each officer student to evaluate whether the DL4AME was as effective as the on-campus program.

After exploring the above five learning effectiveness measurement indicators, a questionnaire was designed to survey a group of ten officer students. This survey attempted to gather feedback from officer students to determine whether DL4AME met their expectations.

Figure 11 depicts the survey results in further detail. The statistical chart shows that most officer students agreed that the learning effectiveness of the "Joint Operation" course by DL4AME was closer to that of an on-campus program than to a correspondence program.

5. Conclusion and Future Work

This paper presents the architecture of a distance-learning system for advance military education. It combines E-learning tool, simulation technology, and web technology to provide a set of military learning and training subjects through a web browser anytime and anywhere. Although this system is a preliminary attempt to develop a new distance learning infrastructure for military advanced education, the outcome still demonstrates that web-based E-learning program is a firm promise to train high-ranking officers for the 21st century.

The next step is to enrich this pilot system with war tactic models and set the system in operational mode. Once the web-based distance learning is fully deployed in the military, military officers will be able to progress and gain new military skills through constant learning without interfering with their daily duties.

In conclusion, previous researches had already shown the benefits of adopting E-learning courses in the military [9–11]. DL4AME further demonstrate that

- E-learning can be just as effective as on campus learning program [12–14].
- E-learning offers "just-in-time" scheduling and it can save traveling time of students.
- Excessive and unnecessary training requirements can be reduced through the use of E-learning.
- E-learning offers enhanced instructions and remedi-

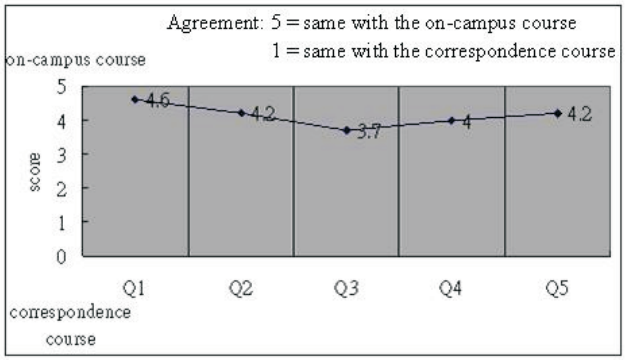

Figure 11. The average feedback from the subjects.

ation techniques on a "anywhere-anytime" basis.

- Finally and most importantly, E-learning environment makes correspondence programs interactive and enhances the effectiveness of the overall learning environment [15].

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