รายงานผลการดำเนินงาน

โครงการจัดตั้งห้องปฏิบัติการวิจัยการจัดการระบบสารสนเทศ

แบบชาญฉลาด

Smart Informatics Management System (SIM-LAB)

จัดทำโดย

ดร.ธงชัย แก้วกิริยา

เสนอ

คณะกรรมการวิจัย

สถาบันเทคโนโลยีไทย-ญี่ปุ่น

คำนำ

รายงานนี้เป็นรายงานสรุปผลการดำเนินงานของโครงการจัดตั้งห้อง Lab วิจัย จัดทำขึ้นเพื่อให้ใช้เป็นสถานที่สำหรับให้นักศึกษา และ อาจารย์รวมทั้งนักวิจัย ได้ทำการศึกษาหาความรู้และได้ใช้ประโยชน์ในการทำวิจัย โครงาน ต่างๆ ที่เป็นประโยชน์ต่อสถาบันเทคโนโลยีไทย-ญี่ปุ่น

ผู้จัดทำหวังว่า รายงานเล่มนี้จะเป็นประโยชน์กับผู้อ่าน หรือ นักศึกษา และบุคคลากรที่สนใจและศึกษาข้อมูลอยู่ หากมีข้อแนะนำหรือข้อผิดพลาดประการใดผู้จัดทำขอน้อมรับไว้และขออภัยมา ณ ที่นี้ด้วย

ผู้จัดทำ
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หัวหน้าห้องปฏิบัติการวิจัย การจัดการระบบสารสนเทศแบบชาญฉลาด
หัวหน้าศูนย์สารสนเทศและการสื่อสาร
อาจารย์ประจำคณะเทคโนโลยีสารสนเทศ
วันที่ 30 ตุลาคม 2557

สารบัญ

1. **ชื่อห้อง LAB**

(ภาษาไทย) ชื่อห้องปฏิบัติการวิจัย การจัดการระบบสารสนเทศแบบชาญฉลาด

(ภาษาอังกฤษ) Smart Informatics Management System (SIM-LAB)

2. **หัวหน้าห้องปฏิบัติการวิจัย**

1. อาจารย์ ดร. ธงชัย แก้วกิริยา อาจารย์ประจำคณะเทคโนโลยีสารสนเทศและหัวหน้าศูนย์สารสนเทศและการสื่อสาร

3. **คณาจารย์ที่เป็นสมาชิกห้อง LAB วิจัย**

2. อาจารย์ปราณิสา อิศรเสนา อาจารย์ประจำคณะเทคโนโลยีสารสนเทศ
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6. อาจารย์ลลิตา ณ หนองคาย อาจารย์ประจำคณะเทคโนโลยีสารสนเทศ
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4. **นักศึกษาที่เป็นสมาชิก LAB วิจัย**

ลำดับ	ชื่อ-นามสกุล	ระดับ	หัวข้อวิทยานิพนธ์/สารนิพนธ์/project	อาจารย์ที่ปรึกษา
1	นายจเร จำนงนรินลักษณ์	M	การออกแบบและพัฒนา Mobile Application บน IOS สำหรับผู้ที่ไม่มีทักษะการเขียนโปรแกรม	ดร.ธงชัย แก้วกิริยา
2	นางสาวเรขา โสมพงษ์	M	การออกแบบและพัฒนา e-learning content สอนภาษาด้วยเกม 3 มิติ สำหรับเด็กออทิสติก	ดร.ธงชัย แก้วกิริยา
3	นางสาวกีรติยา มงคล	M	การออกแบบและพัฒนา e-learning content สำหรับคนตาบอด	ดร.ธงชัย แก้วกิริยา
4	นายอรรถพร สภาพันธ์	M	การสังเคราะห์โมเดลสำหรับประหยัดพลังงานบน Data Center ด้วย Cloud Computing	ดร.ธงชัย แก้วกิริยา
5	นางสาวอรพรรณ ชัยกิตติ	M	การออกแบบและพัฒนา e-learning content สำหรับคนหูหนวก	ดร.ธงชัย แก้วกิริยา/ อ ฐนสิน
6	นางสาวลลิตา ณ หนองคาย	M	การออกแบบและพัฒนาระบบแนะนำผู้เรียน e-Learning สำหรับ ตามการวิเคราะห์ Dan Model	ดร.ธงชัย แก้วกิริยา

7	นายธนพล ดิลกเจริญ	B	การพัฒนาระบบ HPC แบบ Clustering Computer	ดร.ธงชัย แก้วกิริยา
8	นายดลวิชิต จันทร์นาม	M	Design of concept for dynamic resource allocation for virtual machine in virtualization	ดร.ธงชัย แก้วกิริยา
9	นายสาเรศ วัณโสภา	M	การออกแบบและพัฒนา ระบบแนะนำและแปลภาษา ไทย-ญี่ปุ่นบน Mobile	ดร.ธงชัย แก้วกิริยา
10	นายยุรนันท์ มูซอ	M	Design of Framework for Installation Software System Based on P2P	ดร.ธงชัย แก้วกิริยา

สถานที่ตั้งชั่วคราว อาคาร A ชั้น 3 ห้อง A307 (ห้อง Data Center)

5. **ผลการดำเนินงาน (พย 2556-ตค 2557)**

5.1 งานวิจัยจำนวน 8 เรื่อง

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5. "การพัฒนารูปแบบการแปลงโปรแกรมประยุกต์บนเว็บไปเป็นโปรแกรมประยุกต์สำหรับองค์กรบนโทรศัพท์เคลื่อนที่แบบหลายระบบปฏิบัติการ", จเร จำนงนิรันรักษ์, ดร ธงชัย แก้วกิริยา (กำลังดำเนินการ)
6. "การพัฒนาระบบแนะนำสถานที่ท่องเที่ยวสำหรับนักท่องเที่ยวที่วิเคราะห์ด้วยเหมืองข้อมูล", เรขา โสมพงษ์, ดร ธงชัย แก้วกิริยา (กำลังดำเนินการ)
7. "การพัฒนาระบบช่วยสนับสนุนการตัดสินใจในการเลือกซื้อเสื้อผ้า กรณีศึกษา: ร้านกางเกงเพ้น 84", อรพรรณ ชัยกิตติ, ฐนสิน ญาติสูงเนิน, ดร ธงชัย แก้วกิริยา (กำลังดำเนินการ)
8. "การพัฒนาระบบแนะนำการเลือกซื้อกลิ่นรสโดยใช้เทคนิคต้นไม้ตัดสินใจ", ศุภชาติ นิพัท, ดร ธงชัย แก้วกิริยา (กำลังดำเนินการ)

5.2 งานวิจัยที่ได้รับการตีพิมพ์จำนวน 4 เรื่อง

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ภาคผนวก

Finding Path Generator Function for Planning Support of Students Based on Trajectory Mining

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Abstract

This study proposes FPG ("finding path generator") functions based on CMMI principles to recommend a student's academic growth development plan by evaluating their growth history based on a PDS (Plan–Do–See) cycle. FPG function consists of four steps. The first step is to record student histories. The second step is to build a visualization path. The third step is generating the finding path generator function. The last step provide result. The possibility of the proposed FPG functions is also discussed through flowchart diagrams, and an example based on 60 student's samples is provided.

Keywords: Trajectory mining, Data mining, planning support function.

1 Introduction

Data engineering is popular in many fields, such as the analysis of business' growth [1], and is also being applied with personal e-learning systems to assist in online learning and teaching [2] [3]. The consideration of the growth prospects for student's growth capability based on trajectory mining is an example of earlier research in which a student capability growth structure is extracted from growth trajectories [4]. The goal is to find growth patterns within student sample groups.

Capability structure extraction from growth trajectory to identify constraints on growth and to extract the capability structure of a student dataset has been proposed [5]. In the past, we proposed the formal concept of trajectory mining in the capability space to implement an information system [6]. It used the basic concept of Capability Maturity Model Integration (CMMI) to evaluate software development on the basis of its capability and maturity [7]. Consideration of maturity and capability expands from initial development to optimization. Capability assessment involves five levels: Level 1 (the lowest) to Level 5 (the highest). In [8], the concept of CMMI was applied to growth trajectory analysis by dividing each capability and application by growth level for science teachers sharing knowledge based on subject contents.

The paper discussed above only proposed the concepts of trajectory mining, such as finding pattern growth, identifying constraints of growth, and applying these to the trajectory and application. Therefore, to continue these concepts, the evaluation method to apply the technique to real data is required. Learning plans is essential to students because through good plans and recommendations, students can achieve their academic goals more easily and successfully, and can also learn more effectively.

In order to suggest students in study plans, this paper proposes a finding path generator function that generate planning support for students based on their growth history. The motive of this plan is to recommend study areas and assist students in planning their studies. The remains of this paper is organized as following; section 2 presents spiral learning on capability space. Section 3 introduces the finding path generator function for planning support. Section 4 illustrates an example of planning support for students and finally section 5 summarizes this paper.

2 Spiral learning on capability space

2.1 Term Definition

Let us define first the capability space and capability structure by assigned capabilities C_i: $C_1, C_2, C_3, \ldots C_n$. Each capability C_i has some levels: l_{i1}, l_{i2}, l_{i3},.., . Generally, each has five levels: l_{i1}, l_{i2}, l_{i3}, l_{i4}, l_{i5}. Unit U_i represents a growing object such as a student or teacher. For example, a student in English class seeks to improve capability such as listening capability, speaking capability, etc. We can prepare five levels: poor, average, good, great, and perfect.

2.2 Visualization path of growth trajectory

A visualization path is a path of each capability level represented by a vector type. Each path can reach a destination or goal depending on individual's current capability level. We can create a visualization path by analyzing data from a student's growth log or that from a questionnaire if log data is unavailable or for a new student.

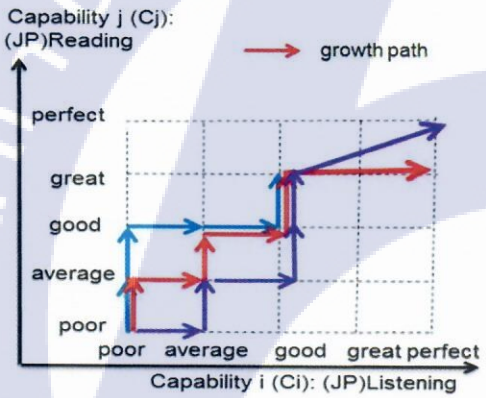


Figure 1. Example of growth trajectory

As shown in Figure 1, the growth trajectory indicates the path that can be followed to increase a capability by visualization of the path and interrelations between capabilities. In the example, C_i represents listening capability and C_j is reading capability. There are five achievable levels (poor, average, good, great, and perfect). Three possible paths are shown, indicating ways to improve their capability levels in the two capabilities.

We now define the capability space. The basic idea comes from evaluation of knowledge space theory [9], [10] for knowledge acquisition. Then, capability space is a set of potential capabilities. Furthermore, we define capability subspace as a set of state vectors that exist within two or more capability axes. We take two axes C_i and C_j, for example. Figure 2 shows an example where $X_i(t)$ is a capability state for unit U_i at $X_i(1) = (l_{11}, l_{21}, l_{31} \ldots l_{n1})$. We assume units grow only by one capability for one change from state (l_{i1}, l_{j1}) *to* (l_{i+1}, l_{j+1}).

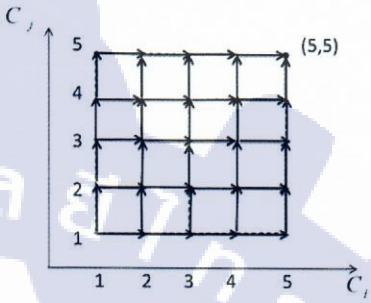


Figure 2. Two-axis based Capability Space

A capability structure suggests dependency between two . For example, high level such as l_{i5} in Figure 3(a) can be achieved without any precondition imposed by C_j or vice versa. However, achieving level l_{i5} as in Figure 3(b) may sometimes require satisfying another condition. In this example, l_{i5} is achieved only if a unit achieves l_{i4} first, but l_{i4} requires that l_{i3} and l_{j3} are met first, thus l_{i3}, l_{j3}, and l_{i4} are prerequisites to achieving l_{i5}.

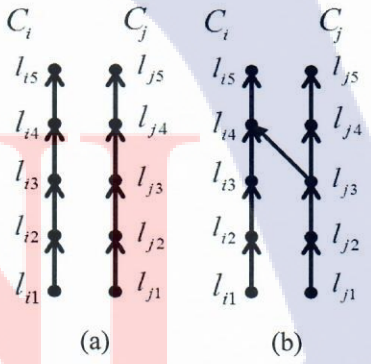


Figure 3. Example of capability structure

2.3 Plan–Do–See Cycle

Plan–Do–See is a principle applied to improve

the quality of general management [11] (Figure 4). "Plan" is preliminary analysis and prediction of effects that may occur on account of upcoming changes. For example, "Plan" set the goal to pass the Japanese language proficiency N1 test within five years. "Do" is what is being done and there is little to change in plan control. For example, a diligent student reads and practices Japanese all the time with the intent of passing the N1 exam as planned. "See" is the evaluation work that has already been done and revised to improve the student's chances of meeting the goal.

For example, a student has done as planned, then it is determined whether the N1 has been passed or not. If the goal has not yet been achieved, the plan is revised. Thus, planning support is based on the Plan–Do–See cycle.

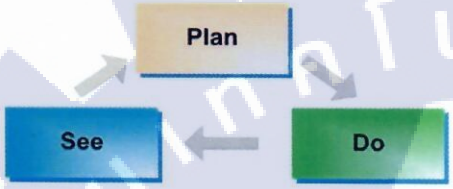


Figure 4. Plan–Do–See cycle

2.4 CMMI and SPICE Model

In this study, we use the basic principles of CMMI that are used to evaluate software organization through analysis of software capability and maturity. Both maturity and capability are indicators of consistency and growth trends reflecting the quality of a software product. CMMI applies growth levels to maturity and capability from level 1 to level 5, as shown in Figure 5.

Figure 5. Capability Maturity Model Integration

In addition to CMMI, we introduce the Spiral Enhancement Capability Support (SPICE) system [12], as shown in Figure 6. SPICE is a learning support system that can store and update student growth logs. In this paper, we use SPICE to store and analyze logs for growth trajectory and capability structure planning. SPICE also allows users to share experiences with each other. Moreover, SPICE allows a supervisor to improve student capabilities through effective planning.

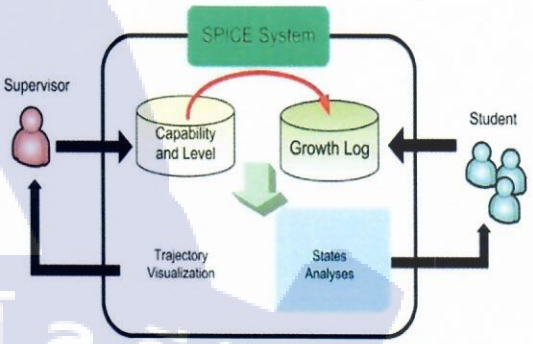


Figure 6. Model of SPICE

2.5 Review of previous systems

The previous research [6] presented the development of a prototype system for supporting growth by using visualization of the growth history. The research was divided into three parts: the first was the input of capability data for students. For this part a dataset was imported into the system. The second part was to visualize the learning trajectory based on the learning history data from the first part. Visualization included two types: individual and group visualization. The last part was the analysis of history data in order to recommend learning paths to a student.

This system would require extensive manual intervention in order to analyze the results for multiple students, thereby requiring a large amount of analysis time and cost. Moreover, the system only supports the "See" part of the Plan–Do–See cycle. Table I shows the comparison between available functions of the process discussed in [6] and this research. Visualization function supported only the evaluation purpose (See). FMG (finding message generator) [13] planning shall support the "Plan" function. This paper proposed FPG (finding path generator) function for planning support students which supports both "Plan" and "See" functions in the PDS cycle.

Table I Comparison of functions

No	Function	Plan	Do	See
1	Visualization	-	-	●
2	FMG	●	-	-
3	Planning support (FPG)	●	-	●

Finding path generator function will support "plan" and "See" because the process of extracting the planning support function must have to plan from student growth log. Then, we will get the extracted data as the planning result (See Figure 7). For "See", the result of extracted planning support function will show the result from the past until the future which students have been recording. This means the follow up and evaluation from planning.

From the past research [13] cannot recommend to student as the group path planning support. This type of learning recommendation will be necessary for students who would like to plan for learning from the beginning to the end.

3 Finding path generator function

3.1 FPG function

FPG is finding path generator function. FPG function will be generated planning support for students. FPG functions divided into four steps. The detail will be described in section 3.2.

3.2 Process of finding path generator function

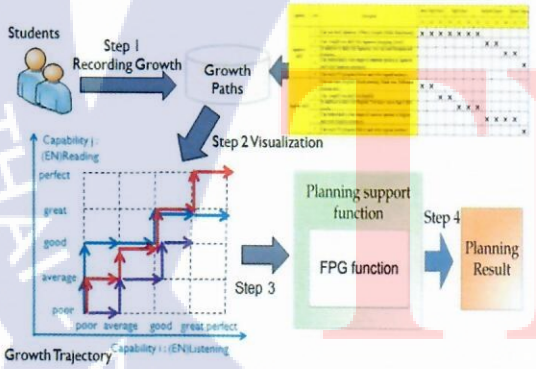


Figure 7. Finding path generator process

Let us divide the process of the planning support function into four steps. The first process is to record student histories. This process collects data through student questionnaires in some cases (if documented history data is not available). Students provide achievement data per year reflecting their current capability levels.

The second process is to build a visualization path for each capability level. Each path can achieve the planned destination depending on an individual's current capability level.

The third step involves generating the finding path generator function. FPG is the planning path support. FPG is also the plan generated from extraction of a student's learning history but FPG function focuses on a group planning path for students. Finally, the last step provide result. The result from the FPG function will recommend group study plan (planning path support).

3.3 Flowchart for finding path generator

FPG function, we consider the consistency for learning path for a student group. In this case, we define that number of students for each path are more than 15 students, it means consistency. If number of students for each path are less than 15 students, it means inconsistency.

We describe the flowchart for the FPG function in this section. The process begins by reading output data from the visualization function. Then, we set a start point to create the planning path support. Later, the student number of path is checked. Is the number of each path > or = 0 ?. If the condition of flowchart is "yes", the process will be compared the number of each path. If the condition of flowchart is "no", the process will be checked conditions. Later, the process selects most of the path.

Next, process defines planning for one path. The second condition determines if a student's data shows that both capabilities have not yet been completed at level 5. If the condition of flowchart is "yes", the process will be defined all paths based on the condition check. If the condition of flowchart is "no", the process will be returned to check the first condition again. Later, process displays the output for a group planning path support. Figure 8 shows a flowchart of finding path generator function.

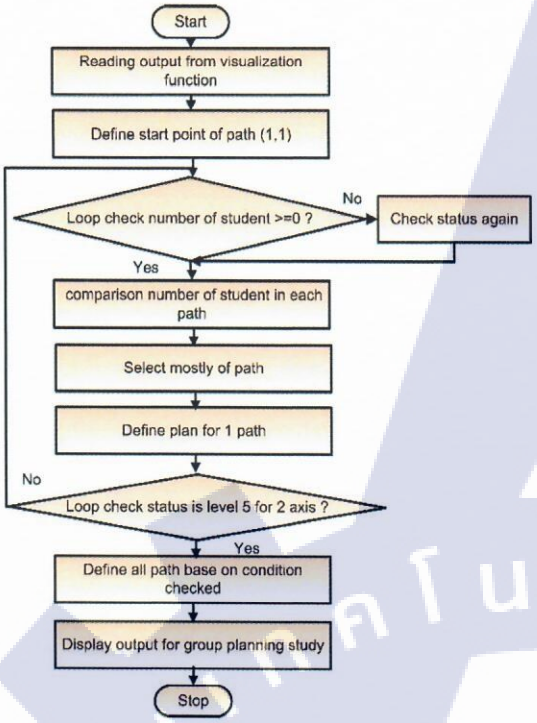


Figure 8. Flowchart of finding path generator

4 Example of planning support

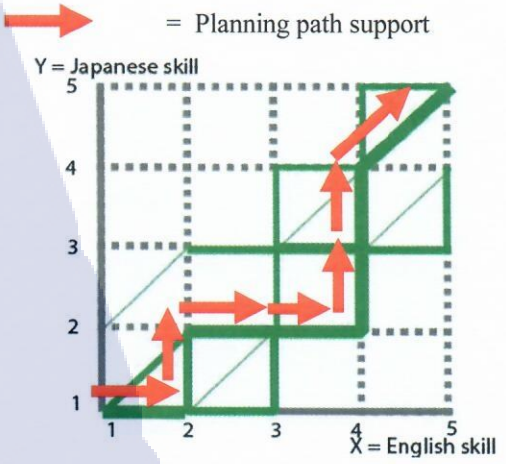
4.1 Sample Data

As a case study, we use samples of students from the Thai-Nichi Institute of Technology. The data samples consist of the following: undergraduate Information Technology (IT) students in third and fourth year, undergraduate Japanese Business students in the third year, undergraduate Computer Engineering students in second year, and graduate level IT students.

A total of 60 students are represented in the case study. We define eight capabilities (*English skill, Japanese skill, presentation skills, Java skills, study planning, web skills, e-mail skills, and database skills*). Each capability is assigned a capability level so that current student capabilities can be evaluated and study plans can be recommended.

4.2 Example plan

We randomly select the *Japanese skill* and *English skill* as the capabilities.



For planning path support of student group
Path 1: You should achieve the English skill level 2 and Japanese skill level 1.
Path 2: You should achieve the English skill level 2 and Japanese skill level 2.
Path 3: You should achieve the English skill level 3 and Japanese skill level 2.
Path 4: You should achieve the English skill level 4 and Japanese skill level 2.
Path 5: You should achieve the English skill level 4 and Japanese skill level 3.
Path 6: You should achieve the English skill level 4 and Japanese skill level 4.
Path 7: You should achieve the English skill level 5 and Japanese skill level 5.

Figure 9. Planning support example

Figure 9 is the example of planning path support for students. We consider a group sample for English skill and Japanese skill. The planning path support came from FPG function. The result of FPG function is shown in Figure 9 which is consists of seven paths for planning path support.

(1) The student must achieve the English skill level 2 and Japanese skill level 1 at first. (2) The student must achieve the English skill level 2 and Japanese skill level 2. (3) The student must achieve the English skill level 3 and Japanese skill level 2. (4) The student must achieve the English skill level 4 and Japanese skill level 2. (5) The student must achieve the English skill level 4 and Japanese skill level 3. (6) The student must achieve the English skill level 4 and Japanese skill level 4. (7) The last path, student must achieve the English skill level 5 and Japanese skill level 5.

5 Conclusion

This paper presented finding path generator function of planning support for students based on trajectory mining and have also presented a case study example. The goal of this study is to provide a method to guide students to select a study plan to further their academic growth. This

study proposed the process of a finding path generator function comprising four steps, as previously discussed. In addition this paper proposed the flowchart of finding path generator function for planning support. We use the *Japanese skill* and *English skill* as the capabilities for demonstration.

The current proposal focuses on finding path generator function for planning support for students. FPG function is the function generated planning path support for a student group. In the future research, we will propose other methods in order to guide students.

Acknowledgement

The authors would like to sincerely thank the students of TNI who responded to our survey. This work was partially supported by Japanese KAKENHI-A (13370017) and KAKENHI-C (2350049).

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The Design of a Rule Base for an e-Learning Recommendation System Base on Multiple Intelligences

T. Kaewkiriya, N. Utakrit, and M. Tiantong

Abstract- **The problem of e-Learning systems, learners are given learning contents that do not match individual aptitudes. This paper aims to design a rule base for recommendations focusing on e-Learning and learning profiles which are based on multiple intelligences. Design of the rule base was divided into four sections as follows. The first section covered a survey of the variables. Second section was creation of the questionnaire. Third section was a survey of the student sample groups. The last section was an analysis of data generated from the results of the survey. The process of selection for the rule base was undertaken by comparing the performance of the following algorithms 1) ID3 algorithm 2) C4.5 algorithm 3) NBTree algorithm 4) Naïve Bayes algorithm 5) Bayes Net algorithm. The C4.5 algorithm had the highest percentage of prediction. Percentage of prediction from the C4.5 algorithm equaled 83.436%.**

Index Terms- **: e-learning, Recommendation system, Data mining, Multiple Intelligence**

I. Introduction

In traditional teaching, teachers determine the environment of all classes and learning methods. The current system of learning and teaching has evolved from the original, for example the e-Learning system [1], distance learning [2]. The condition of learning and teaching today provides learners with opportunities to learn by themselves [3], teachers are only a guide. Generally, each learner has different abilities or aptitudes. Therefore, if learners are not equally skilled in the class, the learning performance becomes unbalanced and some learners might fall behind.

Past research has offered various types of learning and teaching methods, such as learning and teaching by brainstorming [4]. Learning and teaching by brainstorming means that learners will participate in problem solving in the class. If learners brainstorm, the more opportunity to solve problems arises. The advantage of learning and teaching in this way helps groups of learners to solve problems faster than normal learning and teaching. The limitation of this method is that learners do not gain learning contents according to the individual's aptitude.

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For this research [5] learning and teaching is a project base learning method (Project Base Learning) which focuses on every learner. From this learning and teaching method, learners can learn from the project at their own speed. The project is divided into appropriate groups of learners and learning contents. But the limitation occurs when learners are given contents that do not match their capabilities.

Researches [6], [7], [8] also use problem base learning (Problem Base Learning). This learning and teaching method focuses on learners by defining problems and solving them. This learning and teaching method is suitable for learners who are experts in analysis. But the restriction remains the same that learners do not get the lesson according to the individual's aptitude. Research [9] focuses on learning and teaching by emphasizing on learning activities base on Multiple Intelligence. This research focused on learning activities. But again was limited as individual's aptitudes were not catered for. In addition, [10] proposed learning activities by using Multiple Intelligences in the environment of e-learning. But the research focused on only learning activities and failed to consider learners with problems during study.

In addition, there is a form of learning and teaching that emphasizes learners as the center (Student Center Learning) [11]. This learning and teaching method focuses on the role of learners. Teachers are responsible for providing only a guide to learners. In the case that learners have problems and cannot solve them, teachers have a duty to assist and guide the learner to study further.

In addition, a group of researchers have used this technology to develop games with multimedia in order to help learning and teaching. Research [12], [13] are learning and teaching methods which use games to display learning material. This learning and teaching method is suitable for learners who enjoy playing games because when they play the game, they are learning at the same time. However, this application is suitable for only a small group of learners.

From the research mentioned above, learning and teaching by employing types of project base learning, problem base learning, activity base learning, game base learning and student center learning were found to be limited. In each method, learners are given learning

contents that do not match individual aptitudes. Thus, this research presents the design of a rule base for e-Learning recommendation. Rule bases are rules which come from the data analysis of learners. This research consists of 4 parts; First section, introduction of previous work. Second section covers a presentation of the background for this research. Third section, describes the concept of framework. Lastly, the proposed design of the rule base for learner recommendation.

II. PREVIOUS WORK

Research [14] presented the concept design as a model to guide e-learning learners according to the analysis of VARK base. The design of this model can guide learning contents of e-learning that match the aptitude of each learner. The aptitude of each learner can be analyzed according to the theory of VARK Model [15].VARK consists of visual techniques, which means visual learning, such as graphs, charts, flowcharts. Aural means learning though speech and dispute. Read/write means learning though reading and writing. Kinesthetic means learning from touching, testing and trail. Nevertheless, research [14] is still limited as the aptitudes of learners are not only 4 aspects. The aptitudes of learners have several aspects, such as Multiple Intelligence theory (MI) [16]. So, the guide according to VARK does not cover the aptitude of all learners.

Research [17] is about the learning activities based on analysis of Multiple Intelligences only. So, it does not cover the components of learning and teaching systems. In addition, research [18] also presented e-learning lessons by focusing on the contents but not on learners. So, learners with different aptitudes will be given the same contents and performance will not be as good as it should. Research [19] found the way to split learners according to their learning styles and learning management in relation to learners by trials with computer programming subjects. However, learners still get the same learning content, although there are separations of students group according to the type of learning.

Research [20] found that the creation of learning path of each learner and offered learning contents to learners. The creation of learning path of learner was from the history of users (Log file). In addition, it also adjusted learners' learning to be appropriate. However, this research is still limited as learners were given the same learning contents. Consequently, the performances of learners were not as good as it should be.

III. BACKGROUND

The theory of Multiple Intelligent[16] presents that each learner has different aptitudes which can be divided into cognitive aptitudes of humans by 9 types; 1. Verbal/ Linguistic Intelligence, 2. Logical/ Mathematical Intelligence, 3. Musical- Rhythmic Intelligence, 4. Body/ Kinesthetic Intelligence, 5. Visual/ Spatial Intelligence, 6. Interpersonal Intelligence, 7. Intrapersonal Intelligence, 8. Naturalist Intelligence, 9. Existential Intelligence. From 9 intelligences, each learner can have different dominant intellectual parts. The most important aspect is that from more dominant development, the result reflects individual progress. In addition, each learner may have more than one dominant area of intelligence. The Multiple Intelligence model is shown in Fig. 1.

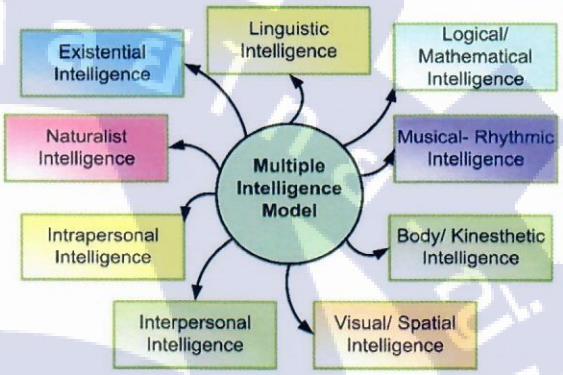

Fig. 1. Multiple Intelligence Model

The Multiple Intelligence theory is divided into 3 groups. 1) Analytic group, this group focuses on analysis and the thinking processes. The analytic group consists of 3 parts; Logical-mathematic intelligence, Musical intelligence, Naturalist intelligence. 2) Introspective group, this group focuses on imagination and understanding. The introspective group consists of 3 parts; Intrapersonal intelligence, spatial intelligence, and Existential intelligence. 3) Interactive group, this group focuses on communication and interactive. The interactive group consists of 3 parts; Linguistic intelligence, Interpersonal intelligence, and kinesthetic intelligence.

Figure 1 shows the Multiple Intelligence model. This research uses the principle of Multiple Intelligence to design a rule base for the e-learning recommendation system. The design of the rule base is just one of five modules in the framework which is based on the Multiple Intelligence principle (See Fig. 2).

IV. CONCEPTUAL FRAMEWORK

Fig. 2 shows the framework of an adaptive e-Learning guidance system which consists of 5 modules [21].

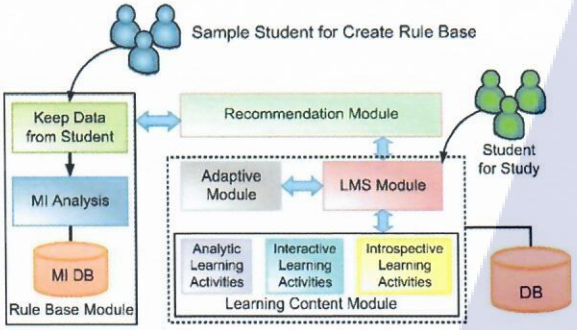

Fig. 2 Conceptual Framework

A. *Rule Base Module*

The Rule base module is the module that keeps the learning styles of learners according to their aptitude of Multiple Intelligences.

B. *Recommendation Module*

The recommendation module is the module that introduces learners to the type of learning content learners should get, such as Analytic Content, Introspective Content, or Interactive Content.

C. *LMS Module*

The LMS module is the module that acts as an intermediary between learners and systems. As parts of the LMS module are connected to most of the other modules in order to use it in learning and teaching.

D. *Adaptive Module*

The adaptive module is the module that improves learning. The module's function is to monitor learner's learning status with testing between classes passing on criteria test scores. Adaptive module will encourage learners to study other chapters further, but if the test scores between classes do not meet the criteria, this module will suggest returning to review again, etc.

E. *Learning Content Module*

The Learning Content Module is the module that stores learning contents which comes from the analysis of 9 Multiple Intelligences and divided into 3 groups; 1) Analytic content used with learners who have analytical and mathematical aptitude. 2) Introspective content used with learners who have the imaginative and artistic aptitude. 3) Interactive content used with learners who have the skills of communication and interactive aptitude to others.

V. DESIGN OF RULE BASE

A. *Acknowledge Process for rule base design*

The process of creating a rule base consists of 4 steps. (1) First step is a survey of variables that affects the ability of Multiple Intelligence for students. This process studies previous research to study variables that have an impact on the ability of Multiple Intelligences. Moreover, the author of this paper also interviewed Multiple Intelligence experts. (2) The second step is to create the questionnaires to survey data from sample groups. The questions of the questionnaires consist of two parts. One covering general information about the respondents (defined as a main variable) such as name, year, field, faculty, etc. The second part is the question to separate the ability of Multiple Intelligences (defined as a prediction variable). (3) The third step is an information survey from a sample of students to answer the questionnaires created from the last part. This paper uses the sample of 3,000 TNI students. (4) The fourth step analyzes the survey information from the third step using Data Mining.

This research uses five algorithms for analysis. 1) ID3 algorithm 2) C4.5 algorithm 3) NBTree algorithm 4) Naïve Bayes algorithm and 5) Bayes Net algorithm. Process for selection algorithm. Then, results from the 5 algorithms will be compared to find the most efficient referring to prediction. Fig. 3 shows the process of rule base design.

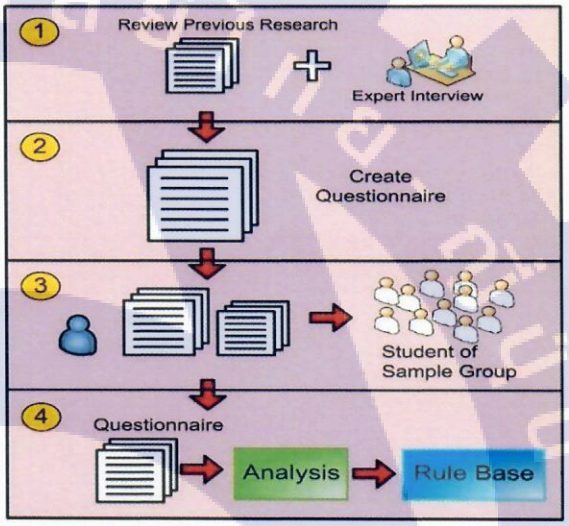

Fig. 3 Process of Rule base creation

B. *Comparison of Algorithm*

This section presents the evaluation of creating a rule base to guide students by considering the percentage of precision from student's ability. One can compare the evaluation of the rule base by using 5 methods; 1) ID3 algorithm 2) C4.5 algorithm 3) NBTree algorithm 4) Naïve Bayes algorithm and 5) Bayes Net algorithm. The results of the comparison are shown in Table I.

TABLE I.
COMPARISON OF ALGORITHM FOR RULE BASE

Algorithm	% Prediction
1. ID3 Algorithm	78.615
2. C4.5 Algorithm	83.436
3. NBTree Algorithm	77.008
4. Naïve Bayes Algorithm	60.939
5. Bayes Net Algorithm	66.378

Table I shows the comparison of the rule base creation. The result of each algorithm follows, ID3 algorithm equaled 78.615%, C4.5 algorithm equaled 83.436%, NBTree algorithm equaled 77.008%, Naïve Bayes algorithm equaled 60.939%, Bayes Net algorithm equaled 66.378%. This paper focused on percentage of prediction for each algorithm. C4.5 algorithm was found to have the highest percentage of prediction. Percentage of prediction of C4.5 algorithm equaled 83.436%.

C. An Example of the Rule Base

Result of the rule base design for C4.5 algorithm is depicted in Fig. 4. An example of the rule base is depicted in Fig. 5.

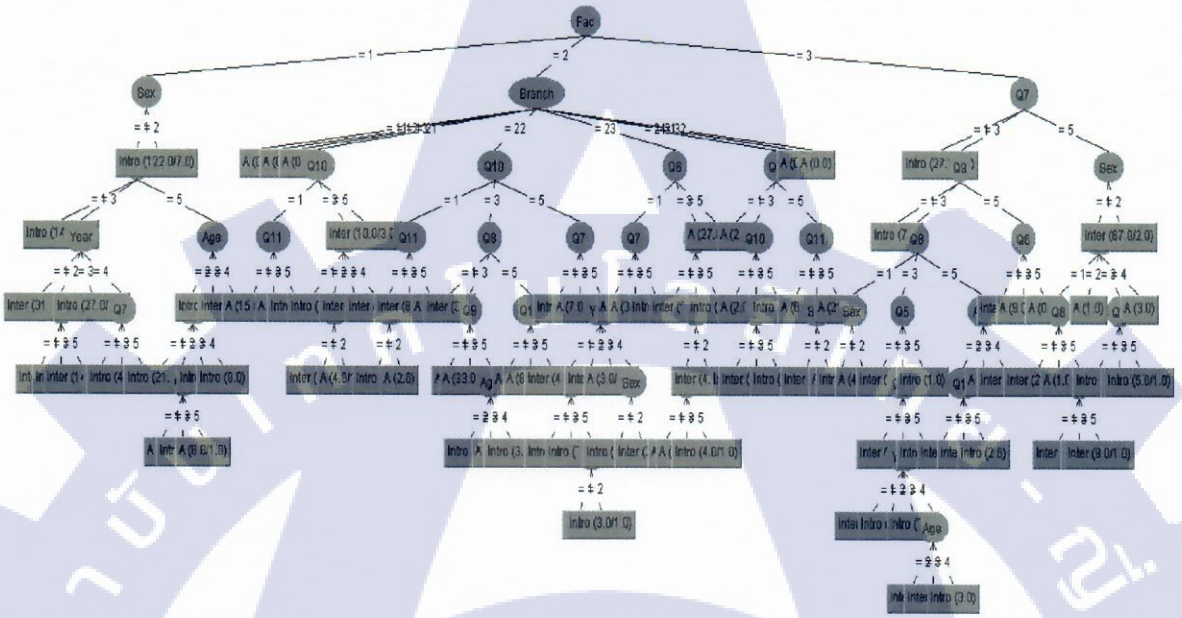

Fig. 4 Result of C4.5 Algorithm Rule Base

No	Rule Base	Prediction
1	IF Fac=1 and Sex=1 and Q5=Low	Intro
2	IF Fac=1 and Sex=1 and Q5=Medium and Year=1	Intro
3	IF Fac=1 and Sex=1 and Q5=Medium and Year=2 and Q7=Low	Intro
4	IF Fac=1 and Sex=1 and Q5=Medium and Year=2 and Q7=Medium	Intro
5	IF Fac=1 and Sex=1 and Q5=Medium and Year=2 and Q7=High	Inter
6	IF Fac=1 and Sex=1 and Q5=Medium and Year=3	Intro
7	IF Fac=1 and Sex=1 and Q5=Medium and Year=4 and Q7=Low	Analytic
8	IF Fac=1 and Sex=1 and Q5=Medium and Year=4 and Q7=Medium	Intro
9	IF Fac=1 and Sex=1 and Q5=Medium and Year=4 and Q7=High	Analytic
10	IF Fac=1 and Sex=1 and Q5=High and Age=1 and Year=1	Intro
11	IF Fac=1 and Sex=1 and Q5=High and Age=1 and Year=2 and Q7=Low	Analytic
12	IF Fac=1 and Sex=1 and Q5=High and Age=1 and Year=2 and Q7=Medium	Intro
13	IF Fac=1 and Sex=1 and Q5=High and Age=1 and Year=2 and Q7=High	Analytic
14	IF Fac=1 and Sex=1 and Q5=High and Age=1 and Year=3	Intro
15	IF Fac=1 and Sex=1 and Q5=High and Age=1 and Year=4	Intro
16	IF Fac=1 and Sex=1 and Q5=High and Age=2	Intro
17	IF Fac=1 and Sex=1 and Q5=High and Age=3	Inter
18	IF Fac=1 and Sex=2	Intro
19	IF Fac=2 and Branch=11	Analytic
20	IF Fac=2 and Branch=12	Analytic

Fig. 5 Example of Rule Base

VI. CONCLUSION

The objective of this research was to design a rule base to recommend e-learning and learning activities based on Multiple Intelligence. Design of the rule base consists of four parts. The first part was a survey of the variables. Second part was creation of the questionnaires. Third part was a survey using student sample groups. The fourth part was an analysis of data which came from the results of the survey. The process for selection of the rule base was undertaken by comparing 5 algorithms as follows 1) ID3 algorithm 2) C4.5 algorithm 3) NBTree algorithm 4) Naïve Bayes algorithm 5) Bayes Net algorithm. The result of each algorithm is, ID3 algorithm are as follows 78.615%, C4.5 algorithm equaled 83.436%, NBTree algorithm equaled 77.008%, Naïve Bayes algorithm equaled 60.939%, Bayes Net algorithm equaled 66.378%. When considering percentage of prediction for each algorithm, C4.5 algorithm had the highest percentage of prediction. Percentage of prediction for the C4.5 algorithm equaled 83.436 %.

Alongside the rule base recommendation system the author of this paper also proposed a model of recommendation for e-learning and learning activities. The conceptual model was divided into 4 sections; 1) The Rule base section separates the form of students' learning into 3 patterns from the aptitude of Multiple Intelligences. 2) The Recommendation module introduces students to a detailed content which matched their aptitude. This module will match rules from the Adaptive module. 3) The LMS module for learning and teaching. 4) The e-Mentor module automatically sents the instructions to the students who needed the assistance. 5) Learning content module stored contents of Multiple Intelligences approaches which consisted of three types 1) Analytic content 2) Introspective content 3) Interactive content.

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Framework of Dynamic Resource Allocation System for Virtual Machine in Virtualization System

D. Jannarm and T. Kaewkiriya

Abstract— **The purpose of this research is to design of concept dynamic resource allocation system for virtual machine in virtualization system. The process of this design is assigning the basic resource to virtual machine as well as designing the modules for monitoring and detecting the resource usage in virtual machine for each time period in order to allocate the resource suitably by simulate three situations of using the resource. The first situation is the used resource is equal to initial resource without adding additional resource. The second situation is the used resource is more than initial resource but it can add more resource. Finally, the third situation is the used resource is less than initial resource and the leftover resource can be regained. According to this proposed allocation resource, it is very helpful for allocating the resource in Virtualization system effectively because the system will detect the resource for each time period in real time. Also, the system can allocate and recover the unused resource depend on real usage.**

Index Terms— **Resource management, Virtual machine, Virtualization system.**

I. Introduction

Nowadays, Virtualization system [1] is being used by many organizations especially in data center which can be vastly useful for data management because Virtualization system is to combine multiple servers to exist in one device which is called "Sever Consolidation [2]." Also, Virtualization technology enable IT infrastructure to be more flexible by allowing Virtualize Machine in Virtualization system to be able to share resource from the same hardware. However, using the resources on each Virtual machine has to depend on the time period of usage and all applications on Virtual machine. It makes the usage of resource in physical hardware can be inconstant all the time. Thus, a capability of allocation of resource on Virtual machine should be considered about appropriate resource with high performance for applications which run on Virtual Machine.

That means the resources have to be determined based on usage. If the resources are defined more than necessity, it will waste the resource. On the other hand, if the resource is determined less than usage, the performance of system in providing applications on Virtual machine will be ineffective which comes from insufficient resource.

According to the resource adjustment and "Live migration [3]"(the process of running virtual machine from one physical server to another) it brings the combination of theory to control a variety of usability in order to enhance the performance of resource allocation to be suitable for the use of Virtual machine, applications and the resource allocation between Virtual machine and physical server in Virtualization system such as Vmware, Xen which contain the same controller for sharing resource. For example, in the process of sharing CPU, there are Credit scheduler [4] for management and Balloon driver [5] for RAM usage management. However, in the present, the resource assignments on Virtual machine are defined constantly which can highly occur errors. Thus, the preventing of this case is determining amount of resource in Virtual machine more than real usage in order to support each workloads in each virtual machine. Also, this amount of resources can be calculated from prediction of service such as database server, web server and others services which are located on each Virtual machine.

After analysis the dynamic resource allocation system for virtual machine has been identified to have the modules as follows; 1) Resource sensor module 2) Resource detection module 3) Resource regulator module 4) Resource Management module 5) Resource provider/reclaimer.

This paper mainly consists of six main sections: first: Introduction Second: Review related research. Third: Related theory forth: Conceptual framework fifth: Simulation experiments sixth: Conclusion and Guideline for future research.

II. Related Work

Previously, Gang Ning et al. [6] had studied about resource allocation on Xen hypervisor and presented its methods which divided into 3 levels (by priority) as follows; 1. Core application level 2. Service application level 3.Common application level as the result of method, the core application level was the fastest provider. Moreover, Minaroli,D et al. [7] used Fuzzy to predict the requirement of resource on Virtual machine by inventing Fuzzy controller for checking on the performance and making a discussion of resource management. Nigmandjanovich,S.B et al. [8] studied through an experiment. As an experiment, they set up agent on Virtual machine for monitoring resource usage and identified Policy-base to each service in order to prioritize the access of resource. Minarolli,D et al. [9] presented Distribution as the method of resource management through Artificial neural network. Also, they used artificial neural network as a principle of learning. Ying Song et al. [10] demonstrated Distribution sharing resource between Physical machine in Data center and presented Algorithm in Distribution which distinguished into two types; local and global. Wenyu Zhou et al. [11] suggested resource allocation for Virtual Machine cluster by using load balance. Load balance was used to distribute resource on each Virtual

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machine cluster at the same domain. Chao-Tung Yang et al. [12] utilized the principle of the cluster to share resource by producing a cluster at a physical host to balance workload.

However, according to previous researches, it shows that they analyzed the resource allocation base on real resource usage on Virtual machine and applications in order to specify Rule and Priority. Also, they used control theory to help them predict and create a model for producing a controller.

This research has presented a model of resource allocation with dynamic work as follows. The first section) is for monitoring resource usage. The second section) is used for detecting the use of resource. The third section) is to check on the demand of resource. The forth section) is resource allocation. The fifth section) is to notify the resource usage to Virtual machine besides the system can be able to allocate resource and restore some resource as needed for each time period.

III. Background

Virtualization technology is to imitate a virtual version of resource in computer such as CPU, Ram and storage. With Virtualization, a single computer can allow the system hardware to run multiple different operating systems at the same time. This makes Virtual machine to work as a completely independent computer which installs on hardware. Currently, there are a lot of virtualization software [3] for business and also provides as open source without expense. Virtualization can be classified into three categories which are following;

A. Full Virtualization

Full Virtualization [14] or native virtualization is a process that make an entire computer system into a software construct. This software construct performs like the original hardware in every way. As performed by software construct, it is no need to modify hardware which executes on the Virtual machine. Full virtualization uses a special software called a Hypervisor to work through Virtual machine monitor (VMM) as Binary transaction to Virtual machine. See fig. 1.

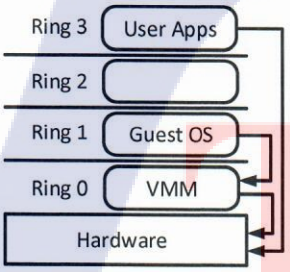

Fig. 1. Infrastructure of Full Virtualization.

B. Paravirtualization

Para virtualization [15] is the collaboration between Virtual machine and Hypervisor to provide more effective performance. In paravirtualization system, hypervisor can modify non-virtualize hardware inside Virtual machine or kernel by an intermediary between Virtual machine and Hypervisor to make the entire system can communicate and work together like a cohesive unit as in fig. 2.

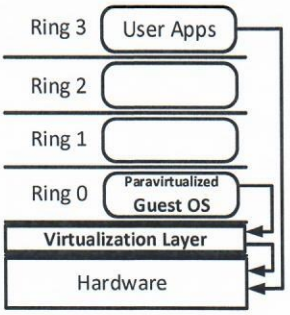

Fig. 2. Infrastructure of Paravirtualization

C. Hardware Assisted Virtualization

Hardware assisted virtualization [16] is the development of hardware technology to support and simplify Virtualization techniques. For instance, Intel Virtualization- Technology (VT-x) and AMD's AMD-V are targeted to maximize the effectiveness of Virtual machine monitor (VMM) in term of Binary translation of Full virtualization and Paravirtualization. As fig. 3.

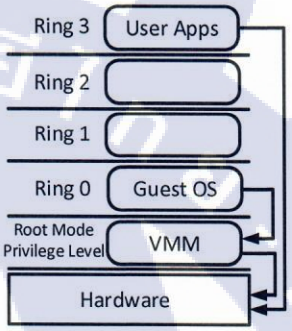

Fig. 3. Infrastructure of Hardware Assisted Virtualization

IV. Conceptual Framework

This research introduces the concept of resource allocation system in Virtualization system as follows: In general, each virtual machine is configured to use the default resource. After that, it is a process for monitoring resource of Virtual machine at each time period in order to determine whether the system needs more resources or use fewer resources. This process helps to allocate and restore resource from Virtual machine depends on demand. Also, the conceptual framework of resource allocation is shown in Fig. 4.

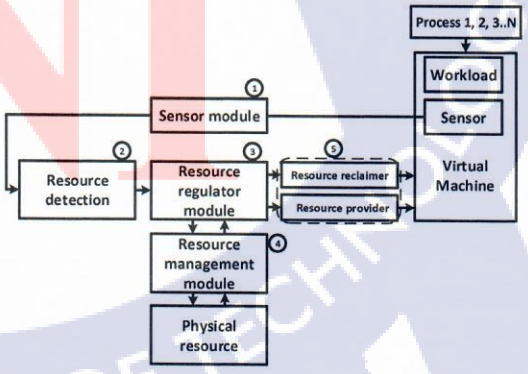

Fig. 4. Conceptual framework

The main function module of resource allocation:

Resource sensor module: This module used for monitoring resource of Virtual machine in real time.

Resource detection module: This module is used for detecting resource usage and specify the source that which virtual machine it comes from.

Resource regulator module: This module is to control and set the rules for resource allocation and restoration.

Resource management module: This module is about resource management and the hypervisor interaction for resource requirement and restoration.

Resource provider/reclaimer: This module is to inform the resource allocation and restoration value to virtual machine.

V. Scenarios

According to the models of resource allocation, it has shown a term and condition of resource management for Virtual machine in the following circumstances; It assumes that we create virtual machine and configure the default resource (initial.Res) at 1,000 MB in order to install virtual machine and application enable to provide high quality of service. It has to specify the resource usage not to be more than 80% of initial.Res. Description of this system operation is shown in Fig. 5. Moreover, it possibly defines the resource allocation according to these scenarios.

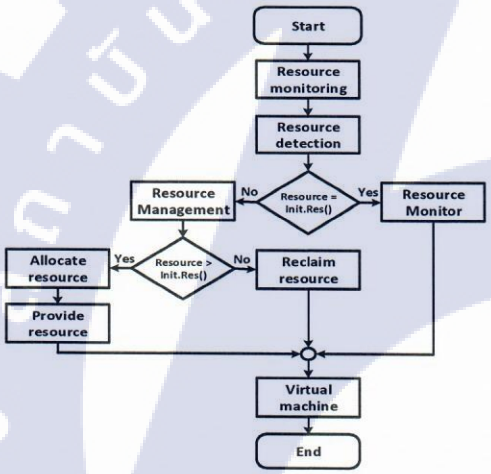

Fig. 5. Process of work

Scenario 1: Virtual machine uses 800 MB of available resources. According to a term and condition of resource allocation, it starts with resource monitoring of Virtual machine. The detection of resource usage value is 800 MB which is equivalent to the maximum usage value of initial resource from available resource. Thus, it is no need to allocate or restore resource from Virtual machine.

Scenario 2: Virtual machine increases using resource up to 1000 MB. According to a term and condition of resource allocation, it starts with resource monitoring of Virtual machine. The detection of resource usage value is 1000 MB which is more than the maximum usage value of initial resource from available resource. (The initial resource value is 800 MB) That means, the resource allocation has to increase to 200 MB in order to be sufficient for usage. From this scenario, it can sum up that the initial resource should be increased from 1000 MB to 1200 MB.

Scenario 3: According to second scenario, Virtual machine decreases using resource down to 600 MB. According to a term and condition of resource allocation, it starts with resource monitoring of Virtual machine. The detection of resource usage value is 600 MB which is less than the maximum usage value of initial resource from available resource. (The initial resource value is 1000 MB) Thus, it is needed to restore resource, 400 MB for proper usage. In conclusion, according to third scenario, the initial resource should be reduced from 1,200 MB to 800 MB.

VI. Conclusion

According to the proposed models of resource allocation, it monitors the resource usage of Virtual machine all the time, which effects to the initial resource to be changed according to the actual usage for each time period. This process benefits to resource allocation and restoration to be more appropriate for Virtual machine performance. Moreover, it can support the quality of application services running on Virtual machine by specifying the proper percentage of maximum initial resource as needed.

However, the model of resource allocation indicates that it has to rely on a connection of Hypervisor in order to use physical resource. That means the physical resource should be adequate for a virtual machine running on a Physical hardware.

For guideline for the future research, since this research is to present a concept and models of resource allocation for Virtual machine according to scenarios. Thus, in the future, it is necessary to invent the algorithm for assigning function in each module in order to create resource allocation system.

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Framework for e-Learning Recommendation Based on Index of Learning Styles Model

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Abstract—**Learning is the important one for learner. Every learner must learn, but how to learn for the most effective? This is the question. Lots of theory about learning styles for example Kolb's Learning Styles, VARK Learning Styles and Index of Learning Styles (ILS) which is created by Felder and Soloman. This paper adapts ILS with e-learning because of e-learning is the high-technology that focus on learner and they can study anywhere and anytime. Besides that it can forecast the best learning style for learner automatically by using data mining. This paper propose framework of recommendation e-learning by analysis Index of Learning Styles Model with data mining. Referring by experts it's satisfied with the average 3.87 (SD=1.21)**

Index Terms—**e-learning, recommendation, ILS, Index of Learning Styles, Learning Styles.**

I. Introduction

Everyone can learn everywhere and every time. Especially learners usually get knowledge from class room. (Having teachers to teach, and learners to learn) but the effective it's depend on teaching method. So, teacher must have many strategies to make learners understand clearly; Such as Lectures, Exercises, Activities and Discussions. But all of methods can't help all of learners understand the lessons clearly (Some can understand all of lessons, many can understand some of lessons and lots don't understand at all). So that, teacher should focus on learners that can understand some of lessons and can't understand at all by taking extra tuition class for these learners. But it will increase task for teachers and learners (They will not have free time after class). In fact, the better way is e-learning.

E-learning [1] is the lessons that teach on web based. Learners can learn from internet. So, they can learn anywhere and anytime not only in class room. All of contents will be same in class room. But only this way can't solve the problem for the learners that still don't understand the reason. Because of each person has a different learning style. According to the previous researches, they also already prove that each person has difference learning styles [2]. For example of learning styles, the first is Kolb's Learning Styles (David A. Kolb) is divide learning styles by their experience [3], the second is VARK Learning Styles is divide learning styles by sensory perception (Eyes, Ears, Mouth and Kinesthetic)[4] and the third is Index of Learning Styles (ILS) [5] is divide learning styles in 4 dimension (2 side of each dimension). These learning styles will support e-learning to help learners get more effective (It differences from class room that teacher can't use all of learning styles for every learners, because of each class room has many learners). If learners don't know their learning styles, they can read and find it out from learning styles theory.

Now a day, e-learning is better choice for teachers and learners. Especially, using with learning styles will give more effective. So, presenting framework that can guide learners, which learning styles is suitable with them by name's The framework of recommendation e-learning from ILS Model with data mining.

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II. Procedure for Paper Submission

Theory of Learning Styles

"Style" means characteristics or the personal responding to environment so "Learning Styles" means characteristics or the personal responding for learning., divided to many theories for example.

1. Kolb's Experiential Learning Cycle Theory by David A. Kolb[8]. He believes people have learned from their experiences. He divides learning styles into 2 dimensions are Perception and Data processing. In each dimension has 2 sides (Cycle Experiential)
    1. Concrete Experience (CE) is learning by **real experience**, use feeling to solve problem more than theory or reason.
    2. Reflective Observation (RO) is understanding their experience for applying (how to solve problem).
    3. Abstract Conceptualization (AC) is using theory or reason to understand and solve the problem.
    4. Active Experiment (AE) is concluding everything then do the action.

Learner can check them self which learning styles that they have or they can use instrument of David A. Kolb. This instrument has 2 scales - Scaling by making experience and Scaling of kinaesthetic skill, with 9 questions.

But Kolb's Experiential Learning Cycle Theory focuses on experience only. But sometimes learning doesn't come by experience always. Moreover, if learners don't know the way of learning styles in physical.

2. VARK Learning Styles Theory by Fleming, N.D. and Mills, C.[9]. He proposes 4 learning styles for humans.
    1. Visual (V): the learner who can learn better by picture, diagram, and graphs. And have a good memory in story.
    2. Auditory (A): the learner who can learn better by listening or discussion.
    3. Read/Write (R): the learner who can learn better by reading or writing.

4. Kinaesthetic (K): the learner who learn better by real action or simulation.

Moreover, VARK Learning Styles Theory has questionnaire to check which learning styles of learner is. In the questionnaire has 16 questions, in each question has 4 choices (according to 4 types of VARK's learning styles). The result will be shown from the most choice that learner chooses. So, VARK Learning Styles focus learning styles on physical more than thinking. But if learners is good at both styles (physical and thinking), he/she can learn more effective.

3. Index of Learning Styles (ILS) by Felder and Soloman[6] (Fig 1). This theory starts from engineering learning styles case then develop to another subject of sciences. ILS has 4 dimensions in each dimension has 2 sides.

1. Dimension of processing
   Active – The learner who can learn better by the action, like to have discussion.
   Reflective – The learner who can learn better by thinking like to thinking, by them self only.
2. Dimension of recognition
   Sensing – The learner that who learn better by real experience, can understand better if explain example from real experience.
   Intuitive – The learner that who learn better by theory, like to analysis the problem.
3. Dimension of input data
   Visual – The learner that who learn better by pictures, graphs, diagrams.
   Verbal – The learner that who learn better by words, listening, writing.
4. Dimension of understand
   Sequential – The learner that learning better by ordering and sequence.
   Global – The learner that learning better from global then in detail.

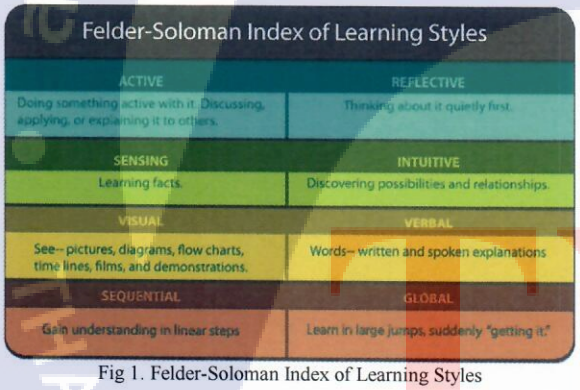

Fig 1. Felder-Soloman Index of Learning Styles

Index of Learning Styles covers both sides learning styles (physical and thinking). Also having questionnaire for learner. The questionnaire has 44 questions; in each question has 2 answers (meaning from dimension side). The result will be show from score that incline in each side. If score is in the middle mean learner can learn both sides.

E-learning

The lessons that manage by using program computer for learners to learn by them self without teacher or trainer. If they have internet they can learn from everywhere (not only in class room). [18]This technology can help learner to learn easier and have more effective. So, e-learning is used for many fields for example statistics, researching, education management.

Moreover e-learning can help learner who doesn't understand and repeat by them self or learner who absent, too. And the contents are same as classroom.

Recommendation and Prediction

[10] The concerned data is interested data or business data. In general having 4 steps. First, Basic data for processing. Second, input data from user. Third, algorithms and Fourth, data recommendation – divided in 2 steps. First, prediction phase and second is recommendation phase, the prediction phase is about the data of user interest used or has seen before. Then it will compare with the data that have in database for analyzing and predicating what that person want or need. That is call recommendation phase.

Recommendation systems[17] usually used business, e-commerce, social-network and also in field of education for learners have more effective.

Data Mining

Data mining or Knowledge Discovery in Database (KDD) [11] means searching knowledge form global data. So, data mining is searching data that is useful from large database (choose only the data that be concerned). The Main methods that use in data mining have 2 methods. First, Descriptive data mining is explaining in general format of data for designing. Second, Predictive data mining is predicting from old data then adapting with new data for predicting the future.

III. Previous Work

There are many previous works about using Index of Learning Styles to proof learning effective of learners.

The study of Asawinee Namakankum[12], Topic *Learning Styles of Nursing Students* for find out learning styles of Master of Nursing, Chiang Mai University. In 2007 total 589 students by using Index of Learning Styles (ILS). The first learning styles in year 1-3 are Sensing style, the second is Visual style and the last is Sequential style. Bu the first learning styles in year 4 is Visual style, the second is Sensing style and the last is Sequential style. Thesis information can help teacher to adapt technique for teaching their students.

The study of Kanjana Panyotee[13],*Topic Learning styles of Suranaree University of Technology students according to Felder and Soloman Model* with students that enroll in 3rd semester , in 1998 total 718 students. The first is Visual style, the second is Sensing style and the last is Verbal style. Concluding by gender, most of male can learn by visual style better than female. But female can learn by sensing style better than male. Concluding by major, Information Technology and Agricultural Information Technology can learn better by sensing style. Bu Engineer can learn better by Visual style.

The study of Sharon M. Wetzig[14],Topic *Learning Style preferences and Learning Strategies in intensive care nurse education* by using Index of Learning Styles (ILS). The result can be find learning styles in 5 types. 1) A learner

who's good in both side of each dimension (1 type). 2) A learner who's is middle in one side of each dimension (2 types). 3) A learner who's good in one side of each dimension (2 types). This information is using with strategies of Index of Learning Styles (ILS).

The study of Julie Willems [15], Topic *Using learning styles data to inform e-learning design: A study comparing undergraduates postgraduates and e-educators* to design e-learning that balance with three groups (undergraduates, postgraduates and educators) by analyzing the difference of each person to design e-learning. Such as, how do learners respond? Which learning style is suitable with them? The output is the postgraduates and educators are closer more than undergraduate.

The study of Ted Brown[16], Topic *Are learning styles preferences of health science students predictive of their attitudes towards e-learning* by using Index of Learning Styles (ILS) from Health Sciences students 10 branches, to find out their attitude with e-learning. The result is learning styles can define attitude of e-learning. This information is very useful for teacher. Especially, when using learning styles with technology multimedia.

IV. FRAMEWORK

Design framework for e-Learning Recommendation Based on Index of Learning Styles (Fig 2)

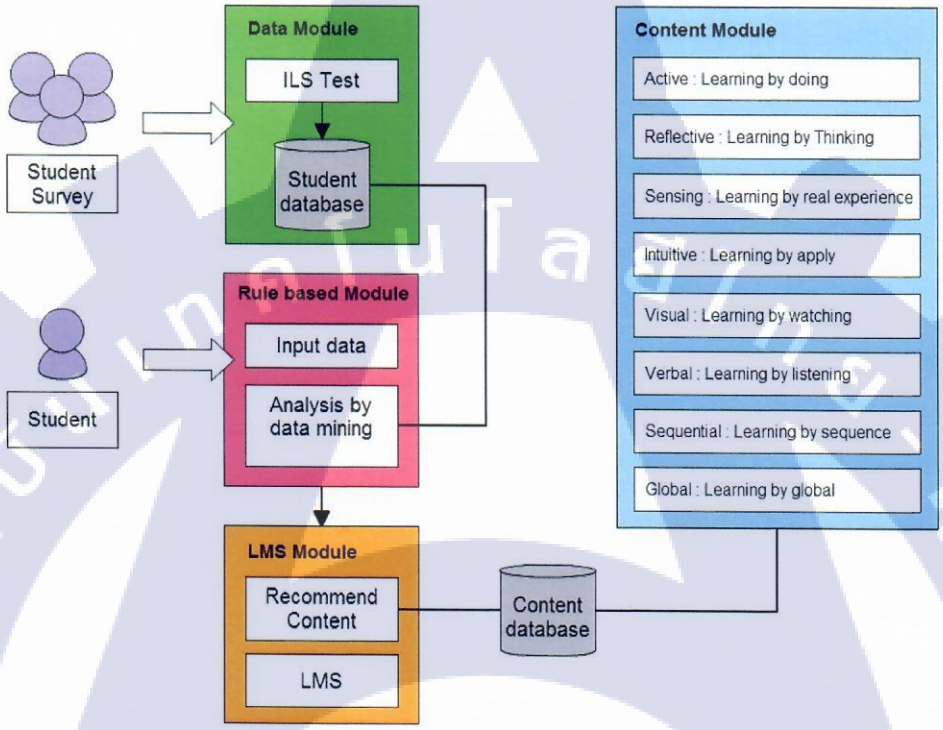

Fig 2. The framework for e-Learning Recommendation Based on Index of Learning Styles Model

1. **Data Module** is the module that storages data of student's surveying by using questionnaires then store data and learning styles of learners in *Student Database*.
2. **Rule based Module** is the module that uses technique of data mining to find their learning styles by personal data with learner data in *Student Database*. When it is completed, the result will be showed in LMS Module.
3. **LMS Module** is the module that recommends the suitable learning styles for learner for example. If learner has the suitable learning style more than one, the results will be showed for learner to choose (which one that he/she prefers). After he/she chooses, the content will be called from *Content Database* in Content Module.
4. **Content Module** is the module that stores Science's content that was is designed by Index of Learning Styles., having 4 dimensions are
   - Active: the lesson that learns by doing
   - Reflective: the lessons that learns by thinking.
   - Sensing: the lesson that learns by real experience.
   - Intuitive: the lesson that learns by theory and apply.
   - Visual: the lesson that learns by watching.
   - Verbal: the lesson that learns by listening.
   - Sequential: the lesson that learns in order or sequential.
   - Global: the lesson that learns by global.

   All of contents are store in *Content Database*.

I. EVALUATION

Evaluation of model by 5 experts contented 4 modules which are Data Module, Rule base Module, LMS Module

and Content Module and testing group also with overall of model. Divided in 5 periods as follows

4.01 – 5.00 : Most optimal
3.01 – 4.00 : Well optimal
2.01 – 3.00 : Average optimal
1.01 – 2.00 : Less optimal
0.00 – 1.00 : Poor optimal

After explanation to all experts and ask for their evaluations, obtained the result as table1.

TABLE I: THE ARRANGEMENT OF CHANNELS

Detail	$\bar{x}$	S.D.	Note
1. Optimal of Data Module	3.60	1.26	Well optimal
2. Optimal of Rule base Module	4.00	1.10	Well optimal
3. Optimal of LMS Module	4.20	0.89	Most optimal
4. Optimal of Content Module	3.80	1.55	Well optimal
5. Optimal of Student and Student Survey	3.80	0.89	Well optimal
6. Optimal of overall Model	3.80	1.55	Well optimal

According to the expert evaluations, the best module is LMS Module ($\bar{x}$ = 4.20) and the overall model has average 3.80 as good condition level. After calculated the average all of $\bar{x}$, the average will be 3.87 that is also in good condition level. So this model might be helping the learner to learn more effective. But this is only framework of the model, in the future it will be develop to use in real.

II. CONCLUSION

According from the learner problem, using e-learning with Index of Learning styles and data mining to search the suitable learning styles for each student. By designing this framework will help each student can understand the lesson and have more effective by their learning styles. Moreover learners can learn from everywhere and any time whenever they need.

In the future, this framework will be developed for using in real-time. It will be very helpful for everyone.

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