Applying Petri Nets to Model Customized Learning and Cooperative Learning with Competency

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Summary
In this paper, to have effective and individual customized learning which is considering individual grade with cooperative learning which creates knowledge for their needs with involving at the education positively has been modeled by using Petri Net. First, after checking all competencies, all complements have been divided with 3 levels which are Excellent, Average and Poor. Individual customized learning can supply contents according to the above levels. It has been modeled that, if needed, after individual customized learning, cooperative learning is available and then, if needed after the cooperative learning, individual customized learning would be arranged then. If there is a cooperative learning product after the cooperative studying, combining instructor evaluation, downloaded count and evaluation by learner with mega data can be used as for one resource. Learner who wants to refer the cooperative learning product, the learner can check the evaluation by learners by referring to instructor evaluation and downloaded count and then refer to desired contents. The cooperative learning product should be allowed to research after making readable data only.
Key words:
Cooperative Learning, Competency, e-learning, Petri Net, Customized Learning.

1. Introduction

E-learning is best education method whenever and wherever to supply learning opportunity and overcome a limitation of time and space. E-learning can be applied to learners with various classes and ages against to education in the class. In order to deliver information at e-learning environment, suitable learning should be arranged after understanding individual variation of each learner and self-concentrated and cooperative attitude of each learner should be arranged to obtain the knowledge. To suggest unified course of studying under learning system with many people who have much individual variation against to the study, it's very difficult to achieve deserved object of studying. Since individual ability of learner is different, customized learning would optimize education achievement according to the ability of learner. Considering a level of each learner, contents and course which is suitable for learner would be suggested. While learning the knowledge, new learning community with people who share specific information together can be formed. Also, mutual help between members at community would be arranged to help them create individual knowledge. In addition, knowledge to substitute for real experiences can be accumulated through positive interaction at the community.   Under E-learning environment, it can be called as "cooperative learning, it helps learner serve positive, creative and cooperative learning to reorganize and originate the knowledge which they need by involving at learning program positively"[1]. However, it's not possible for people to have direct studying for appearances at many fields, the appearances can be studied through examples and these examples can be modeled through a tool such as Petri Net. In on-line environment, generally it is most likely that the concentration of learner and the intensity of immersion decrease than in off-line environment. Then, it is strongly requested that learners should be participate voluntary and actively. And it is very important not only cognitive activity of each learner and emphasizing social interaction but also individual and group activity[2]. So, to have effective and individual customized learning which is considering individual grade with cooperative learning which creates knowledge for their needs with involving at the education positively has been modeled by using Petri Net in this paper. First, after checking all competencies, all complements have been divided with 3 levels which are Excellent, Average and Poor. Individual customized learning can supply contents according to the above levels. It has been modeled that, if needed, after individual customized learning, cooperative learning is available and then, if needed after the cooperative learning, individual customized learning would be arranged then. If there is a cooperative learning product after the cooperative studying, combining instructor evaluation, downloaded count and evaluation by learner with mega data can be used as for one resource. Learner who wants to refer the cooperative learning product, the learner can check the evaluation by learners by referring to instructor evaluation and downloaded count and then refer to desired contents. The cooperative learning product should be allowed to research after making readable data only.

2. Competency

Concept of competency has been suggested first by David McClelland, psychologist at Harvard University. It's very difficult to deduce a standard definition since definition of competency for scientific meaning is various and extensively[3]. If synthesizing the definition of competency even there are various different definitions by various scholars, competency includes observable performance to effect to calculate excellent result to individual or group and knowledge, function and attitude, based on standard of behavior[4]. If checking competency, it will be helpful to increase ability of learning. Even superior learning design is supplied, customized learning, it's difficult, if individual competency wouldn't be analyzed. Competency is consisted with various factors, not only factor. In order to have effective training, intellectual ability such as understanding ability, judgment ability, speed of understanding and reasoning power as well as metallic factor, which is influenced to learning, and emotional factors such as concentrating ability, achievement motivation and emotional stability should be considered. This is simple human test below, Fig1 divides into 5 factors and then displays percentage. And Fig2 scores character of Fig1 including subordinate grade and then departmentalizes with percentage. The value has been divided into 3 different grades, low with 0~40, normal 40~60 and high 60~100[5].
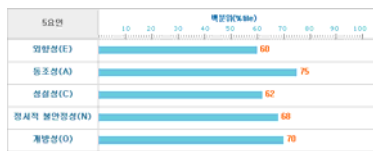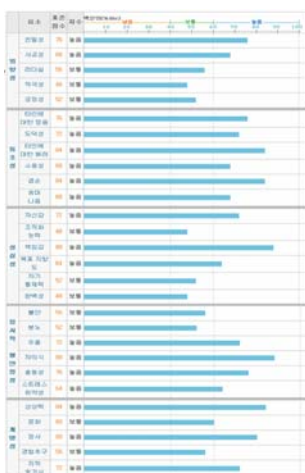

Fig. 1 Human Test.

Fig. 2 subdivision of Human Test .

3. Customized learning and Cooperative Learning

3.1 Cooperative Learning for e-Learning

Generally communication between humans at cyber space which is composed by networks between computers can be arranged at e-learning system. At this place, learner can achieve various learning through communication between individuals and especially, needs or people who have similar opinions and interest, it helps them achieve their objects or solve their homework by grouping the community. In order to achieve effect of cooperative learning, the group needs to be arranged with 4~6 members[6]. The cooperative learning is one of teaching‒learning method which promotes mutual action, communication exchange and cooperation in order to maximize union object for all learners. It became generally known to have excellent effect for cognitive side as well as affective side[1]. Considering general processes level for cooperative learning at e-learning environment, generally it has been divided with 3 steps which is processes, selected processes and sub processes[7]. The processes displays basic processes to achieve cooperation learning under e-learning environment and selected processes displays that it can be missed, selected or utilized, depends on status of instructor. And sub processes displays into sections for detail behaviors of processes or selected processes. Model of cooperative learning at e-learning is divided into 6 steps, education preparation and checking objective, cooperative learning and team organization, investigation of cooperative learning and planning, self-centered individual education, cooperation co-work at the team, sharing product, evaluation and self-examination of cooperative learning between teams

3.2 Customized learning

Individual customized learning is to optimize education environment by adjusting various needs and abilities of learner and to supply individualized learning, learner-directed learning and active learning[8]. There are many difficulties to meet learning objective under environment which includes many people with different individual variation so that needs for customized learning is increasing now. In other words, for customer side of education, customized learning for user-centered are desired now. Considering grade of learner, it's possible to supply contents to learner and contents with suitable degree of difficulties after seizing the grade of learner through an item pool. Systematic characters to supply customized contents are below. First, there is a

recommendation system to supply customized service to learner with result which is analyzed with data mining method, based on collected learner file and education behavior information. Second, there is a method which service and information can be supplied according to set-up shape and details when learner or new comer visits a website to supply the service. A function to edit basic screen and check selecting customized information, suitable for customer would be supplied. Third, there is a method to compose a website in order to have optimized way for visitor to visit desired website immediately.

4. Petri Net

Petri Net is abstract model which is created on paper "Communication with Automata" in order to express information flow of system which Carl Adam Petri is operated with parallel and asynchronous[9][10][11]. This net can be regarded as similar with flowchart and automata which is located between finite state automata and turning machine. Benefit of Petri Net is able to display concurrency and synchronized event and is able to display visuality as well as convenient to understand. A lot of logical studies as well as development tools with Petri Net have been developing till now. Major application part of Petri Net is modeling. However it's not possible to study some appearances at various studying fields, these appearances can be studied through models and also can be modeling through a tool such as Petri Net[12]. Modeling constituent of Petri Net is composed with transition, place, arcs and token[13]. Transition displays to happen accident, action or behavior and questionnaire area for real world or process, accident and work of system can be indicated. Transition is displayed with bar. Place displays preliminary condition to happen transition at system or further condition after transition. Enter place indicates preliminary condition, input data, desired sources and conditions and output place indicates further condition, output data, released resources and conclusion. Place can be displayed as cycle. There should be transition between place and place nearby another place at Petri Net. It means that the place shouldn't be closed each other. Relationship between place and transition is displayed through arc. Arc is displayed as directional arrow and indicates relationship with place which effects to or after accident happening. Token is located at the place and indicates sufficiency rate and then displays as dot(•)[14].
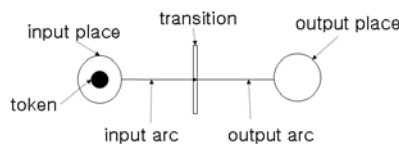

Fig. 3 Basic Component of PN.

When input places of a transition have the required number of tokens, the transition is enabled (firable). An enabled transition may fire (event happens) taking a specified number of tokens from each input place and depositing a specified number of tokens in each of its output place.

Fig. 4 enabled and fire of PN.

Petri Net is defined as PN={P, T, A, W, M0} where P={p1, p2, …, pm} is a finite set of places. T={t1, t2, …, tK} is a finite set of transitions. A:{P*T} U {T*P} is a finite set of arcs. W is Weight function and M_0 is initial marking. Petri Net which doesn't have the initial marking can be displayed as N= (P, T, A, W). Marking is a number of token at the place and describes active behavior progress through transaction of marking according to timing. Arc can be classified with weight and arc, k is added up can be interpreted as a set of parallel arc. There are Ordinary PN, Timed PN, Generalized PN, Colored PN, Extended PN and etc at Petri Net. Fig. 5 is Petri Net which displays cooperative learning at e-learning. Left part of Fig. 5 is before joining cooperative learning and right part of Fig. 5 is after joining cooperative learning[15][16][17].
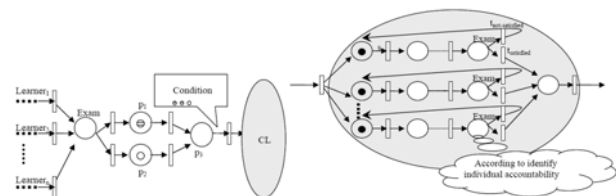

Fig. 5 Cooperative Learning as PN.

5. Applying Petri Net to Model e-Learning

After checking competency by diagnosing learner with diagnose tool, analyzing competency according to diagnose result, customized learning would be arranged, suitable to learner level. If there is prior knowledge for leaner, the prior knowledge can be used. However system is able to recommend Customized Learning(CuL) or Cooperative Learning(CL) to learner by applying competency with suitable level, learner is possible to select whether to choose individual customized learning or cooperative learning. Individual customized learning supplies suitable learning against to learner grade by taking contents from contents repository according to competency level. If the education is passed, it would be finished or cooperative learning would be available. If not,

cooperative learning would be acceptable with it that individual education would be repeated, if needed. At cooperative learning, team would be organized by using competency. For example, leadership or related information acquirement and Communication skill would be displayed with percentage then the team with a different constituent member in the point is composed would be organized with the score. Individual education under cooperative learning, study should be arranged after contents which are suitable to individual competency, are brought. After evaluation of cooperative learning, if it is passed, it would be finished. If not, individual customized learning or cooperative learning should be repeated. If there is satisfied result after cooperative learning, resource with combining metadata would be placed and then the data should be saved at repository which another learner can refer to.
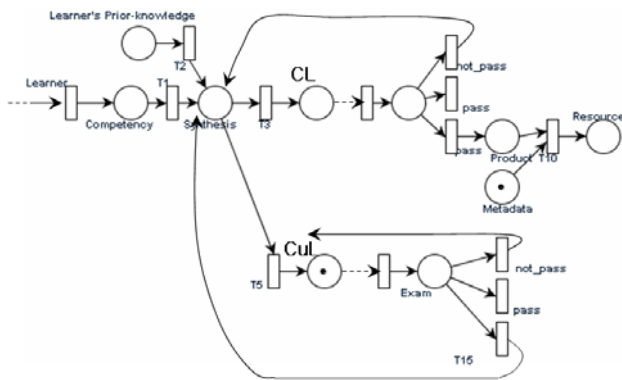

Fig. 6 Totality of E-learning Modeling as PN.

Petri Net is defined as PN={P, T, A, W, M0} where P={p1, p2, …, pm} U {cp1, cp2,…cpn} is a finite set of places that consist of two subset[15][16]. This is different from an ordinary Petri Net where only one type of places. T={t1, t2, …, tK} is a finite set of transitions. A:{P*T} U {T*P} is a finite set of arcs. W: F→I is a weight function, I={1,2,…} representing set of nonnegative integers. The function W can be extended to incorporate with a weight k. There $W_k : F \xrightarrow{k} I$ represents a set of k parallel arcs with the same sources and destination. M_0 is initial marking.

5.1 Applying Competency

In this paper, competency would be used by using ETK framework[18][19]. The model consists of three vital components. Emotional Competence(E), Technology Competence(T), Knowledge Competence(K). Together they constitute the ETK model. Emotional Intelligence includes Communication, Human Emotion Skill, Intellectual skill and Cultural Skill. Technology

competence includes technology acquisition, transfer and blending, telecommunications and IT management, research and development and innovation. Knowledge competence includes visioning and strategic planning, benchmarking, knowledge protection, relevant knowledge acquisition, human resource development and training, business plan protocol, assessment and continuous expansion. These components are regarded as each one unit. If selected E with referring as each unit for all constitutions, all constitutions should be displayed as percentage and then would be used according to each level. Similarly, T, K, ET, TK, EK, and ETK would be used and it would be used after combining all as like Fig 7 or necessary constitution would be used separately as like Fig 8 after selecting some necessary constitutions for individual or cooperative learning.
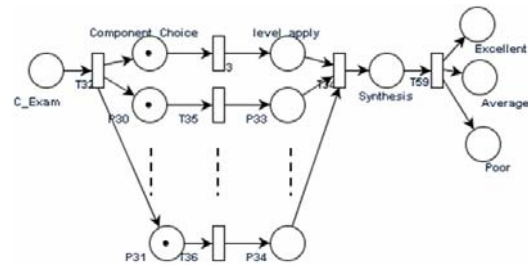

Fig. 7 synthesis of each Competency as PN.

In this paper, all constitutions of each competency have been divided into 3 levels, Excellent, Average and Poor as. Fig. 8 is an example of analysis power which is one of constitutions of competency. If Analysis power is Excellent, suitable education data of high level is used or course would be consisted. Excellent is used without the increasing strengthening.
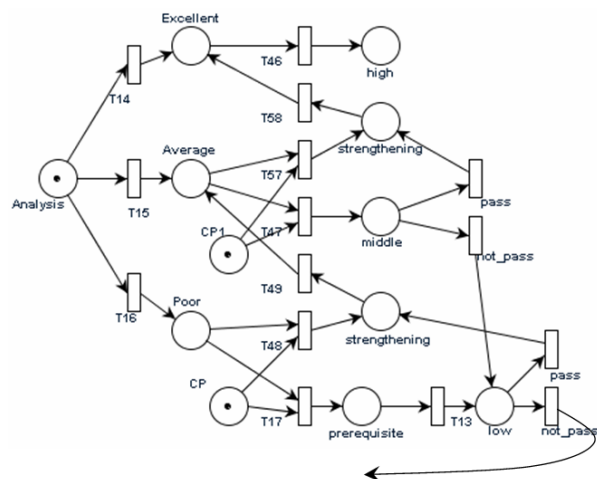

Fig. 8 Analysis Competency as PN.

In case of Average or Poor, it is possible to use control place(CP) to strengthen analysis power or doing itself without change. Let's consider the lowest level, Poor. Firstly, Considering the study of low level without the strengthening of analysis power. Learner can do low level study with doing prerequisite. And if learner didn't pass the exam when the end of study, learner should do prerequisite again. Unless learner did pass the exam, then learner should strengthen the analysis power and study next stage which request more high-ranked analysis power. In this manner, it is able to do study with higher analysis power.

5.2 Petri Net Model for Cooperative Learning

If there is data to analyze Competency or previous learner, level of competence would be researched. At cooperative learning, team would be organized by using competency. For example, leadership or related information acquirement and Communication skill would be displayed with percentage then different team -around 3~6 members- would be organized with the score. Individual learning under cooperative learning, study should be arranged after contents which are suitable to individual competency, are brought. After finishing the cooperative learning, evaluation would be arranged. If not passed, competency would be restarted. If needed, individual customized learning would be available. If passed, it would be finished. If there is a product of cooperative learning, it would be reorganized which another learner can be reused later.
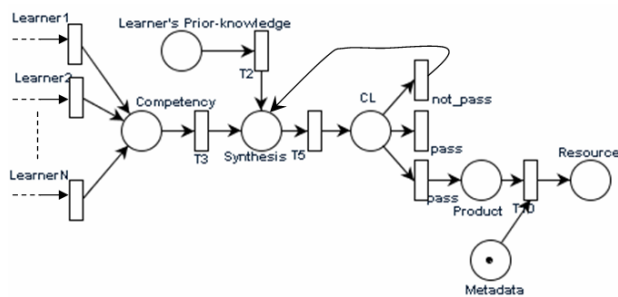

Fig. 9 Cooperative Learning of PN.

I believe, self-control learning of learner through internet, product which has been prepared by another team would be very effective. It seems, it has enough level if the product has been prepared by group comparing to individual. After cooperative learning, the cooperative learning product should be saved with metadata at the repository and then utilized, if needed. The cooperative product should be allowed to research after making readable data only.
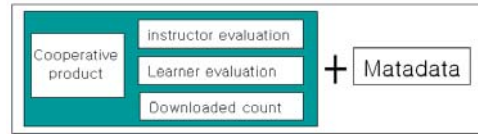

Fig. 10 inner structure of Cooperative Learning Product.

Here, instructor evaluation is evaluation score according to cooperative learning and learner evaluation is evaluation by learner who refers the product. Learner evaluation would be saved received score to average when learner gives desired score among 1-100. Downloaded count is a number to be increased automatically whenever learner uses. Make learner whether to refer to or select the product after showing instructor evaluation, downloaded count and leaner evaluation. Allow to add up some kinds for cooperative learning to constitutions of Meta data. Add up cooperated people, name of group (or Group ID), number of cooperated people, instructors, learner's age of cooperative learning and cooperative learning, cooperative learning Model (ex. General cooperative learning, cooperative discussion and cooperative idea creation).

6. Conclusion and future work

In this paper, to use individual customized learning and cooperative learning, it would be modeling, if there is cooperative learning product, it would be recycled after making resources again. In case of referring to resource by learner himself, it becomes close to self-control learning better. In case of referring to resource by another learner, learner is easy to obtain the knowledge. Graded contents which supply to current learner, it wouldn't be individual content for individual learner but grade distribution range against to whole learners according to ability of learner and then contents would be classified and classified contents would be arranged and supplied according to grade of learners at the group. Therefore, in order to be real customized learning of suitable learner, first, individual competency should be understood and appropriate education should be arranged then. In this paper, all constitutions of competency have been divided into 3 levels, Excellent, Average and Poor. But, another process to settle the grade with details and optimize them to contents. Since idea of education up to now has been defined to extend them after finding individual various aptitudes and abilities, education has been arranged focusing on individualism. However, generally cooperative learning is effective to promote education accomplishment than individual education and traditional class. To contribute promoting education attitude and inducing education motive with having optimistic feeling

against to education work, it also has great purpose of the cooperative learning. Nevertheless, to exclude individual customized learning entirely, it shouldn't be correct so that it should be desirable to utilize individual education and cooperative learning properly. In this paper, it has been modeled by considering this key point.

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