Requirements Engineering Education using Expert System and Role-Play Training

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***Abstract*—In this paper, we propose a method for use in requirements engineering education in a university, and based on 3 principles. (1) A type of expert system, which accumulates business domain knowledge related to the customer's business field, and answers learners' question on behalf of the customer is necessary. (2) Group-work role-play training is essential to elicit customer's real requirements and analyze them from various points of view. (3) A software agent system to monitor learner's behavior during role-play training, and act as an advisor in giving timely advice to learners is necessary. Learners who have no practical experience in defining requirements may follow a recommended procedure to elicit requirements and analyze them. In order to confirm the effectiveness of the proposed method, we have implemented an exercise for corporate workers and fourth undergraduate students. Requirements modeling skill level of the students was increased to the same skill levels of the corporate workers by using proposed method. The students got to understand the importance of the requirements and get them into shape.**

Keywords—requirements engineering education; role-play trraining; KAOS

I. INTRODUCTION

At present, in order to survive, a company expects its computer system to support the implementation of a new business model producing enormous profits, and the restructuring of business operations. However a top executive in the company is not readily convinced that a newly developed computer system could satisfy a corporation's expectations because the return on investment in the computer system has not been measured. A failure to respond to customer expectations arises from a lack of requirements definition and the analysis skills of the system engineers [1]. The information industry in Japan has been indicating the importance of requirements engineering, and requiring universities to train and produce system engineers with skills for not only analyzing requirements presented by a customer but also deducing genuine requirements, which the customer does not recognize yet.

In the field of requirements engineering four requirements processes are defined: (1) the requirements elicitation process, which involves extracting customer needs from a document called a Request for Proposal (RFP) provided by a customer, and by interviewing the customer; (2) the requirements analysis process, involving extracting the relationships between requirements, and their priority, and the development object; (3) the requirements specification process, which is writing a requirements specification document; and (4) the requirements verification process, which involves checking the consistency between the requirements and satisfaction of customer needs [2].

(1) In the requirements elicitation process, the behavior of a system engineer is dependent upon: a communication skill in understanding what a customer requires, a negotiation skill, seeking a win-win solution, while maximizing stakeholders' profit as much as possible, an interpersonal skill building good human relations among stakeholders, and an observation skill investigating the customer's operations, and discovering business issues and unknown needs.

(2) In the requirements analysis process, the system engineer makes use of an analysis skill in identifying essential needs with consideration of the interests of stakeholders, a modeling skill used in representing the customer's business process from various viewpoints, and creativity, which is the capability of defining the requirements specifications with due regard for the social impact of the system to be developed using information obtained from the customer.

(3) In the requirements specification process, a system engineer uses skill in writing to compose a requirements specification document, in which anyone, even someone with different interests, can arrive at only one interpretation.

(4) The requirements verification process requires an observation skill, an analysis skill, a modeling skill, and creativity.

In order for a system engineer to progress through all these four processes smoothly, a facilitation skill and an organization skill are also necessary.

However, it is difficult for system engineers, even those with advanced system development skills, to elicit essential

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requirements. A system engineer has to collect information on the system to be developed, understand business matters and practice, know the relevant laws and regulations, and consider the possibility of customer's requirements with the cooperation of an expert in the business domain of the customer. In order for a new engineer to acquire the skills related to requirements engineering, it is necessary for them to participate in systematically learning requirements engineering knowledge and to gain practical experience in making use of this knowledge in on-the-job training (OJT) with a customer. However a university cannot arrange such OJT projects. To provide practical experience for learners in a university we are proposing a method of requirements engineering education using a combination of three key ideas:

(1) Role-Play (RP) training in an on-line group-work training environment, in which a student makes use of knowledge of requirements elicitation and analysis studied in a classroom lecture.

(2) A business domain expert software system, as an alternative to a customer responding to students' questions concerning the customer's business matters, for use during the role-play training.

(3) A software agent playing the role of an adviser or a mentor, in order for a student who has no experience of system development to arrive at the correct decision through an orderly approach.

The proposed education method aims to increase the following skills: communication, negotiation, interpersonal, observation, analysis, modeling and creativity. Writing skills are improved by correcting text. Facilitation skills and organization skills may be obtained only in an OJT environment. Ways of acquiring these three skills are not discussed in this paper.

Section II explains requirements engineering education using role-play and the online group-work training environment in conjunction with a domain expert software system and a software agent system. Section III describes related work. Section IV describes differences in the results of two role-play training exercises: first, role-play training provided to fourth-year students in the School of Computer Science, Tokyo University of Technology; second, an exercise implemented for cooperate workers studying in the National Institute of Informatics (NII). Section V discusses the effectiveness of the proposed requirements engineering education method introducing the domain expert software system from the results of the role-play training carried out with the fourth year undergraduate students. Finally section VI discusses the results and section VII provides conclusions and looks to the future of requirements engineering education using role-play training.

II. Requirements Engineering Education using Role-Play Training in an Online Group Work Training Environment

A. Three Key Ideas for Requirements Engineering Education

(1) Role-Play training in an online group-work training environment

Role-play training has significant advantages over OJT. In the real world of business, once a business worker enters a company, she or he can experience only one role depending on the corporate position in the business. On the other hand, with role-play training, a learner can experience management from different perspectives, not only that of a project manager in a vendor company but also that of a customer. In a real business, workers only get to experience a few projects during their lifetimes. With role-play training a learner can participate in many more simulated experiences than with OJT. A learner can experience extremely difficult projects and can practice role-play exercises which target specific skills for requirements engineering.

In order for a member of teaching staff to know whether a student has learned how to take appropriate action when practicing an exercise during a role-play, and in order to evaluate the acquired skill levels of students, we have since 2007 developed an online group-work training environment named PROMASTER (Project Management Skills Training Environment) to gather the behavioral track records of each student [3][4]. We have used PROMASTER for students to acquire human-related skills such as communication, negotiation, and leadership in a lecture course on project management, and the effectiveness of using role-play training has been established. We are trying to apply PROMASTER to requirements engineering education to provide training in the human related skills needed in the requirements elicitation process. Group-work is necessary to elicit requirements and analyze them from various perspectives.

(2) Domain Expert Software System

Each business domain has its own specialist knowledge, which is needed, including: constraints on developing the system; regulations for a customer's business; dependency relationships among stakeholders; interests; and the causes of problems, which are business domain-specific information. A student needs to ask questions to analyze the requirements. To respond to any questions, an expert system accumulating the domain knowledge is required

(3) Software Agent System

The software agent system BONAMI (an agent system Based ON Aggregated Mentoring and expert Intelligence for project management) plays the role of a mentor bringing rich experience in developing systems [5][6]. It works with PROMASTER to support students by giving advice as necessary so that they can take appropriate and desirable action. To fulfill this role, the software agent is required to encourage the students to introduce the roles of the stakeholders which they are playing in a role-play exercise, to focus on the exercise problems, to collect information, to move the exercise forward, to participate in discussions, and to wrap up their discussions.

Fig.1 shows four processes in requirements engineering and the skills required. The four processes are repeated cyclically. The proposed method targets the requirements elicitation and analysis processes [2].

B. Goal Oriented Requirements Analysis Technique

In the requirements analysis process, the structuring of requirements obtained from a customer is an important task in clarifying the consistency and dependencies among requirements, and in detecting lack of or ambiguity in requirements. Goal oriented requirements analysis, which is one of the model based description techniques, is used to represent the structure of requirements. The basic concept of goal oriented requirements analysis is to find a solution to avoid problems, to identify a business objective as underlying needs, and to assign a software system to be developed, human resources, and the existing software systems to be responsible for satisfying the goal. KAOS (Knowledge Acquisition in autOmated Specification)is a commonly used method for goal oriented requirement analysis [7]. The goal model diagram is represented by a directed acyclic graph.

Fig. 2. is an example of the structured requirements shown by a KAOS goal model of a software system to be developed for solving issues in research laboratory management. If "Planned papers are submitted every year" is found as a tentative goal, which a professor wants to achieve, "A research team is improving the team's performance" is found as the reason for the existence of the tentative goal. The identified goal stating a strategic objective related to the research laboratory is allocated as the top-goal of the software system to be developed. In order to satisfy the top-goal, a finer-grained goal represented as "Enough research funding is achieved by "Director", and the tentative goal should be achieved. In order to achieve the tentative goal, "Research data is well managed" is required as a sub-goal. If the sub-goal cannot be decomposed into any finer-grained goals, then this goal is allocated as a requirement. There is only one agent, "Intellectual property management system", which is responsible for achieving the requirement and is system to be developed. Otherwise "Intellectual property management system" cannot accumulate enough research funds as an agent, and train team members. These two sub-goals are distinguished from requirements. These are named expectations, If "There are conflicts among team members" is found as a cause that prevents achievement of the top-goal, the cause is allocated as an obstacle in the structured requirements. "Research organization management" is allocated as domain knowledge to satisfy the top-goal.

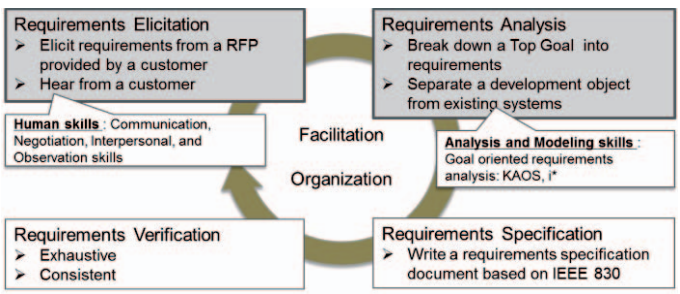

Fig. 1. Four Processes in Requirements Engineering

C. Domain Knowledge

In general there are many stakeholders in a system development project. Each stakeholder has an individual interest depending on their position, a given authority, a responsible role or individually assigned work. Each item of work has a job-related aim and dependencies. The dependencies among stakeholders' tasks may often cause problems. In order to extract a sub-task, which a stakeholder performs to achieve an assigned task, the dependency between stakeholders should be analyzed. A goal model technique, i* goal model, can extract the problems caused by dependencies, and present their relationship [8].

Fig.3. presents an example of an i* goal model of a software system to be developed for solving the problem of book management in a research laboratory. The dependencies between stakeholders, and tasks are presented. An answering sentence sent back to a student as a chat message is drawn up on the basis of a student's anticipated question. In practice, the sub-tasks allocated to achieve tasks belonging to stakeholders having the dependency are extracted. Then, the description of the relationship between sub-tasks is a candidate for the answering sentence.

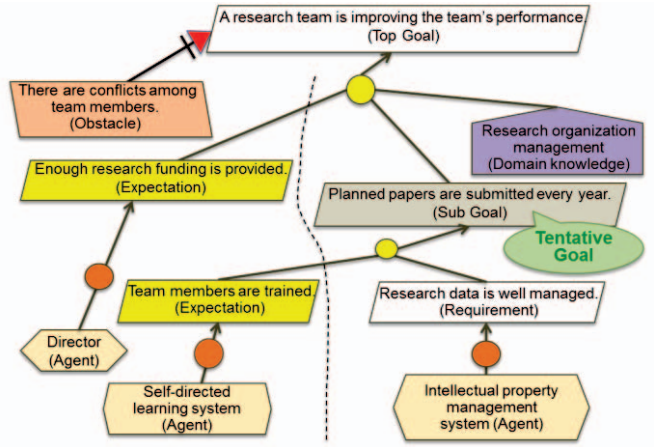

Fig.2. An Example of a Goal Oriented Requirement Analysis (KAOS)

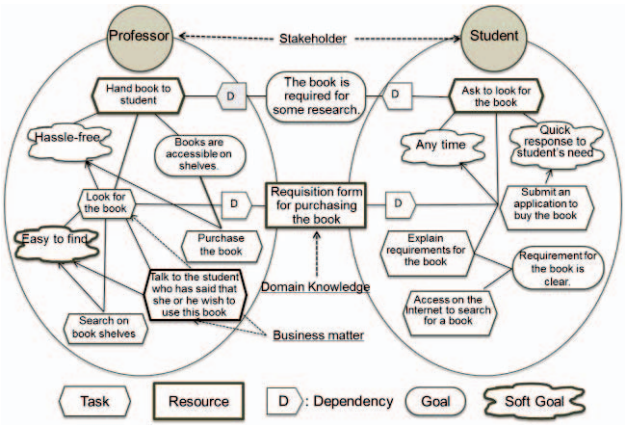

Fig.3. An example of i* model extracting the domain knowledge

D. Group Work with A Domain Expert Software System

We have developed a domain expert software system. The system plays the role of a customer and a domain expert, which has knowledge concerning constraints on developing the system, in particular regulations for a customer's business, dependencies of relations among stakeholders, interests, and the causes of problems.

Fig.4. shows role-play training with the domain expert software system named ATHENA (A THink factory accumulating domain Expert knowledge for Navigating learners) in the online group-work training environment consisting of PROMASTER with BONAMI. A RFP is the origin of requirements, stakeholders, business processes, assets, and their relationships.

Before undertaking a role-play exercise for requirements engineering, a member of the teaching staff extracts the domain knowledge from the information described in the RFP, and collects as much information as possible related to the customer's business field from various sources. In order to respond to a question, ATHENA extracts key words from a chat message written in text format, and searches candidate sentences to send back to the student.

Students progress through the role-play training as follows:

1st : Receive a RFP from the teaching staff,

2nd : Read the RFP closely,

3rd : Elicit requirements and structure requirements using the KAOS goal model,

4th : If necessary, ask a question,

5th : Receive the answer,

6th : Repeat 2nd through 5th stages of the requirements definition processes to refine the structured requirements.

III. Related Work

The work presented in this paper is focused mainly on requirements engineering education using role-play training. The important key skills required by a requirements analyst are modeling and interviewing. The requirements engineering training provides a learner with exercises on the following: closely read a document describing the information concerning a customer's business domain; identify problems in the current operating environment; abstract underlying problems; and develop the structure of the requirement. Tsumaki points out that in order to acquire the modeling skill required in the requirements analysis process, a member of the teaching staff should provide an unknown subject for a learner, and the learner should deal with abstraction of the problem [9]. The difficulty of modeling arises from abstraction, which is the main work in the modeling, but which depends on the individual's cognitive style.

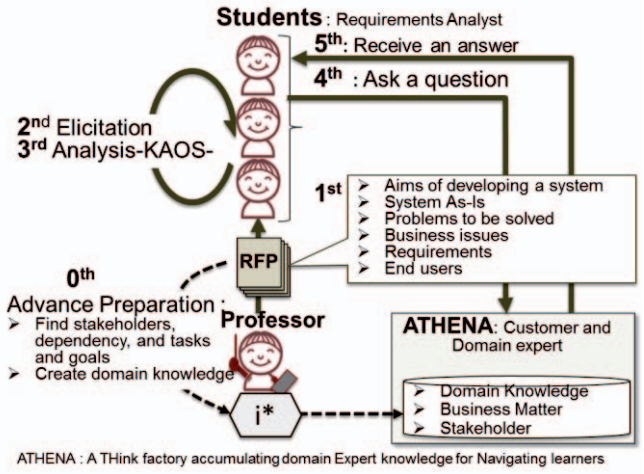

Fig. 4. Group work Training using the domain expert system ATHENA

In past software development aimed at operational efficiency improvement, the product or service, which is the target for modeling has already been abstracted because the business regulations applying to the product or service have generally been established. A system engineer playing the role of a requirements analyst has no opportunity to model the product or service, even if she or he is capable of doing so and has the necessary requirements analysis skills. However, with the advancement of the information society, the target for modeling is becoming uncertain. In other words, the scope for development is not obvious. Abstraction is of increasing significance in the requirements elicitation and analysis process. In requirements engineering training, there is a need to provide an exercise in which a learner can challenge assumptions, because the outcome of abstraction is dependent on the individual system engineer. Yamamoto points out that past requirements specification training using the model-based technique provides only one correct answer; however, there is now a dissociation of the actual system development and the training course for model-based requirements technique. He confirms that it is important to have a question about diversity in modeling and an interest in what type of model is developed [10].

From investigating these related studies, our research principle is to provide an environment in which a student thinks about an exercise without an obvious single answer.

IV. Requirements Engineering Education Using Role-Play Training

We provided role-play training on the online group-work training environment of PROMASTER for requirements engineering education to 4th–year undergraduate students in the School of Computer Science, Tokyo University of Technology in 2011, and to corporate workers studying in the National Institute of Informatics (NII) in 2012. Two of the three key ideas, (1) Role-Play training in an online group-work training environment and (3) Software agent system have already been realized. This section discusses the results of role-play training using the online group-work training environment consisting of PROMASTER and BONAMI.

A. Role-Play Training for 4th-year Underraduate Students

In order to provide role-play training, a virtual project needs to be profiled in a role-play scenario. A summary of the scenario is as follows: "The name of a company in this scenario is Wellness Sports. The company operates a number

of sport/gym clubs. As a result of M&A, three different types of customer management systems are in operation. Major issues for the company are to integrate the three systems into one to reduce the system operation cost, and to launch new services to expand the business. The project is just starting to achieve these two issues. Two stakeholders appear, one is a staff member in the planning department of Wellness Sports, and the other is a team leader in a vendor company, who is an expert in designing information systems. The Wellness Sports staff member, who is the customer, and the development leader, who is the vendor, need to define the requirements of the system to be developed together."

Before starting the role-play training, we gave a lecture covering the overall picture of requirements engineering, the modeling procedure used in KAOS modeling, and the KAOS modeling tool, Objectiver* [11]. This took sixty minutes. Teams of two 4th -year undergraduate students in the School of Computer Science participated in the role-play. In total five such teams were organized.

* Objectiver is a trademark of Respect-IT sa

B. Role-Play Training for Corporate Workers

A summary of the role-play scenario used in role-play training for corporate workers in 2012 is as follows: "In the research laboratory of a university, many books, magazines, references, papers submitted by research members, and design documents for a system developed in the laboratory are kept unfiled. In order to progress the research work, the literature and deliverables should be organized. Three stakeholders: a professor; a student; a student assigned to manage the literature and deliverables appear in the role-play scenario. Three learners, playing the roles of the three stakeholders, together define the requirements and expectations to achieve the real aim."

We gave a lecture covering the overall picture of requirements engineering, model components and the modeling procedure used in KAOS modeling to the corporate workers studying in the National Institute of Informatics (NII) before starting the role-play training. This took about 120 minutes. A team of three learners participated in the role-play. In total four such teams were organized.

In 2013, we redesigned a lecture course of requirements engineering for the corporate workers because corporate workers did not need to practice the human related skills by means of the role-play. They have already gained human related skills during their professional practice. The important thing was that they should spend their precious time acquiring the goal modeling technique rather than the human related skills. At first, a RFP is presented to learners,. Each learner creates the structured requirements diagram on an individual basis.

C. Evaluation

The effectiveness of the proposed method for requirements engineering education is presented by a portfolio evaluation examining a number of aspects of KAOS modelling and a performance evaluation based on the number of relevant communications. The portfolio evaluation is based on scoring a structured requirements diagram drawn by the role-play team members. The items that are checked to determine the score for the diagram are shown in TABLE I. Check items 1, 2, 3, and 5 are rated on whole diagram. If the check item is satisfied, that item scores 100 points, otherwise zero. Check items 4, 6, 7, and 8 are rated by a ratio of the number of correctly drawn components in the diagram to the total number of components drawn in the diagram.

The score for the diagram can represent the students' acquired skill level of requirements elicitation and analysis using KAOS, so providing the portfolio evaluation. In order to compare the score of the diagram drawn using the proposed method, which includes the domain expert software system, ATHENA with the score of the diagram drawn by the basic role-play without ATHENA, the score of each checking item is calculated as shown in TABLE I. The result of the portfolio evaluation may suggest the need for a refinement of the role-play scenario and the pedagogical method.

The relation between skills acquired by the proposed method and categories of chat messages, which relate to learner's actions, is shown in TABLE II. The acquired each skill level can be scored as the number of chat messages categorized into each category. The score of performance evaluation presents the students' acquired human related skill level.

TABLE I. PORTFOLIO EVALUATION OF STRUCTURED REQUIREMENTS

	Checking item for KAOS modeling Skill	Score of KAOS modeling Diagram	
		Average Score of all teams	Normalized Average Score
1	A unique agent is responsible for satisfying a requirement or an expectation	Y(=100) or N(=0)	*1
2	All requirements or expectations are related to any one agent	Y(=100) or N(=0)	*1
3	A top goal satisfying customer's real needs is revealed	Y(=100) or N(=0)	*1
4	Goals are presenting the desirable state of an organization	R/T	*2
5	OR and AND decomposition are appropriate to satisfy a goal	Y(=100) or N(=0)	*1
6	There are HOW and WHY decomposition	R/T	*2
7	An expectation and a requirement are clearly differentiated	R/T	*2
8	Granularity of a requirement and an expectation is appropriate size	R/T	*2

*1: (Y(=100) or N(=0)x6.25)/100 *2: R/Tx6.25/100

R/T=Number of Correctly drawn Components/Total Number of Components

TABLE II. PERFORMANCE EVALUATION OF LEARNER'S ORDERLY MANNER

	Skills acquirable by the Proposed Method	Category of Chat Message Related to Skill
1	Interpersonal	Greeting
2	Communication	Make sure what a student understands
3		Ask things a student doesn't undersatand
4	Facilitation	Facilitate discussion
5	Negotiation	Advocate own requirements
6	Analysis	Notice the neccesity of requirements
7	Creativity	Get requirements into shape

V. ROLE-PLAY TRAINING SUPPORTED BY DOMAIN EXPERT SYSTEM

A. Role-Play Training Environment

The role-play training environment, in which ATHENA works closely with PROMASTER and BONAMI to respond to students' questions concerning business matters during role-play is shown in Fig.5. PROMASTER is an online group work training system that can implement role-play training. All the information necessary to run a role-play is described in a role-play scenario, which is developed in advance. A scenario describes a virtual project, exercises related to the skills to be acquired, and details of how the role-play is expected to proceed. The scenario is composed of a set of information cards. PROMASTER sends the information cards to the students' PCs. The students know the state of the virtual project from the information card displayed on the screen, and hold discussions by exchanging chat messages to solve the problems that have emerged in the virtual project. The software agent, BONAMI monitors and analyzes the chat messages, and provides advice or a hint as necessary. The domain expert software system, ATHENA, receives a question written in text format by a student during the chat session, analyzes it by the morphological analysis, selects an appropriate sentence from the huge number of sentences registered in ATHENA, and sends it back to the student as a response.

B. Role-Play Exercise

The scenario used in the experiment is similar to the role-play for corporate workers in 2012 except the number of learners required, as follows: "In a research laboratory of a university, many intellectual assets are kept unfiled. In order to increase the productivity of research activities, an intellectual property management system is required. Two stakeholders, a professor and a student taking the role of intellectual property manager appear in the scenario. The two learners, playing the roles of the two stakeholders, together develop the structured requirements model."

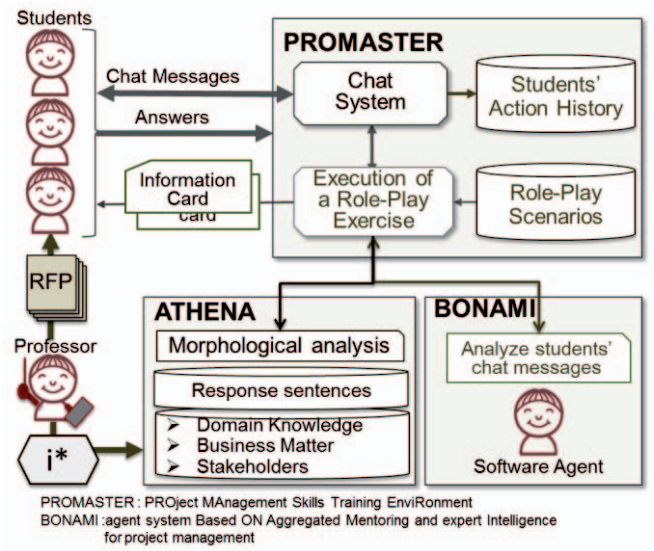

Fig. 5. Role-Play Training Environment with a Domain Expert System

The role-play exercise consists of an introduction phase, a requirements elicitation phase, a requirements analysis/ specification phase, and a closing phase. The first three phases are represented in Fig.6. In the introduction phase, the operating instructions for PROMASTER are introduced, and the purpose of role-play training is explained. Next in a requirements elicitation phase, students read a distributed RFP, recognize the business issue, and elicit the requirements to be achieved. Then in the requirements analysis phase, students practice the requirements analysis with respect to each step.

Students repeat the requirements elicitation and analysis to refine the KAOS goal model presenting the structured requirements. While repeating the cycle, if necessary students ask the domain expert software system, ATHENA, about the background of developing the system, industry practice, regulation, and related law in the customer's business field. Students develop the structured requirements diagram presented as a KAOS goal model using the modeling tool, Objectiver.

C. Effectiveness of Proposed Method

Teams of two fourth-year undergraduate students in the School of Computer Science participated in the role-play. In total five teams, involving ten students, were organized. We gave the sixty-minute lecture about overall picture of requirements engineering, model components and the modeling procedure used in KAOS modeling, and the KAOS modeling tool, Objectiver.

The normalized score of each check item related to KAOS modeling skills, which is required to develop the structured requirements diagram are shown in TABLE III. The score is the average score for the KAOS modeling diagrams created by all the role-play teams. The scores of three types of role-play

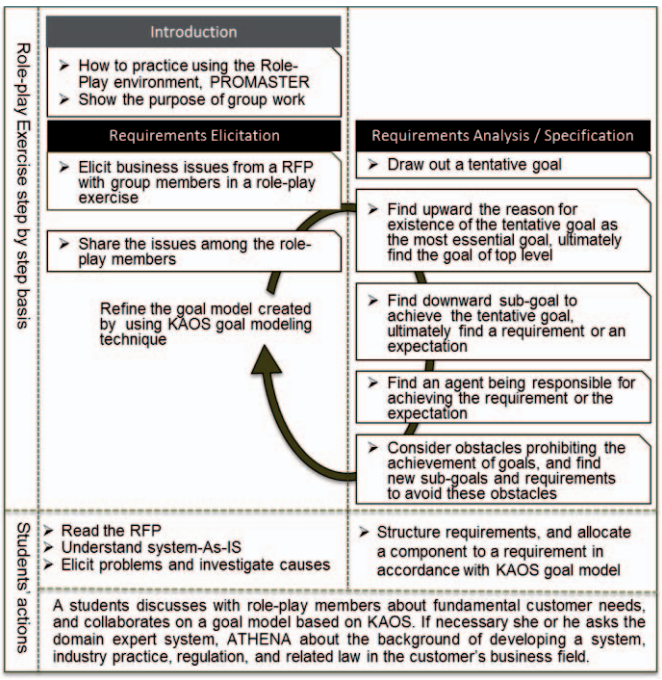

Fig. 6. Structure of a Role-Play.

training are presented: role-play training for corporate workers studying through an adult education course in NII named as Model RP training because learners could desirable actions; Basic RP training is the first role-play exercise for requirements engineering education, without the domain expert software system; Proposed RP training is the enhanced role-play training carried out in conjunction with the domain expert software system, ATHENA, as an alternative to a customer and an experienced expert.

As shown in TABLE III presenting the results of the portfolio evaluation, in the case of the Basic RP training, the score of modeling skill of "OR and AND decomposition are appropriate to satisfy a goal" (check item 5) and "Granularity of a requirement and an expectation is appropriate size" (item 8) are less than a quarter of the score in case of the proposed method.

Basic RP training, and the score of modeling skill of "All requirements or expectations are related to any one agent" (item 2) is less than the score in the case of the Model RP training.

The total score in the case of the Basic RP training is lower than the score for the Model RP training. Students were not able to acquire the fundamental goal decomposition techniques: OR and AND decomposition; appropriate granularity size of a requirement and an expectation without providing domain knowledge.

In contrast, in the case of the Proposed RP training, the scores of all items are much the same as the scores in the case of the Model RP training. Also the total scores of the Proposed RP training and the Model RP training are very similar.

According to the results showing increased scores, the role-play training in conjunction with ATHENA, which accumulates the customer's own business matters and business field practice is a useful methodology for helping students acquire KAOS modeling skills. Some of this domain knowledge can be derived by developing an i* goal model.

TABLE III. SCORE OF KAOS MODELING -PORTFOLIO EVALUATION-

	Checking item for KAOS modeling Skill	Score of KAOS modeling Diagram		
		Model RP	Basic RP	Proposed RP
		Corporate workers, 2013	4th undergraduate students, 2011	4th undergradute students, 2014
1	A unique agent is responsible for satisfying a requirement or an expectation	6.25	5.00	6.25
2	All requirements or expectations are related to any one agent	5.00	3.75	6.25
3	A top goal satisfying customer's real needs is revealed	6.25	6.25	6.25
4	Goals are presenting the desirable state of an organization	4.75	5.96	4.98
5	OR and AND decomposition are appropriate to satisfy a goal	5.00	1.25	6.25
6	There are HOW and WHY decomposition	5.62	4.56	5.69
7	An expectation and a requirement are clearly differentiated	5.70	5.15	5.10
8	Granularity of a requirement and an expectation is appropriate size	5.28	1.38	5.34
	Total score	43.85	33.3	46.10
	Standard deviation	0.54	1.80	0.52

We have redesigned the structure of the role-play scenario for students to acquire the modeling skill of the OR and AND decomposition (item 5), and the defining a requirement and an expectation of appropriate size (item 8). The revised role-play scenario includes practice exercises, which students address in accordance with a step-by-step process. The practical exercises take advantage of KAOS modeling skills to develop the structured requirements based on KAOS modeling, in which students practice skills in a cyclic series as shown in Fig.6.

TABLE IV shows the frequency of appearance of chat messages categorized into each category during the role-play. The appearance frequency is the average number of chat messages exchanged by all role-play teams. We view the appearance frequency as the score of the performance representing the students' human-related skill level. The skill of "Notice the necessary of requirements" (category 6), and "Get requirements into shape" (category 7) in the case of the Basic RP training are less than in the case of the Model RP training. Students were unable to take appropriate actions for getting requirements into shape through the Basic RP training.

Meanwhile in the case of the proposed RP training, the scores for categories 6 and 7 are close to the scores obtained through the Model RP training. This increase in the appearance frequency of chat messages categorized into each category signifies that students were able to make a mention of the necessity of requirements, and take actions for bringing the requirements into shape. The role-play cooperating with ATHENA may have contributed to an increase in the performance score of categories 6 and 7 because ATHENA told students the importance of requirements engineering, and provided the business material to them during the role-play. ATHENA is therefore useful for the requirements engineering education.

VI. DISCUSSION

In TABLE III, the KAOS modeling skill of "Goals are presenting the desirable state of an organization" (check item 4) shows the skill level of expressing the goal. The method of expressing the goal is subjected to naming conventions. According to the conventions the goal is named as a word followed by a verb in its passive form. The corporate workers obtained lower scores than the students, even though the workers had had experience in developing systems. We assume

TABLE IV. NUMBER OF CHAT MESSAGES E - PEROFORMANCE EVALUATION

	Category of chat message Related to Skill	Model RP	Basic RP	Proposed RP
		Corporate workers, 2012	4th undergraduate students, 2011	4th undergraduate students, 2014
1	Greeting	0.4	1.0	1.3
2	Make sure what a student understands	2.7	5.6	3.8
3	Ask things a student doesn't undersatand	0.3	3.2	0.2
4	Advocate own requirements	3.8	3.2	8.3
5	Propose various alternatives	0.0	0.0	0.0
6	Notice the neccesity of requirements	6.3	1.0	5.1
7	Get requirements into shape	5.0	2.8	7.5
	Correlation between the appearance frequency distributions of categorized chat messages in the proposed RE training method and a model RE training		0.15	0.83

that the corporate workers would have been trained to write a design document expressing the specific functions to be achieved since they had entered a company, however they are inexperienced in presenting a desirable state of an organization or a customer wants to achieve or maintain, cease or avoid. The corporate workers may instinctively follow a pattern of thinking based on their experience when they write a specification for a function to be achieved, and so they find it more difficult to adapt to the way of naming conventions.

The students were able to raise their skill level of KAOS modeling: all requirements or expectations are related to any one agent as check item 4; OR and AND decomposition are appropriate to satisfy a goal as item 5; granularity of a requirement and an expectation is appropriate size as item 8. The reason may be that the proposed role-play training provides the opportunity for students to use practically the knowledge about the requirements engineering step-by-step basis.

As shown in TABLE IV, students exchanged more chat messages categorized as category 2 and category 3 in the case of the basic role-play than the corporate workers, or even students practicing the proposed role-play. Both the chat messages categorized as category 2 and those categorized as category 3 are concerned with inquires about the goal decomposition, which is one of the most important techniques required by KAOS modeling.

Another remarkable point is that the students practicing the basic role-play exchanged far fewer messages categorized as category 6 or category 7 than the corporate workers. In contrast, the students practicing the proposed role-play exchanged more messages, as did the corporate workers. Both the number of chat messages categorized as category 6 and those categorized as category 7 express the students' level of understanding of the importance of the requirements, and the students' skill level in getting the requirements into shape. As described above, at first with the basic role-play training, the students could neither understand nor use the requirements engineering techniques based on KAOS modeling. However, students might be able to improve their skill level by using the proposed role-play training with the domain expert software system ATHENA because discussions referring to the necessity of requirements became active during the role-play.

VII. CONCLUSIONS

We have proposed a method of requirements engineering education using role-play training with an expert system which accumulates the domain knowledge related to the customer's business field. Students were able to raise their KAOS modeling skill of "OR and AND decomposition" and "elicit a requirement decomposed in the appropriate granularity size" as the result of the portfolio evaluation. Also the students' performance level was raised as indicated by the number of chat messages categorized into "Notice the necessity of requirements" and "Get requirements into shape", which was similar to that for corporate workers. Students progressed to be able to take an appropriate action to notice the necessity of requirements and get the requirements into shape.

However the effectiveness of the domain expert software system in responding the learners' questions may not be certain, because there were no chat messages categorized into the category of "proposing various alternatives" for any type of role-play training, even for corporate workers. The reason for the result may be due to the fact that the scenario used in the three types of role-play training addresses a well-known theme, and so does not require the learners to have specific domain knowledge.

In the future we would like to forward to increase the effectiveness of the ATHENA system and develop a role-play scenario which requires learners to collect more domain-related knowledge.

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