Role playing as experiential learning method for quality engineering education

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Role playing as experiential learning method for quality engineering education

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Abstract. Every learning activity should be well designed so that it can be easily understood and can attract the attention. However, challenges will arise for quantitative courses such as quality engineering (QE). The QE course is quantitative course in industrial engineering aimed for engineering system to produce qualified product. This paper will discuss about role playing as learning method for quality engineering courses. Role playing is designed by considering students as a part of Research and Development (R&D) department from Food Company trying to improve quality of products. Role playing is fully conducted for one semester with integrated activities consisting of teaching, R&D Meeting, market survey, experimentation and presentation. To build atmosphere, the course's materials are delivered like training. Pudding experiment was chosen to help students to understand types of DoE particularly. In addition, student gets the role of R&D such as leaders, surveyors to conduct market research, analysts to determine Critical to Quality which is worth to be controlled. Thus, learning process is conducted with experiential learning method. By using this method, the central tendencies of mark are 77,5 for mean, 78 for median and 84 for mode. Thus, we can draw that students can easily achieve Learning Objectives in a fascinating way.

1. Introduction

Learning process is one of crucial process in teaching process. It should be designed as attractive as possible so student will focus on the learning activities. Thus, the learning objectives are easier to be achieved. In this case, experiential learning is preferable considered to involve student actively in learning process. It can significantly improve students' memory for concepts [1]. Experiential learning is learning method involving student to build a fascinating and conducive academic atmosphere. As the previous research result, experiential learning is an effective approach on academic achievement and scientific process skills [2]. Kolb's Experiential Learning theory mentions that Learning is a process, in which knowledge is created through transformation of experience [3]. Based on this theory, experiential learning was chosen as learning method for Quality Engineering course. Role playing is an instance of experiential learning which gives student some roles and certain situation. It is an interesting example of an active learning and it can incorporate drama, simulations, games, and demonstrations of real-life cases related to any topic [4].

However, the use of role playing as learning methods is still rarely used in engineering field particularly in quantitative course. In this paper, role playing as experiential learning will be used in Quality Engineering course, so we can investigate the effect of this learning method. There are three major elements in experiential learning that must be considered in role playing. They are (1) meaning

making that allows students to relate the knowledge to their daily lives; (2) paradigm shifting that allows students to visualize, to understand and to enact the assumption and implications of different ideas and perspectives; (3) self-understanding that allows students pay more attention to their own thinking [5]. Thus, the role playing as experiential learning method is able to facilitate the accomplishment of learning objectives, and to form the soft skill competence during student plays the scenario either in individual activity or in group activity. This learning method facilitates the delivery of content courses, particularly for quantitative courses such as Quality Engineering. Quality Engineering is a course studying the method to engineer production system through designed experiment in order to obtain the desired quality. This paper aims to discuss the role playing as experiential learning method for Quality Engineering.

In this case study, role playing was designed by considering students as Research and Development Department (R&D) staff from a food company producing pudding. They were responsible to improve the quality of its products. Class activities were also adjusted to the scenarios created such as the scenario for teaching activities resembling as employee training, group discussions resembling as meetings, defining Critical to Quality (CTQ) resembling as simple market survey. During one semester, the series of activities were the teaching of designed experiment concept, market survey, R&D Meetings, experiments, result presentations. Through these activities, students were expected to get hard skills and soft skills in a fascinating method. The expected soft skill was in line with the suitable soft skill for engineer such as leadership, communication, critical thinking.

Indicators of success in engineering education are if students achieve competence in the design process, identifying problems and backgrounds, planning problem solving methodology, testing and evaluating, applying science, engineering and mathematics, applying engineering thinking, selecting the appropriate problem-solving tools, drawing conclusions [6]. In this role-playing activity, students are conditioned to experience all of these processes. This is required for an engineer because engineers are the creators rather than investigators, so that students must be confronted with real problems and be processed with more innovative learning method [7]. Role playing is part of experiential learning that requires the active involvement of students. In Michael [8] and Jennifer and Gregory [9], all forms of active learning processes are suitable learning methods for engineering education.

2. Methodology

Experiential learning implementation is conducted by considering the learning cycle of students, namely concrete experiences, reflective observation, abstract conceptualization, and active experimentation [10]. In this case, concrete experience is designed by designing role playing scenarios in several activities those are in accordance with the learning objectives. In the reflective observation phase, students run a role-playing scenario by formulating the problem with a factual and process approach based on market surveys. Then, abstract conceptualization is realized by activity that students start to plan feasible experiments. The last phase is to carry out the experiments that were planned before. In general, those phases are implemented into role playing through the following flow chart. In the flow chart, the methodology for implementing role playing in Quality Engineering course was as follows in figure 1.

In this case, the role playing was applied in odd semester of 2016-2017 which consisted of 24 students. Thus, the class management and roles induction for role playing became easier and more intense. Furthermore, the 24 students were divided into three groups. Each group pointed the team leader. However, the series of integrated activities for role playing must be in line with learning objectives. Thus, figure 1 shows the methodology to design the role playing. First step to plan was done by mapping learning objectives into activities, so the series of activities were designed to achieve the relevant hard skills or soft skills. The mapping is presented in table 1.

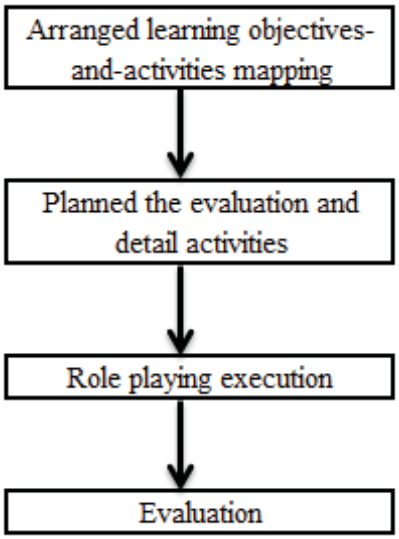

Figure 1. Methodology in designing the role playing.

Table 1. Learning objectives-and-activities mapping.

Week	Activity	Learning Objective
1	Introduction	Student understands the history of quality engineering
2-3	Training for team	Student is able to use the right Design of Experiment type to solve the problem
	Market survey	Student is able to identify the critical to quality to be controled/ engineered
4	Meeting	Student is able to plan the right designed experiment
	Experiment Simulation	Student is able to analyze the feasible planning for designed experiment
5	Experiment	Student is able to apply the series of designed experiment
6	Quiz	Student is able to use the right Design of Experiment type to solve the problem
	Training for team	Student is able to apply the series of designed experiment
7	Result Presentation	Student is able to apply the series of designed experiment

Once designing the activities those were integrated and in accordance with learning objectives, evaluation planning was also arranged to guarantee and to monitor the success of learning process. Hard skill aspect was evaluated through quiz, experiment mark and midterms. While soft skill aspect was evaluated by observing the indicator as follows in table 2.

Table 2. Soft skill Indicators.

No	*Soft skill*	Activity	Indicator
1	Communication	R&D Meeting and Presentation	Argumentation is understandable, ethical and persuasive
2	Thinking Critically	Design the experiment	The task is correctly complete with considering the limitation of resource, the rules and the scenario
3	Teamwork	Marker survey, R&D Meeting, Experiment	The task is correctly complete Having initiatives to help other member to achieve group goals

3. Role playing implementation

At the beginning of the semester, students had been conditioned as a R&D team consisting of 7-8 people, in which there would be a leader and staffs. Each staff member had a role determined by the leader in accordance with the needs of their planned experiment. The team was assigned to improve product quality in accordance with specified qualifications determined by the customer's expectations of the product. Thus, the leader must divide the members into several roles. All of these activities were continuous series and were carried out in a group. Through the activities, students learnt by implementing the theory into the real case so there would be a process of analysis and selection of the right tools to solve the problem being faced. During the process, hard skills and soft skills competencies were formed by practicing, working in team, designing quality improvement efforts and analyzing experimental results. The detailed class activities every week are presented in the following table 3.

Table 3. Role playing activities design.

Week	Activity	Content
1	Introduction	Delivering syllabus, class rules and class activities
2-3	Training for team	Delivering course's materials
	Market survey	Doing survey to potential customer
4	Meeting	Determining members' role and planning the designed experiment
	Experiment Simulation	Doing feasibility analysis for planned experiment
5	Experiment	Implementing the steps of designed experiment
6	Quiz	Evaluate learning objectives achievement
	Training for team	Delivering course's materials
7	Result Presentation	Evaluate learning objectives achievement

Moreover, all of student built the design of experiment by following these steps:

3.1. Define each member's role and responsibility

3.2. Determine the goals

- Learn and understand the process of making pudding
- Identify the things influencing the taste
- Determine factor and its levels, interaction of factors (if any), block and its block (if any)

3.3. Define the measures of quality taste

- Analyze measurement of quality (e.g.: delicacy, elasticity, etc)
- Determine response variable
- Determine the unit of response variable

3.4. Verify feasibility (rough estimate)

- Estimate the time for running one experiment
- Consider the time limitation (100 min for all experiment)
- Consider the materials limitation
- Estimate the adequacy data (do we need replication?)

3.5. Design the experiment (precise estimate)

- Choose the design of experiment type
- Determine the replication
- Recheck the feasibility

3.6. Collect the data by conducting the experiment

3.7. Process the data and draw the conclusion

4. Result and discussion

After the role playing was designed and implemented for one semester. In the implementation, obstacles were encountered that the preparation of tools and materials for experiment were limited and self-supporting. However, the role playing was successfully carried out and the evaluation as follows.

4.1. Fascinating learning process was reached

Based on the observation during the learning process, it was found that the students reflected a comfortable attitude in class activities. In this condition, the academic atmosphere could be well built so it facilitated the understanding of Qualty Engineering course. The indicator of this success was shown by the lecturer GPA coming from students' feedback in the end of semester, and course GPA.

4.2. Verbal and written communication in meeting, experiment and presentation was excellent

Communication competencies were well reached in the role-playing activity. The types of communication observed were written communication and verbal communication. The lecturer observed it during group meetings, experiment and presentation.

4.3. Teamwork and thinking critically skill were built

During the Quality Engineering course, there was a harmonious and conducive academic atmosphere. In this academic atmosphere, good teamwork and thinking critically were developed. Those are shown by the good goal achievement in each activity even though there were some obstacles, limitation and scenario. Although the survey and experimental activities was self-supporting, there was good management particularly in the division of roles and responsibilities. Therefore, the planned activities could be well and smoothly carried out.

4.4. The understanding of course was easily achieved

Due to the conducive academic atmosphere, students' understanding of the course could be well done. This was indicated by the acquisition of accumulated mark in midterm. The following figure was the distribution of accumulated marks in midterm.

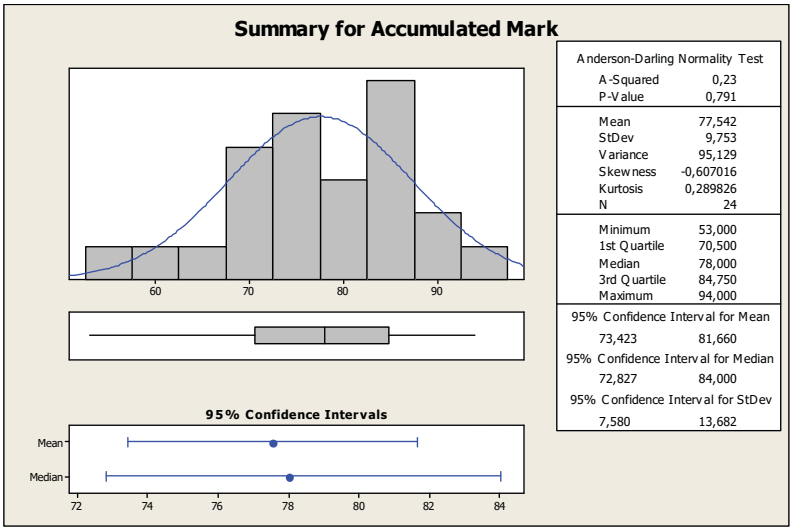

Figure 2. Descriptive statistics for accumulated mark in midterm.

Accumulated mark was obtained by processing the quiz results, midterms mark and experiment mark. Experiment mark was obtained from the assessment of the methodology implementation in the designed experiment to solve the problem. This had been explained in the implementation of role playing. Based on Figure 2, accumulated mark in midterms has an average grade of 77.5, which means very good. In addition, the bar graph shows that many students get the score between 80 and 90. In precise value, 84 will be obtained as the mode value. By using the Andrew Darling method to test the normality, p-value of 0.791 is obtained which is greater than the alpha value of 0.05. It means that do not reject null hypothesis. Here is the pair of the hypotheses:

H0: NTS data is normal distributed

H1: NTS data is not normal distributed

Thus, it can be concluded that the distribution of accumulated mark is good because it follows normal distribution characters.

4.5. Discussion

In its implementation, there was a gap between planning and reality. At the beginning of semester, lecture had conveyed the role of students as research and development department teams. It was expected that students will carry the role during a semester for all activities. However, this role looked very prominent in experiment activity which was presented from the good organization, leadership style and member management during the R&D meeting and experiment. While the process of delivering the course was not like in employee training. It tended to one-way teaching from lecturer to students. This problem was caused by the role induction to students, which was not able to deliver intensively because there was an influence from other courses with different learning method. However, considering the good results of this method, it is necessary to discuss how to build ambient so that the role induction and scenarios are not interrupted with other factors. Moreover, the results obtained are more optimal. Thus, the evaluation for the next role-playing implementation is necessary to reaffirm the role of students regularly.

5. Conclusion

Based on the evaluation result, it was concluded that the role playing for Quality Engineering course was able to build the conducive academic atmosphere. All students had actively involved in every activity and had been able to place their self into certain role. By using this method, the central

tendencies of mark are 77,5 for mean, 78 for median and 84 for mode. Thus, we can draw that students can easily achieve Learning Objectives in a fascinating way.

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Preface

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PREFACE

The Third International Conference on Innovation in Engineering and Vocational Education (ICIEVE) 2019, hosted by Universitas Pendidikan Indonesia (UPI), was held on 26 November 2019 in Mason Pine Hotel Bandung, West Java, Indonesia. The conference aims at providing a platform for scientists, scholars, engineers, industrial professionals, and researchers to exchange, share and discuss their innovation, experiences, research works and problem-solving techniques in all issues in engineering and technical vocational education.

As the previous two conferences did, this year's conference also involved keynote speech and parallel sessions whose proceedings are published by IOP Conference Series indexed by Scopus and other internationally reputable indexers. To have a more in-depth discussion, this year's ICIEVE invited four speakers as follows (1) Prof. Dr. Astrid Seltrecht, a professor of Didactics of Health and Nursing sciences at Otto von Guericke Universeity Magdeburg, Germany; (2) Prof. Dr. Frank Bunning, and appointed professor of technical education and didactics at Otto von Guericke University Magdeburg, Germany; (3) Prof. Dr. Ida Hamidah, a professor at the Faculty of Technical and Vocational Education, Universitas Pendidikan Indonesia, Indonesia; and (4) Prof. Maizam Alias, a professor from Faculty of Technical and Vocational Education, UTHM, Malaysia.

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Table of contents

Volume 830

2020-04-01

← Previous issue Next issue →

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Open all abstracts

042010

The utilization of local bamboo based materials for innovation of playing and creating media in children age of preschool

P Purwanto

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E Prasetyaningsih, P Renosori and M Satori

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A H Nu'man, L Nurwandi, I Bahtiar and S Omar

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A Aviasti, R Amaranti and N Nugraha

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Y S Rejeki, E Achiraeniwati, N R As'ad and N Hadiid

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A N Rukmana, A Aviasti and R Amaranti

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Synthesis and characterization of chitosan-bentonite modified polyurethane with biomedical potential

T Rihayat, S Suryani, S Riskina and N Nurhanifa

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S Suryani, T Rihayat, N Nurhanifa and S Riskina

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R Ridwan, T Rihayat, S Suryani, A S Ismi, N Nurhanifa and S Riskina

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R Rusmana, A A Melkias, N Nurrohman and I M W Kastawan

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Investigation of reducing electricity consumption in the refrigerator by using domestic refrigerant MC-22

M Mutaufiq, E T Berman, K Sumardi, A Wiyono and I M Gandidi

View article PDF

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Design of an on-off control system and a new display via internet based on Arduino Uno with application to window A/C

E Ertham and R Samudra

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E T Berman, M Komaro, M Miftakhudin, M Mutaufiq and A Suherman

View article PDF

OPEN ACCESS 042034

Web-based real time air properties display application

A Badarudin, P Pratikto and M A Falahuddin

View article PDF

OPEN ACCESS 042035

Optimization of B-series propeller geometry dimension to improve traditional fishing ship performance

D Mulyana, F Koeshardono, A Sudradjat and R Y Widiatmoko

View article PDF

OPEN ACCESS 042036

Development of an algorithm code concept to match the diesel engine and turbocharger

M M A Gifari, S Sriyono, I Mubarak, R A M Noor and T Permana

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Terrain genetic unit for spring-based regional development in mountains in Indonesia

D N Usman, F Hirnawan, S Widayati and S Sriyanti

View article PDF

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Correlation of rock characteristics to gold content in the Honje Formation and Cipacar Formation, Pandeglang, Banten

D N Usman, N Sulaksana, F Hirnawan, I Haryanto, S Widayati, S Sriyanti and L Pulungan

View article PDF

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Coal handling quality from pits to stockpiles to market specifications

L Pulungan and V Arbianto

View article PDF

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P Pramusanto, A Nurrochman, H E Mamby and P Nugraha

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Monitoring of mine waste from copper ore flotation

L Pulungan, D N Usman, E A Kurniawan and R A Galiano

View article PDF

OPEN ACCESS 042042

Deformability analysis of anisotropic rock

I K Wijaksana

View article PDF

OPEN ACCESS 042043

Hydrological monitoring in open PIT mining areas using geodatabase attribute in Geographic Information Systems (GIS)

N F Isniarno, G Aziz and I Iswandaru

View article PDF

OPEN ACCESS 042044

Optimization and slope stability coal mine with dewatering system using limit equilibrium method

I Iswandaru, N F Isniarno and R F Hirnawan

View article PDF

OPEN ACCESS 042045

Groundwater study in Subang Industrial park and its recharge area as a suggestion for establishing recharge and discharge zones of Subang Groundwater Basin

Y Ashari, L Pulungan, I K Wijaksana, N F Isniarno and D Mildan

View article PDF

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Identification of characteristics of the Kutawaringin Gold Ore Vein, Bandung, Indonesia, based on its alteration level in the bond work index test

S Solihin, P Pramusanto and D Guntoro

View article PDF

OPEN ACCESS 042047

Analysis of velocity groundwater in unconfines aquifer zone using infiltration measurement

N F Isniarno, R Amukti, R Nurhasan, A Rahmagustiar and G I Prahasta

View article PDF

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Gold water treatment, waste monitoring, and management with the fitoremediation method

L Pulungan, Z Zaenal, Y Ashari and F Megantara

View article PDF

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Increasing the performance of silica modified quaternary triammine for sorption of Gold(III) Ion

N Ngatijo, D R Gusti, R Bemis and A H Fadhilah

View article PDF

OPEN ACCESS 042050

Development of data communication trainer with hands-on and remote laboratory hybrid system

N D Jayanto, A B Pantjawati, E Haritman, B Mulyanti, N Nurhidayatulloh and L A Pratama

View article PDF

OPEN ACCESS 042051

Development of Internet of Things (IoT) based learning media in efforts to improve student skills at the industrial revolution era 4.0

J Kustija, D L Hakim and H Hasbullah

View article PDF

OPEN ACCESS 042052

Remote desktop system in IoT and HTML 5-based virtual laboratory for HMI (Human Machine Interface) practicum and hydraulic simulation

N D Jayanto and J Kustija

View article PDF

OPEN ACCESS 042053

Design of Graphical User Interface (GUI) on IoT-based remote laboratory for Programmable Logic Controller (PLC) practicum and pneumatic simulation

L A Pratama and J Kustija

View article PDF

OPEN ACCESS 042054

Implementation of Building Information Modelling (BIM) Revit to meet the needs of the construction industry

F N Aryanti, R R T Busono and S Siswoyo

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Didactical design of Organic Light-Emitting Diodes based on the Nature of Science and Technology

R F Marsya, A Mudzakir and F Khoerunnisa

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OPEN ACCESS 042056

Seismic multiattribute for predicting reservoir properties: Case study of globigerina limestone reservoir, Madura Strait

A Prakoso and A Haris

View article PDF

OPEN ACCESS 042057

Role playing as experiential learning method for quality engineering education

R D Wahyudi and M A Hadiyat

View article PDF

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