Power System Analysis Course Learning: A Review

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Abstract: ***This article discusses about issues and solutions of power system course to be made as a development reference for improvement. The method used is descriptive analysis by article studying which published from year of 2001 to 2018, and from other sources. For achievement of competency and problems solving happened in this course, there are solutions offered in literature review. Based on that literature review, there are learning solutions that has been applied by previous researchers are 32% using learning model, 26% using simulation (software), 21% using combination (of simulation, experiment, and model), 21% using education or laboratories tools.***

Index Terms: Power system analysis, literature study, problem and solution

I. INTRODUCTION

Power System Analysis Course is a mandatory course of major or study program in electrical engineering field. That course is branch of electrical sciences that learns about electrical power system fields, related with generation system, transmission, and electrical load/power. Generally, this course discusses how to generate, transmit electrical power to users, and to analyze and evaluate phenomena often occurs in electrical power system, how the relation between components integrates with each other to achieve a goal to fulfill load requirement.

This course has concept of evaluation, analysis, and creation about phenomena from a very difficult and observe system and counted variable value related with this system, such as current, voltage, power flowing in that system, between system relations, involving complex mathematical calculation. In a board field of study, there is improvement design towards system from evaluation result and phenomena analysis happened in the system. Therefore, there has to be one way or method which is conducted to have competency achieved.

Along with advancement in Communication and Information Technology area nowadays, it can be utilized in education field such as to assist implement learning activity in competency achievement. Many electronic devices in the form of computer programs used for learning, as known as e-learning (electronic learning) namely: CAI (Computer Assisted Instruction) or CAL (Computer Assisted Learning), learn via internet, GIS (Geographic Information System) education, school website, etc. Therefore, in accordance with Communication and Information Technology advancement, learning function not only as function of teachers or lecturers, but also has function as education sources utilization used by learners to study by themselves [1].

Rapid development of electrical technology has own challenges in teaching that course. On the other side, improvement in communication and information technology has important role to assist learning activity. Review in this article has goal to express many kind of problems and solutions in power system analysis course. The method used is literature study with descriptive analysis.

II. STUDY AREA AND DATA

Quest of journal article or reading material reviewed in this article are sourced from these sites below:

http://ieeexplore.ieee.org/Xplore/home.jsp,
http://www.sciencedirect.com/science/journals,
https://www.eric.com/journals

Sites selection criteria applied is required from association and or institution providing accredited journal article or proceeding publishing service, reputable and has been indexed internationally such as Scopus. Next, do a search on web page using key words: teaching power system analysis, learning power system analysis, and science education in power system. Based on search conducted, obtained preliminary data on IEEE as much as 52 articles, 20 articles from Science Direct, 50 articles from ERIC. Obtained preliminary data total is 122 articles.

Further, do a screening for all articles while applying criteria as below:

1. Article publication year from 2012 to 2018
2. Article titles have to contain one of these words: teaching of power system analysis, learning of power system Analysis, and science education in power system.
3. In the abstract explain briefly about one of these words: teaching of power system analysis, learning of power system analysis, and innovation education in power system analysis.
4. Articles have passed peer-review, written in English, and can be downloaded.

After doing selection and screening, based on article criteria provisions which meet the requirements for literature review, on each database of

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the web site page as shown in Figure 1 until final data obtained as shown in Table 1

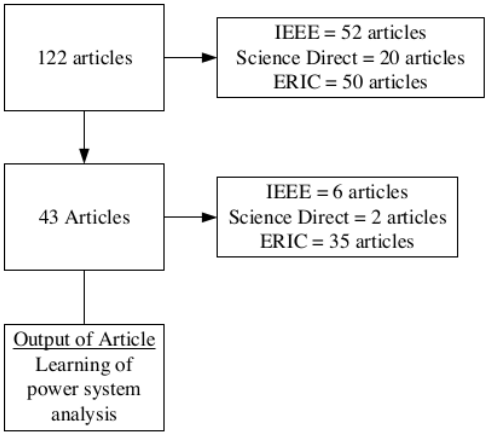

Figure 1. Article screening process that reviews ASTL learning

Table 1. Total of reviewed article

No	Publishing Journal Institution	Amount
1	IEEE	6
2	ScienceDirect	2
3	Eric	35
Total		**43**

From a total of 43 articles as reading materials to be studied and grouped based on publication year from 2018 to mid as much as 5 articles, year 2017 as much as 5 articles, year 2016 as much as 5 articles, year 2015 as much as 16 articles, year 2014 as much as 7 articles, year 2013 as much as 2 articles, and year 2012 as much as 1 article. There are several authors have more than 1 articles. Total of final data is re-verified to obtained certainty that those articles meet all the criteria to be included in review by reread all the articles.

III. RESULT AND DISCUSSION

Result of articles review explained that learning for power system analysis course found to be have many problems, but many kind of solutions offered. Findings from literature study divided to 2 tables, namely diverse problems table and solutions table. The first one to be revealed is diverse problems, then diverse solutions. Problems such as lack of effectivity and efficiency in teaching and learning, lack of students interest in following lecture, lack of teaching tools, hard to understand the concept, limitation in providing teaching tools fund, students' relatively low average grade, not achieving competence, low learning motivation, etc. Table 2 as below is result of exposure and summary from article reviews contain problems related to power system analysis course.

Table 2. Problems related to power system analysis course

Ref.	Problems
[2]	Distributed generation optimization matter.
	Unbalanced load requires 3 phase power flow tools to be analyzed.
[3]	Conventional education method handles OHL balanced operation, often incomplete because of lacking experimental research.
[4]	Preparing an interactive and flexible tools that can be used by students to examine free method control, without involving in programming.
[5]	Electrical engineering text books usually limit the relations between theory and practical work in power system harmonics.
[6]	Lack of student's motivation and focus in learning.
[7]	Improving student comprehension about concept and involvement in class.
[8]	Revolution of student viewpoint about power engineering scope.
[9]	Fundamental difficulty in understanding a.c circuit analysis concept.
[10]	Difficulty in designing, applying, and evaluating an automatic feedback control. How to train student's team work in a project.
[11]	How to establish electrical problem through various problems constructivist approach (PBL), implemented in electrical course.
[12]	How development of electrical power control system trials computer-based for advanced students in Electric Power Engineering is.
[13]	Lack of concept understanding, so it is difficult to produce products from learning.
[14]	Graduate competency is not achieved, lack in understanding concept and practice.
[15]	Low understanding of students about operation system due to lack of equipment.
[16]	The need of education revolution in power system area to fulfill industrial requirement.
[17]	Observation the role of model and education simulation of electrical engineering based on taxonomy bloom.
[18]	There are pedagogical challenges to improve student's learning. Weak ability of engineering/sciences.
[19]	Complex problems in electrical power engineering education. Re-structure education process, form of teaching and course contents (curriculum reform).
[20]	Difficulty in visualize and interpret complex power current manually due to modelling transient behavior equation is differential equation system and equations that model steady-state behavior is hyperbolic (exponential) equations.
[21]	Difficulty in understanding and lack of student interest in learning complex matters in transient power system.

[22]	How to take a learning approach in isolation coordination of electrical engineering curriculum. What suitable model used so students easily understand about isolation coordination.
[23]	How to build science bachelor in Electrical Engineering Program that has knowledge, involvement, interactive, and sustainable.
[24]	How to make bachelor and postgraduate student easily understand, solve problems, and analyze electrical power operation system.
[25]	Very complicated problems contemporary knowledge-based, problem-based to create high level thinking.
[26]	Lack of student HOTS ability when solving problems.
[27]	PBL impact assessment towards student high level thinking.
[28]	Lack of analytical thinking ability in studying, comparing new concept from conventional learning.
[29]	Encounter complex conceptual understanding in fundamental communication system
[30]	Different response towards PBL in several different courses that applied without assistance from lecturer and clear structure.
[31]	Lack of student skills in product-based learning.
[32]	Learning quality shift from traditional to critical thinking learning.
[33]	Low student high level thinking in learning mathematic.
[34]	Creative thinking has not been formed for structure engineering bachelor in search of design solution.
[35]	Lack ability to understand value calculation of transmission economy.
[36]	Examine student's perspective from collaborative marine biology learning.
[37]	Efforts to establish more student-centered education, learning environment, build more realistic experimental assignment, and involve students more in strengthen real world scientific phenomena.
[38]	Complex electrical tools, complex structure characteristics, involving many sciences, various disciplines, difficulty in real form system simulation, many equipment running in high temperature, high pressure, high voltage, and other extreme and dangerous environments, real experiment has high risk, high energy consumption, high cost, not all practically related teach professionally can be done in real production tools.
[39]	The need of simple tools which will facilitate student and lecturer to verify their solutions to reduce time usage.
[40]	One of the option to ensure requirements in education modernization is using virtual reality tools such as simulator, adding immersion factor and interactivity in student learning process.
[41]	How to learn performance of a electrical tools to easily understand by utilize tools as substitution of real form.
[42]	Electrical power system is complete, non-linearity, complicated calculation, difficulty in analyze power system principles given.
[43]	Graduates do not meet the competences according to the jobs needed and lack of skills in create employment.

From various problems found in learning especially in power system analysis in Table 2, problems can be grouped as shown in Figure 2.

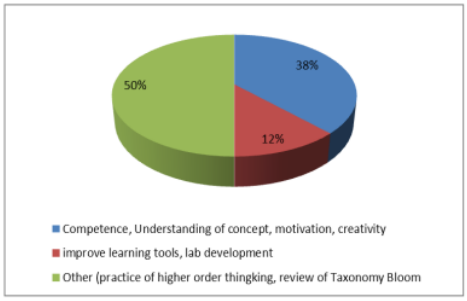

Figure 2. Learning problems of power system analysis course

In this literature review, as problems happened there are many solutions offered for researchers to overcome those problems which focusing on strategy, method or model developed such as: Project based learning/PjBL, Problem based learning/PBL, Computer Based Learning/CBL, using simulations, education tools or in form of lab, and combinations between model with visualization, simulation with experiment, etc. Solution for those problems can be shown in Figure 3.

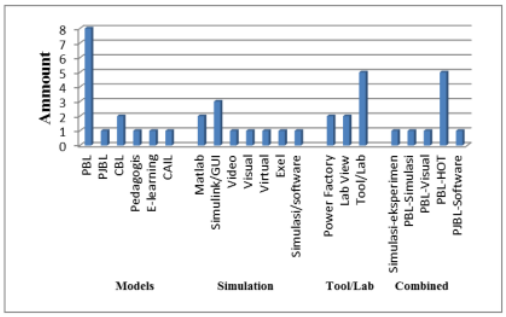

Figure 3. Learning solutions of power system analysis course

This article does not discuss about result of literature review, but focusing about what solution can be given after conducting review as shown in Figure 4 below. Stated solutions shown as below will be the main discussion topic.

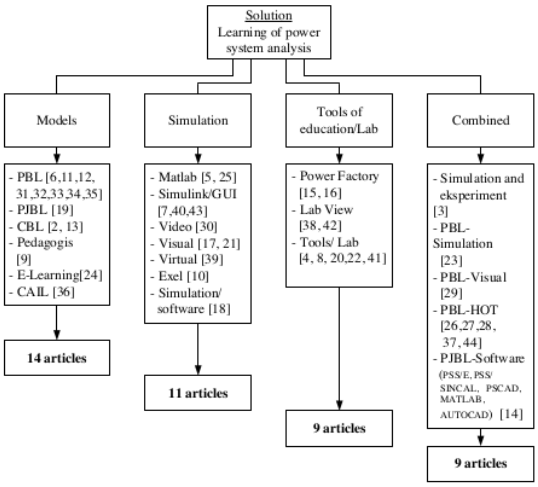

Figure 4. Output of literature review towards ASTL learning

Solution that has been conducted to overcome problems for power system analysis course can be summarized (in percentage) as shown in Figure 5.

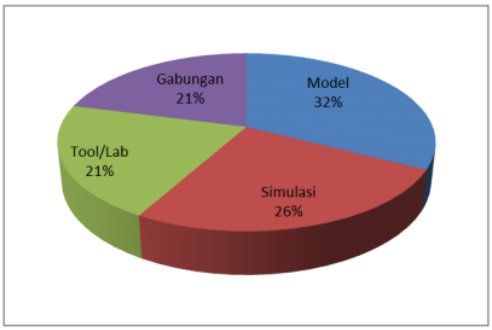

Figure 5. Solution percentage towards power system analysis course problems

Usage of simulation percentage is greater than other parts, because indeed for learning analysis of power system along with abstract material in form of phenomena analysis, loaded with mathematical calculation, very necessary in visual/simulation as substitution of real form from that system.

Conceptually, learning is a process of change namely behavior change as a result of interaction with its environment in fulfilling its life needs. Learning is a process of efforts which individuals do to obtain a generally new behavior change, as a result of its own individual experience in interaction with its environment. Learning is process where an activity is originated or changed through reactions against encountered situation, as long as characteristic of its activity change cannot be explained as trend of fundamental response, maturity, and temporary. While studying/teaching is a conscious effort done by lecturer to educate students to be willing and able to learn.

Learning can be done through many ways, by observing and listening, work alone as well as work in team, giving reason logically and intuitively, and remembering, visualizing, and modeling it. Learning process would be optimal if learners actively involve. At least, when student participates in discussion or when they deliver materials to their friends, 70% of entire materials will be remembered.

Teaching that should have happened is teaching which gives rise to learning for competence achievement. In other words, desired learning (teaching which rises learning) is effective learning for competence achievement. Professional lecturers are lecturers who have competence: personality, professional, pedagogical, and social ability to conduct effective learning for competence achievement. Competence-based learning principle is measurable by whether or not competences are achieved.

Learning paradigms nowadays should have shifted from traditional to modern system, from lecturer-centered to student-centered learning.

Electrical power system is a complete system, high voltage, expensive equipment and difficult for students to directly conduct experiment in the field. Therefore, in learning requires a method or way which can replace complex system by simulating, visualizing, measuring, calculating the amount as a replacement of real form, to be analyzed, finding and solving complete problems from its own system as well as mathematical calculation [42] [38], so that builds strong conceptual understanding and achieve competence, improve motivation, and collaboration [29][28].

IV. CONCLUSION

Conclusions for this literature review result are difficulty in understanding concept, lack of student motivation due to complex material, system phenomena that is hard to understand and analyze, requirement with mathematical calculation, difficult to provide and observe system directly, therefore solutions needed as efforts to resolves them. Researchers offer solutions such as: implementing several models in learning, providing simulations as substitution of real form of real system, etc.

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Zulfatri Aini obtained her S.T (1996) in Electrical Engineering. She has worked experience about 5 years (2000-2005) as Lecturer at Sekolah Tinggi Teknik Padang, Indonesia, and (2006-until Now) as Lecturer at Electrical Engineering, Faculty of Sains and Technology, Universitas Sultan Syarif Kasim, Riau, Indonesia. Aini started her master course in Electrical Power System (2003-2005) at Universitas Gadjah Mada (UGM). After her master she became at Sekolah tinggi Teknik Padang as Lecturer up to 2006. Her current research focuses on Power System, Power Electronic and Energy Audit, especially.

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1

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