

Application of Explanation Models for Increasing Level Understanding of Civil Engineering Students in Sanitary Engineering Course¹

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ABSTRACT

Sanitary engineering is a mandatory course and basic science for student of civil engineering education. Sanitary engineering accommodate three learnt domain, there are cognitive, affective and psycho motor. Although all components of learning already supported by adequate infrastructure of learning but learning achievement of civil engineering education still lower. Product development of learning in a form of explanation model proposed for explaining learning materials of sanitary engineering so that learning achievement of students better than before. The main goal of the research is producing and seeing explanation model implementation in materials of sanitary engineering for increasing understanding level of students of civil engineering education. Research method is developmental research. Research location is in class of sanitary engineering of civil engineering education in FPTK UPI Jalan Dr Setiabudhi 207 Bandung 40154. Research started in beginning of August 2007 until November 2007. Subject of the research is lecturer of sanitary engineering and object the research are students of civil engineering education in odd semester of 2007/2008. Precision of standard operational procedure and explanation models for explaining 14 materials in class of sanitary engineering could be increasing understanding level of students of civil engineering education. Research continuation, forum group discussion and workshop need to be done in the future in order to the success criteria of the developmental research of sanitary engineering fully can be reached appropriate with expectation of peoples. Special guidance and appreciation for all students need to be done by lecturer in order to be identified difficulties of learning of sanitary engineering what sources from external factors or internal factors of students them self. Quantities of correction of understanding level in sanitary engineering not become only and only indicators of success level of developmental explanation models of sanitary engineering learnt, but must be considering qualities of correction of understanding level of civil engineering education students in sanitary engineering.

Key words : sanitary engineering, explanation model, developmental research, lecturer of sanitary engineering, students of civil engineering, standard operational procedure, increasing understanding level, research continuation, forum group discussion, workshop.

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INTRODUCTION

Background

Program of study of Third Diploma (D₃) degree in Civil Engineering organized in Faculty of Technology and Vocational, Indonesia Education of University, its purpose to producing technicians and supervisors in Civil Engineering who have competence. Competence of technicians and supervisors in civil engineering must including Civil Engineering works that studied from developmental phases, that are SIDCOM (survey, investigation, design, construction, operational and maintenance).

Facts in the real world indicate that development in Civil Engineering works are quicker, in settlement and housing development also, road constructions and water buildings which have causal impact to around of environment. Progression of science and technology which quicker not been equal by capacity institution of technology and vocational presenting infrastructure that adequate to organize learning process that capable following science and technology changes. The characteristic of technology and vocational study having theoretic and practice courses that must be studied by students for getting learning objectives. Synergic efforts of theoretic and practice course which supported by infrastructure that adequate hoped can increasing understanding level, attitude and skill of students in technology and vocational study.

Sanitary Engineering is a mandatory course that studied by students. After studying course of Sanitary Engineering, students hoped having capability explaining, identifying, measuring and predicting causal impact of activities of Civil Engineering development to environmental components of physics, chemistry, biology and social economic which including types and characteristics of pollution of water, air, soils and economic, social changes; and knowing basic concept of sanitation of settlement environment, radiology aspect to public health, eradication and prevention of vectors of diseases; system of drinking water management, waste water and final solid waste management and destruction: Planning of settlement zone that secure and healthy and infrastructure recruitment which using analysis of Geographical Information System.

Learning that using expository approach in speech, question and answer methods that were fully with LCD and OHP uses and inquiry approach, that are personal assignment (partial assignment) and group assignment, discussion and papers presentation. Mastery learning of students through mid semester examination, final semester examination and assignment evaluation that are papers.

Results of evaluation of Sanitary Engineering learning activities indicating students achievement in Sanitary Engineering course still not satisfy although students and lecturer presentation already fully requirements ; syllabus, handout and unit of learning program/agenda already presented; references already presented. Researcher guessing causes of students achievement in Sanitary Engineering course which not already satisfying are models of material deliveries that complicated, so that researcher proposing explanation model as one of its solution. Explanation model having comprehensive characteristic, presented by graphics, diagrams, brief, easy and practically.

Table 1. Result of sanitary engineering evaluation in even semester 2006/2007

Year	Quality letter						Total
	A	B	C	D	E	BL	
2003	-	-	-	-	1	-	1
2005	24	16	-	-	8	8	
Total	24	16	0	0	9	8	57
%	42,05 %	28,07 %	0 %	0 %	15,78 %	14,10 %	100 %

Problems Formula

Technology and vocational education for Civil Engineering works one of its requiring graduates having understanding, attitudes and skills that linked with study about environmental impact assesment that caused by civil engineering development. After followong this course, students hoped having capability explaining basic concept of environmental sanitation of settlement, water pollution, air pollution, soils, radiology aspects to public health, industrial hygiene, vectors disease eradication; explaining technology of water drinking supply; explaining technology of waste water drainage; explaining process of city solid waste management; expplaining factors and requirements of building that earthquake resistance, explaining characteristic of healthy house, land, healthy infrastucture for settlement zone.

The main problem in the research is not already exactly known contribution and role of understanding of Sanitary Engineering theory in program of study of Civil Engineering, Indonesia Education University to student skill and undertanding in finishing problems about environmental impact assesment that happened cause of development in Civil Engineering that its implicate will be impactable to learning quality of student of Civil Engineering at all and its long time of study.

Assumption in the research linked with learning members, learning process and role of lecturer. Assumptions in the research that are :

1. Learning members having difference ability in understanding learning materials of Sanitary Engineering,
2. Learning process that done already fulfilling effort rule on time, completed learning infrastructure and autonomy of learning members in form of 15 books of references and 16 meetings class discussion,
3. Sanitary engineering lecturer mastering material substances of Sanitary Engineering and variation of learning models in form of teaching experiences of Sanitary Engineering since 1991.

Scope of research limited only on learning activities of Sanitary Engineering in Civil Engineering Department, Faculty of Technology and Vocational, Indonesia Education of University in even semester, academic years 2007/2008.

Problem formula base on background that already proposed that are : “How are forms of explanation models in materials of Sanitary Engineering can be increasing understanding level of Civil Engineering students ?”

Main problem in the research described in research questions that are :

- a. How are forms of standard operational procedure that accurate to explain 16 materials of learning of Sanitary Engineering so that increasing understanding of Civil Engineering students ?

- b. How are forms of explanation models that accurate to explain 16 materials of learning of Sanitary Engineering so that increasing understanding of Civil Engineering students with practically, simple, quick and accurate ?
- c. How are forms of explanation models that accurate to explain materials that formed Sanitary Engineering application that procedural, practically, quick and accurate so that increasing of learning result of Civil Engineering students in Sanitary Engineering course ?

Research Purpose

Main purpose of research base on main problem formula that is producing and seeing explanation model implementation in material of Sanitary Engineering for increasing understanding of Civil Engineering students in Civil Engineering Department, Faculty of Technology and Vocational, Indonesia Education of University.

Between purpose of research that are :

- a. Producing and seeing standard operational procedure implementation that accurate to explain 16 materials of Sanitary Engineering learning so that increasing understanding of Civil Engineering students,
- b. Producing and seeing explanation models implementation that accurate to explain 16 materials of Sanitary Engineering learning so that increasing understanding of Civil Engineering students with practically, simple, quick and accurate,
- c. Producing and seeing explanation models implementation that accurate to explain learning materials in form of application that procedural, practically, quick and accurate so that increasing result of learning of Civil Engineering students in Sanitary Engineering course.

Research Benefit

Benefits of research that got are :

- 1. For Indonesia Education University, identifying weakness variables that must be revised linked with courses and application of technology for students of Technology and Vocational.
- 2. For program of study of Civil Engineering, Faculty of Technology and Vocational, Indonesia Education of University, knowing and implementating priority scale with proportional allocation of education infrastructure of Civil Engineering program for increasing learning quality at all and quicking time of study.
- 3. For researcher, input for revising learning process of Sanitary Engineering so that mastery level in theory of Sanitary Engineering increased.

METHODOLOGY

Research Method

Research method that used for explanation models development in learning materials of Sanitary Engineering for increasing understanding of Civil Engineering students is developmental research.

Subject and Object

Research subject is lecturer of Sanitary Engineering and object are Civil Engineering students of Third Diploma (D₃), Faculty of Technology and Vocational, Indonesia Education of University who taking Sanitary Engineering course in even semester, academic year 2007/2008.

Research Time and Location

Research started from early of September 2007 until November 2007. Research location in learning class of Sanitary Engineering, program of study of third diploma (D₃) in Civil Engineering, Faculty of Technology and Vocational, Indonesia Education of University, Dr. Setiabudhi 207 street, Bandung 40154,

Research Procedure

Research procedure are :

- a. Doing beginning study, that are : class observation, problem analysis and causal analysis in learning of Sanitary Engineering,
- b. Doing planning, that are : identification, definition, competency, purpose formulation and learning phase of Sanitary Engineering,
- c. Developing type and form of beginning product in form of preparing materials of learning, formatting hand book, formatting evaluation instruments and preparing instrument for learning of Sanitary Engineering,
- d. Doing beginning trial test that are : getting expert respondents in study course, learning media, learning methods and expert judgement,
- e. Doing revision to product base on inputs and recommendations from experts,
- f. Doing limited trial test (empiric) with deciding respondents of users candidate for knowing fine level of product (learning effectivity, easy and interesting),
- g. Doing second revision base on inputs and recommendations from limited trial test.
- h. Doing field tested with objects of users candidate of products with wider scope,
- i. Doing product revision base on recommendation in field trial tested and ready used.

Research Instrument

Research instrument is tested that pre test, first post test and second post test. Research instrument that 48 problems for evaluating understanding level of students in 16 learning materials of Sanitary Engineering.

Data Analysis

Data analysis done with percentage analysis and successful criteria that will be got in research are:

- a. Lowest of learning achievement of students increasing from 25 % to 45 %,
- b. Highest of learning achievement of students increasing from 80 % to 90 %,
- c. Fixed reference assessment can be implemented in learning result of students with normal distribution trend,
- d. Amount of students who were re medial less 15 % with mastery level from 45% to 55 %.

REFERENCE STUDY

Developmental Research Methods

Research method for development containing 3 components, that are : (1) developmental model, (2) developmental procedure and (3) product trial test.

1. Developmental model is basic for developing product that will be produced. Developmental model can be procedural model, conceptual model and theoretic model. Procedural model is model that descriptive characteristic that indicating phases that must be followed to producing product. Conceptual model is model that

analytic characteristic which called product components, analyzing componets in detail and indicating relationship between components that will be developed. Theoritic model is model which illustrating mind frame that based on relevant theories and supported by empiric data. In developmental model, researcher must get attention 3 matters :

- a. Illustrating structure of model that uses with brief, as base of product developer.
 - b. If model that used adapted from existed mode then need to be explained a reason choosing model, components that adapted and strength and weakness of model than its original model.
 - c. If model that used developed by theirselves then need to be described about components and relationship between components that includes in development.
2. Some examples of developmental model of learning product explained that are.
- a. Developmental model learning design by Dick and Carey (1996).
This model including 10 components or phases that are:
 - 1) Identifying learning needs and deciding general purpose of learning.
 - 2) Learning analysis with identifying skill and attitude in the beginning.
 - 3) Analysis of student characteristic and context.
 - 4) Formulating purpose of special attitude.
 - 5) Developing instrument of evaluation.
 - 6) Developing learning strategy.
 - 7) Choosing and developing material of learning.
 - 8) Designing and doing formative evaluation.
 - 9) Revising learning package.
 - 10) Designing and doing summative evaluation.
 - b. Model of learning design that developed by Kep (1977) through phases :
 - 1) Deciding general purpose.
 - 2) Identifying student character.
 - 3) Formulating special purpose of learning.
 - 4) Developing and choosing material of course.
 - 5) Doing beginning assessment.
 - 6) Developing strategy and doing learning activities with using learning sources.
 - 7) Using supported infrastructure for learning.
 - 8) Doing evaluation, reflection and revision.
 - c. Developmental model of learning product assisted computer (LAC) that developed by Sutopo (2003) through 6 phase, that are :
 1. *Concept*, concept development done with problem identification, formulating purpose, analysis of learning needs, analysis of student characteristic (level, experience of computer ability), planning and formatting software of learning material.
 2. *Design*, designing product done through 2 phases, that are : (a) designing software including physic design, function design and logic design, (b) developing flow chart for visualizing flow of product work from beginning until finish.
 3. *Collecting materials*, activities that course material collection that needed for product making, like : main material (substance of study), supporting aspects, like : animation picture, audio as illustration, clip art image, graphic etc.

4. *Assembly* is formatting material script of learning that entered to every frame that called screen mapping.
 5. *Trial test* for seeing product range that made can be getting purpose and objective. Good product fulfilling 2 criteria are instruction criteria and presentation criteria. Trial test done 3 times, that are: (1) expert test done with respondents, designers, multi media experts, study expert, (2) limited test done to small group as product users, (3) field testing.
 6. *Distribution* is activities that learning product distribution to product users. Objective of product users including personal sources (lecturer, teacher, instructor, trainer) and learning subject (graduate students, students, learner) school, training and education institution etc.
- d. Instructional system design developed by Leshin, Pollock and Reigeluth (1992). This model through 4 phases that every phase explained being some sub phases, that are :
1. Need analysis, including problem identification, analysis of ability domain or competency (cognitive, affective, psycho motor).
 2. Choosing and sorting material that are contain analysis of main material, supported material and sequential assignment.
 3. Developing learning strategy, including: situation analysis, learning activities analysis, developing interactive message in learning process.
 4. Evaluating learning activities and result.

System Analysis and Modeling

System definition are : (1) system is group of individu that are section of population, group population that are section of community etc. System with different scale and accuracy level can be studied using principal and technical instrument that general used appropriate with theory of general system. (2) System with same scale and accuracy level can be overlapped, system that studying dynamic of species A population can be overlapping with an other system that studying dynamic of species B population if both species are competitor to an other. That must attended by us is about centre of attention to problem that happened. We have to attend system boundary for solving problem that present. Not trivial matter doing beginning phase in system analysis.

Model is summary of real world. Model also is formal description of main problem section, because of section of main problem that we decided is centre of system study that we developed so definition of model is formal description of system with centre of study. Model can be physic model. Mathematic or verbal although some models purposed for words model but the language usually having many meaning (Jeffers, 1978).

Model can be grouped to many ways (Jeffers, 1978). Some dichotomy criteria of model for model development need, that are (1) physic model versus abstract, (2) dynamic model versus static, (3) empiric model (correlative) versus mechanistic (explanatory), (4) deterministic model versus stochastic and (5) simulation model versus analytic.

Four basic phases in developmental process and system model uses (Jeffers, 1978): (1) formulating conceptual model, (2) featuring quantitative model, (3) model evaluation and (4) model uses.

Purpose of system analysis are : (1) to develop a concept or system model qualitative that we study, (2) to develop a system model quantitative that we study, (3) to assess level of model uses linked with objectives that we wanted and (4) to answer questions that known in the beginning of modeling project.

Four phases of system analysis have close relationship. Although theoretic we can think that process progressing sequence, but practically we do that phases more than one time. For that phase continuing, we can identify errors or mismatch sections in a system or process that must revised so that we must go back to beginning phase, sometimes also revision of conceptual model formulation or revision of quantitative model specification.

Causal Consequence Diagram

Causal consequence diagram that derived from system analysis that considering phases of material presentation of learning material of Sanitary Engineering:

1. Causal consequence diagram of environment and development
2. Causal consequence diagram of settlement sanitation, settlement hygiene, food and drinking hygiene, industrial hygiene
3. Causal consequence diagram of air pollution, water pollution, radiology aspects to health, eradication vectors of disease
4. Causal consequence diagram of water drinking sources, requirements of water drinking and water drinking processing
5. Causal consequence diagram of water drainage
6. Causal consequence diagram of waste water sources
7. Causal consequence diagram of waste water treatment
8. Causal consequence diagram of introduction of solid waste and empiric condition in the real world
9. Causal consequence diagram of final solid waste location
10. Causal consequence diagram of solid waste destruction by incinerator and compost
11. Causal consequence diagram of healthy house
12. Causal consequence diagram of geographic information system
13. Causal consequence diagram of land suitability classification for irrigation
14. Causal consequence diagram of land suitability evaluation for settlement and development.

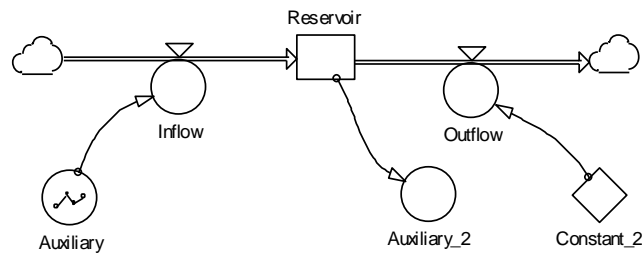
Flow Chart

Flow chart is functional model from causal consequence diagram that designed in past phase and needing information about variables classification in flow chart base on identifier, unit dimension, cumulative characteristic and relationship characteristic. Variable classification in flow chart can be grouped to be:

- a. Reservoir or level,
- b. Inflow or rate input,
- c. Outflow or rate output,
- d. Auxiliary,
- e. Constanta.

Cumulative characteristic only had by reservoir or level variable and only can be linked by inflow and outflow that mathematic function are integral function ($\text{flow} = \pm d(\text{Reservoir}) / d(\text{time})$).

Auxiliary can be linked with auxiliary, constant and reservoir by arrow that non delay or delay.



Picture 1; Symbols that used in flow chart (Muhammadi, Aminullah, Soesilo, 2001)

RESEARCH RESULT AND DISCUSSION

Research Result

Result of developmental research of explanatory model of learning material Sanitary Engineering for increasing understanding of third diploma Civil Engineering students that are:

1. Number of pre test of Civil Engineering students third diploma degree and difficulty level problems of Sanitary Engineering,
2. Number of first post test of Civil Engineering students third diploma degree and difficulty level problems of Sanitary Engineering,
3. Number of second post test of Civil Engineering students third diploma degree and difficulty level problems of Sanitary Engineering,
4. Explanatory models of learning material of Sanitary Engineering for 15 times of learning,
5. Handout of learning material of Sanitary Engineering for 15 times of learning.

Discussion

Number of pre test of Civil Engineering students third diploma degree and difficulty level problems of Sanitary Engineering

Number of pre test of Civil Engineering student third diploma degree for 29 students in Sanitary Engineering before gave explanatory model that are:

1. Students who very understand in Sanitary Engineering course with criteria mastery level $\geq 85\%$ are no student or 0%.
2. Students who understand in Sanitary Engineering course with criteria mastery level $75\% \leq x < 85\%$ are 4 students or 13.79%.
3. Students who enough understand in Sanitary Engineering course with criteria mastery level $55\% \leq x < 75\%$ are 12 students or 41.38%.
4. Students who less understand in Sanitary Engineering course with criteria mastery level $45\% \leq x < 55\%$ are 9 students or 31.03%.
5. Students who not understand in Sanitary Engineering course with criteria mastery level $< 45\%$ are 4 students or 13.79%.

Difficulty level problems of pre test of Sanitary Engineering that are:

1. Problems that very difficult with criteria amount of students who have right answer $0\% \leq x < 20\%$ are 8 problems or 16.67%.

2. Problems that difficult with criteria amount of students who have right answer $20\% \leq x < 40\%$ are 20 problems or 41.67 %.
3. Problems that enough difficult with criteria amount of students who have right answer $40\% \leq x < 60\%$ are 20 problems or 41.67 %.
4. Problems that easy with criteria amount of students who have right answer $60\% \leq x < 80\%$ are 0 problems or 0 %.
5. Problems that very easy with criteria amount of students who have right answer $80\% \leq x < 100\%$ are 0 problems or 0 %.

Number of first post test of Civil Engineering students third diploma degree and difficulty level problems of Sanitary Engineering

Number of first post test of Civil Engineering student third diploma degree for 29 students in Sanitary Engineering after gave explanatory model that are:

1. Students who very understand in Sanitary Engineering course with criteria mastery level $\geq 85\%$ are no student or 0 %.
2. Students who understand in Sanitary Engineering course with criteria mastery level $75\% \leq x < 85\%$ are 6 students or 20.69 %.
3. Students who enough understand in Sanitary Engineering course with criteria mastery level $55\% \leq x < 75\%$ are 21 students or 72.41 %.
4. Students who less understand in Sanitary Engineering course with criteria mastery level $45\% \leq x < 55\%$ are 2 students or 6.897 %.
5. Students who not understand in Sanitary Engineering course with criteria mastery level $< 45\%$ are 0 students or 0 %.

Difficulty level problems of first post test of Sanitary Engineering that are:

1. Problems that very difficult with criteria amount of students who have right answer $0\% \leq x < 20\%$ are 2 problems or 4.17 %.
2. Problems that difficult with criteria amount of students who have right answer $20\% \leq x < 40\%$ are 5 problems or 10.42 %.
3. Problems that enough difficult with criteria amount of students who have right answer $40\% \leq x < 60\%$ are 7 problems or 14.58 %.
4. Problems that easy with criteria amount of students who have right answer $60\% \leq x < 80\%$ are 13 problems or 27.08 %.
5. Problems that very easy with criteria amount of students who have right answer $80\% \leq x < 100\%$ are 21 problems or 43.75 %.

Number of second post test of Civil Engineering students third diploma degree and difficulty level problems of Sanitary Engineering

Number of second post test of Civil Engineering student third diploma degree for 29 students in Sanitary Engineering after gave explanatory model that are:

1. Students who very understand in Sanitary Engineering course with criteria mastery level $\geq 85\%$ are 2 student or 6.897 %.
2. Students who understand in Sanitary Engineering course with criteria mastery level $75\% \leq x < 85\%$ are 10 students or 34.48 %.
3. Students who enough understand in Sanitary Engineering course with criteria mastery level $55\% \leq x < 75\%$ are 16 students or 48.28 %.
4. Students who less understand in Sanitary Engineering course with criteria mastery level $45\% \leq x < 55\%$ are 1 students or 3.49 %.

5. Students who not understand in Sanitary Engineering course with criteria mastery level $< 45\%$ are 0 students or 0% .

Difficulty level problems of second post test of Sanitary Engineering that are:

1. Problems that very difficult with criteria amount of students who have right answer $0\% \leq x < 20\%$ are 2 problems or 4.17% .
2. Problems that difficult with criteria amount of students who have right answer $20\% \leq x < 40\%$ are 3 problems or 6.25% .
3. Problems that enough difficult with criteria amount of students who have right answer $40\% \leq x < 60\%$ are 8 problems or 16.67% .
4. Problems that easy with criteria amount of students who have right answer $60\% \leq x < 80\%$ are 10 problems or 20.83% .
5. Problems that very easy with criteria amount of students who have right answer $80\% \leq x < 100\%$ are 25 problems or 52.08% .

Explanatory models of learning material of Sanitary Engineering for 14 times learning.

Explanatory models of learning material of Sanitary Engineering for 14 times learning presented 14 sheets model, that are:

1. Material of environment and development presented in 1 sheet model.
2. Material of settlement sanitation, settlement hygiene, food and drinking hygiene, industrial hygiene presented in 1 sheet model.
3. Material of air pollution, water pollution, radiology aspects to healthy, eradication of disease vectors presented in 1 sheet model.
4. Material of drinking water sources, requirement of drinking water and water drinking processing presented in 1 sheet model.
5. Material of drainage system presented in 1 sheet model.
6. Material of waste water sources presented in 1 sheet model.
7. Material of waste water treatment presented in 1 sheet model.
8. Material of solid waste introduction and empiric condition in the real world presented in 1 sheet model.
9. Material of final solid waste place presented in 1 sheet model.
10. Material of solid waste destruction by incinerator and compost presented in 1 sheet model.
11. Material of healthy house presented in 1 sheet model.
12. Material of geographic information system presented in 1 sheet model.
13. Material of land suitability classification for irrigation presented in 1 sheet model.
14. Material of land suitability evaluation for settlement and development presented in 1 sheet model.

Handout of learning material of Sanitary Engineering for 14 times learning.

Handout of learning material of Sanitary Engineering for 14 times learning presented in 77 sheets, that are:

1. Material of environment and development presented in 4 sheets model.
2. Material of settlement sanitation, settlement hygiene, food and drinking hygiene, industrial hygiene presented in 3 sheets model.
3. Material of air pollution, water pollution, radiology aspects to healthy, eradication of disease vectors presented in 3 sheets model.

4. Material of drinking water sources, requirement of drinking water and water drinking processing presented in 5 sheets model.
5. Material of drainage system presented in 4 sheets model.
6. Material of waste water sources presented in 6 sheets model.
7. Material of waste water treatment presented in 8 sheets model.
8. Material of solid waste introduction and empiric condition in the real world presented in 8 sheets model.
9. Material of final solid waste place presented in 4 sheets model.
10. Material of solid waste destruction by incinerator and compost presented in 10 sheets model.
11. Material of healthy house presented in 4 sheets model.
12. Material of geographic information system presented in 2 sheets model.
13. Material of land suitability classification for irrigation presented in 9 sheets model.
14. Material of land suitability evaluation for settlement and development presented in 7 sheets model.

CONCLUSION AND RECOMMENDATION

Conclusion

1. Implementation of accurate of standard operational procedure for explaining 14 learning materials of Sanitary Engineering can be increasing understanding of Civil Engineering students.
2. Implementation of accurate of explanatory model for explaining 14 learning materials of Sanitary Engineering can be increasing understanding of Civil Engineering students by practically, simple, quick and accurate.
3. Implementation of accurate of explanatory model for explaining material in form of calculate application of Sanitary Engineering that procedural, practically, quick and accurate can be increasing result of learning of Civil Engineering students in Sanitary Engineering.
4. Passing grade criteria that got in research that are:
 - a. Lowest of learning achievement of students increasing from 25 % to 45 % already got because lowest of learning achievement of students (pre test) from 37.50 % to 45.83 % (first post test) and 56.25 % (second post test).
 - b. Highest of learning achievement of students increasing from 80 % to 90 % already got because highest of learning achievement of students (pre test) from 79.17 % to 83.33 % (first post test) and 89.58 % (second post test).
 - c. Fixed reference assessment can be success implemented in learning result of student with normal distribution trend.
 - d. Amount of students who re medial less than 15 % (< 5 students) with mastery level between 45 % until 55 % already got in research because amount of students who re medial less than 9 students (pre test) become 3 students (first post test) and 1 student (second post test). For mastery learning of students who re medial already got because mastery level from 37.50 % (pre test) become 45.83 % (first post test) and 50 % (second post test).

Recommendation

1. Revision and perfection effort of standard operational procedure implementation which accurate for explaining 14 learning materials of Sanitary Engineering in form of next research, forum group discussion and workshop need be done in the future so that some criteria of successful developmental research of learning activities of Sanitary Engineering can be fully got appropriate with hoped of all stakeholders.
2. Revision and perfection effort of explanatory model implementation which accurate for explaining 14 learning materials of Sanitary Engineering in form of next research, forum group discussion and workshop need be done in the future so that some criteria of successful developmental research of learning activities of Sanitary Engineering can be fully got appropriate with hoped of all stakeholders.
3. Revision and perfection effort of explanatory model implementation which accurate for explaining materials of calculate application of Sanitary Engineering which procedural, practically, quick and accurate in form of next research, forum group discussion and workshop need be done in the future so that some criteria of successful developmental research of learning activities of Sanitary Engineering can be fully got appropriate with hoped of all stakeholders.
4. Success criteria that got in research that are:
 - a. Special guidance to student who have lower learning achievement (50 %) need be done by lecturer in order to be identified difficulties of learning of Sanitary Engineering source from external factors (environment) or internal factors from student himself (1 student).
 - b. Appreciation for student with highest learning achievement (89.58 %) feasible given in order to be more actual for student himself and others students motivated for better achievement.
 - c. Fixed reference assessment after implementing explanatory model of learning of Sanitary Engineering feasible used in order to be quality of understanding level of students in Sanitary Engineering course permanently can be endured in the future with different group of Civil Engineering students.
 - d. Revision of quantity of understanding level of some students in Sanitary Engineering course its feasible not only became indicators of successful level of explanatory model development of Sanitary Engineering, but also must be deciding revision of quality of understanding level of Civil Engineering students in Sanitary Engineering course.

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