Chemistry Education Students' Science Process Skills, in Specific and in General Content

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Abstract--This study aims to obtain the value of the estimated index of Science process skills (SPS) of students in the specific content (SPS-ISC) against the SPS score in general content (SPS-IGC). The SPS-ISC score is set based on the student's answer in answering questions developed based on the SPS indicator on the content of Physical Chemistry 3 (chemical kinetics). The SPS-IGC score is set based on the student's answer in answering questions developed based on the SPS indicator on the content that occurs in daily life. For assessing SPS-IGC used instrument assessment developed Monica (2005). Target research are students in Chemistry Education Study Program Year 2017 consist of class A, Class B, and International Class. Ex-post facto research draft and the withdrawal of conclusion using a linear regression analysis technique. The value of the estimated SPS-ISC score index against the SPS-IGC score was represented the R^2 price of the regression analysis results with SPS-ISC as the Predictor and SPS-IGC variables as critical variables. The results of the index estimation (R^2) SPS-ISC score against SPS-IGC scores on students of PKA, PKB, PKU, and combined classes (combined data of three classes) in consecutive 0.80; 0.97; 0.93; and 0.91 that can be categorized. The meaning of the results is that the SPS achievement efforts through the study of PC3 were able to estimate successive 80, 97, 93, and 91% against the achievement of SPS-IGC students PKA, PKB, PKU, and combined classes. The efforts of the next skill creation, especially the SPS through lectures are able to estimate 91% SPS students when faced with the issue in daily life.

Keywords: SPS-*isc*, SPS-*igc*, estimation index

I. INTRODUCTION

Problem solving in science is the scientific method [1]. Science process skills (SPS) are important elements in the scientific method [2]. According to Ozgelen [3], SPS is a thinking skill used by scientists to build knowledge in order to solve problems and formulate results. Based on these propositions, SPS is an important element for problem solving skills (PSS). SPS is a moderator thinking skill for PSS. PSS is one of the 21st century thinking skills demands [4]. PSS by Trilling & Fadel is included as the expert thinking of a group with critical thinking skills. Considering that SPS is an important element of PSS, when PSS is stated as a 21st Century demand skill, SPS must be inherent. That is, SPS also includes thinking skills demands of the 21st century. In order for graduates of educational institutions to have adequate SPS, efforts should be made to develop SPS through structured and massive learning. So that the chemistry education graduates produced by the FMIPA Unesa Chemistry Education Study Program have adequate SPS, it is necessary to develop SPS. Bachelor of Chemistry Education graduates from the Faculty of Mathematics and Natural Sciences are certainly prepared to become 2013 curriculum participants when they go to school. The 2013 curriculum was developed based on the framework of 21st Century Skills. Within the framework of 21st century competence shows that being knowledgeable (through core subject) is not enough, one must be equipped with creative-critical thinking skills [5].

One of the strategies adopted to improve student SPS is to involve students in activities that facilitate the practice of process skills in course learning. Suyono, Nasrudin, & Yonata have developed Structured Lecture Materials (SLM) in Physical Chemistry 3 courses designed to create SPS exercises for each student [6]. The lecture material is then given the name SLM-PC3 SPS. Through the SPS SLM-PC3 each PC3 course student participant is given an understanding of SPS and is then asked to practice SPS implementation on the substance of chemical kinetics. Narration for efforts to understand students about SPS and directions for the practice of SPS implementation documented in the SPS SLM-PC3 script, including the provision of space to write down the results of thought given by students. This SPS implementation exercise through SLM-PC3 does not eliminate the integrated SPS exercises in face-to-face lectures. PC3 lectures assisted by SPS SLM really meet the principles of science learning as stated by the National Science Educational Standard (NSES).

According to NSES, learning science is something that must be done by students not something done to students. Learning science is an active process. Furthermore, according to Koballa & Chiapetta in science learning students are required to actively learn which is implied in physical or mental activities, not only covering hands-on activities but also minds-on activities [7]. Science learning based on content standards will form students who have a body of knowledge, process standards will form students who have scientific skills, thinking skills and thinking strategies), scientific inquiry standards will form students who are able to think critically and creatively (or critical and creative thinking); assessment standards evaluate students in learning

(authentic assessment). PC3 lectures assisted by SPS SLM aim to train SPS implementation as one of the minds-on and not eliminate integrated SPS exercises in face-to-face lectures.

Why does SPS still have to be trained? SPS is one element of the thinking skills possessed by each individual as well as argumentation skills, critical thinking skills, and others. Thinking skills are not an ability that can develop by itself along with human physical development, but must be trained through the process of providing a stimulus that requires a person to think [8]. How can SPS be trained? SPS can be trained through deliberate efforts for SPS development through the learning [3]. Jack reminded learners, if SPS is not integrated into the learning process, if SPS is not trained in learning, it is feared that students will memorize facts and develop negative attitudes towards science [9]. The importance of SPS training for students has actually been recommended by Woolfolk for a long time. Woolfolk states that SPS exercises can be done by assigning students to explore, test, observe, and organize information [10]. This thinking activity can change the thinking process of students / students and lead to the development of more complex thoughts. In line with Woolfolk, Jack states that SPS has a big influence on education because it helps students to develop higher mental processes such as problem solving, critical thinking and making decisions [9].

The formulation of the problem solved through this research is how is the estimation index or estimation of SPS training results on PC3 content (specific content) to SPS on various content in daily life (general content)? When the dependency relationship between SPS-isc and SPS-igc gives a large R^2 value, the deliberate effort to develop SPS through PC3 can be chosen as one of the actions in SPS preparation in life. SPS is an important element of PSS. When the SPS-isc dependency relation to SPS-igc gives a large R^2 value, a deliberate effort to develop SPS through Physical Chemistry3 can be chosen as one of the actions in PSS preparation.

II. METHOD

The study design was ex-post facto. The fact that was exposed was the Chemistry Education student SPS score on PC3 content (SPS-isc) which was positioned as a predictor variable and on content or phenomena in daily life (SPS-igc) which were positioned as criterion variables. The target of the research is the Bachelor of Chemistry Education Study Program class of 2017 that is programming Physics Chemistry 3 courses consisting of PKA classes, PKB classes, and PKU classes. Student SPS data on specific content, namely student scores in answering questions in the SPS SLM-PC3. The questions in the SPS SLM-PC3 are developed based on SPS indicators as can be seen in Table 1. Student SPS data on general content is the student's score in answering 30 SPS questions developed by Monica [10]. The SPS assessment instrument developed by Monica is limited to 4 (four) SPS components, namely identifying and controlling variables, stating hypotheses, operational definitions, graphing and interpreting data, and experimental design. The content of the material in the Monica SPS assessment instrument is more general or closer to everyday phenomena. The SPS specifications, indicators, and number of SPS items developed by Monica are presented in Table I.

TABLE I SPS SPECIFICATION, INDICATOR, AND NUMBER OF QUESTION

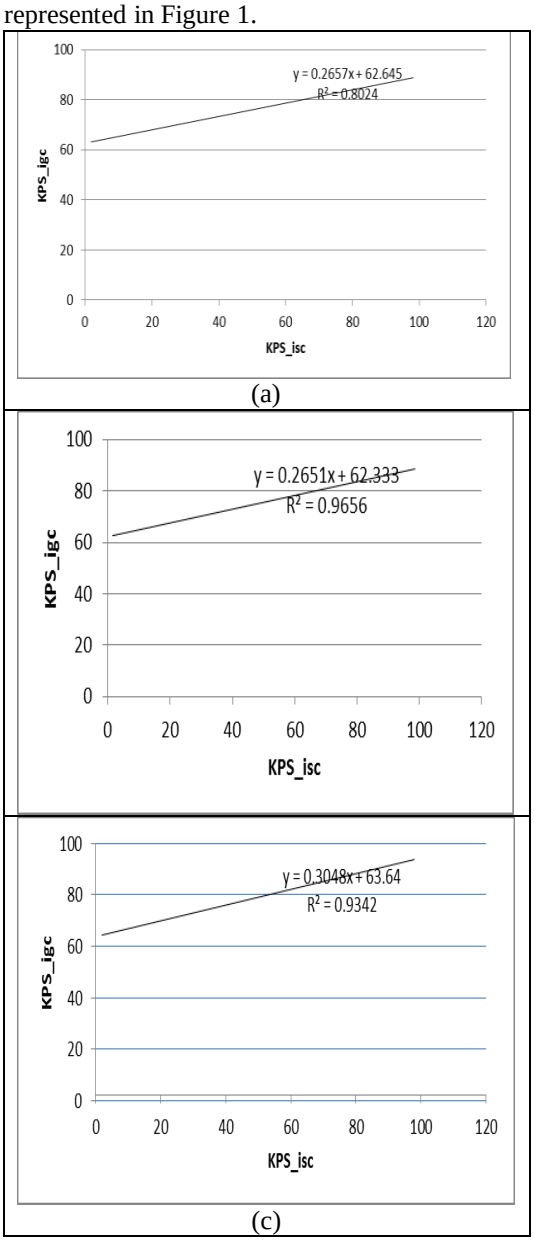
No	Integrated SPS	Indicator	Question	Amount
1.	Identify and control variable	Able to identify independent variables, dependent variables, and control variables if given a description of a research activity.	2, 6, 19, 25, 28, 29, 30	7
2.	States the hypothesis	Able to identify hypotheses to be tested to solve problems that contain dependent variables and independent variables.	8, 12, 16, 20, 23, 26	6
3.	Operational definition	Being able to express an operational definition of research variables that are verbally stated.	1, 7, 10, 18, 21, 22	6
4.	Designing research	Being able to choose the right design to test a hypothesis.	3, 13, 15	8
5.	Draw graphs and interpret data	Being able to identify the relationships between variables from the graphs and data tables of a research result.	4, 5, 9, 11, 14, 17, 24, 27	3
Total	5 integrated SPS	5 indicator of SPS		30 ques-tions

The characteristics of the SPS assessment instrument developed by Monica are reported as follows. The average difference in the power of the items (overall discrimination index) is 0.40 [10] which is quite good. The mean index (level) of the item difficulty for SPS components identifying and controlling variables, stating hypotheses, operational definitions, graphing & interpreting data, and experiment design were respectively 0.43; 0.42; 0.35; 0.42 and 0.36 [10]. Item items are stated to have a moderate level of difficulty if the index is 0.40-0.70; an index below 0.40 is difficult; and an index above 0.7 items is declared easy. The reliability of the 0.81 SPS assessment sheet is in the good reliability range of 0.70-1.0 [10]. The SPS assessment sheet developed by Monica has good differentiation, a moderate and difficult

difficulty index, and has a good personality. Single linear regression analysis was performed with SPS-isc as a predictor while SPS-igc as a criterion. In this regression analysis it is not intended to measure the strength of the relationship between the SPS-isc and SPS-igc variables, but is intended to make estimates or predict SPS-igc based on SPS-isc. The conclusion of the analysis is based on the price R^2 (estimated index) [12]. The value of R^2 represents the amount of variation in the criterion variable (SPS-igc) which can be explained by the predictor variable (SPS-isc).

III. RESULTS AND DISCUSSION

The results of a single linear regression analysis between SPS-isc data as a predictor and SPS-igc as a criterion that occurs in S1 Chemistry study program students class A (PKA), Chemistry Education class B (PKB), and Chemistry Education Leading classes are represented in Figure 1.



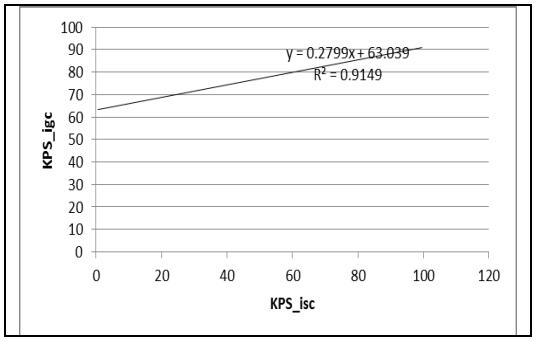


Fig 1 Linear Regression Curve and Estimated Index Value between SPS-isc and SPS-igc. For PKA Students (a), PKB (b), PKU (c), and PK-combination (d).

If the data is observed in Figure 1, the value of intercept in PKA, PKB, PKU, or PK-combination class above number 60. Without treatment in the form of process skills training in PC3 content, students from all three classes have the third SPS faced with daily issues. All students of the academic education study program FMIPA Unesa year 2017 has had the SPS above the 60 number at a score interval of 0-100. The experience of thinking gained from the life and practice of exploring, testing, observing, and organizing the information that happened in the learning class before PC3 learning led to the development of more thought skills Including the SPS as previously stated by Woolfolk [11]. The fact it has had enough SPS on the students did not then stop the efforts of increasing student thinking skills needed to face the global challenges and/or the demands of the 21st Century [4]; [5]. Efforts to improve thinking skills including the SPS are the responsibility of all courses and must be carried out continuously and continuously. Content in each course is an attraction or vehicle for training thinking skills that are precisely needed in the lives of graduates rather than content mastery alone.

When the SPS-ISC and SPS-IGC dependency relationships provide a large R^2 value, the deliberate effort to develop the SPS through a Physics Chemistry 3 lecture can be chosen as one of the actions in SPS preparation in life. SPS essential Elements of PSS [2]; [1]. When the SPS-ISC dependency relationship to SPS-IGC delivers a large R^2 value, the deliberate effort to develop the SPS through a Physics Chemistry 3 lecture can be chosen as one of the actions in PSS preparation. If the R^2 price is observed in Figure 1 for each class of all three target classes or combined classes, then the SPS of chemical education students on general content have not been perfectly able to be estimated based on SPS in specific content, not found R^2 value = 1. Index estimation (R^2) on student PKA, PKB, PKU, and PK-class combined in a row of 0.80; 0.97; 0.93; and 0.91 that can be categorized large. The discovery of this high estimate index (R^2) value is aligned to what Jack has ever discovered. Jack states that the SPS have a major influence on education as it helps learners to develop higher mental processes [9]. The discovery of this high estimate index (R^2) is strengthening the proposition that researchers have proposed earlier that the SPS need to be trained in every lecture [3]. When the SPS is explicitly trained in the PC3, through the

implementation of SLM-PC3 SPS and then proved to have an index of estimates against the high general SPS, then the fears Jack that the student will memorize the facts and have Negative attitudes towards science can be overcome [9].

IV. CONCLUSION AND RECOMMENDATION

a. Conclusion

SPS-ISC Estimate index (R^2) against SPS-IGC scores on students of PKA, PKB, PKU, and combined classes (combined data of three classes) in consecutive 0.80; 0.97; 0.93; and 0.91 that can be categorized. The meaning of the results is that SPS achievement efforts through PC3 learning are able to estimate the consecutive 80, 97, 93, and 91% against the achievement of SPS-IGC students PKA, PKB, PKU, and combined classes. The efforts of the next skill creation, especially SPS through lecturing are able to estimate 91% of SPS students when faced with daily issues.

b. Recommendation

SPS as one of the thinking skills can take place on the learning of other chemical courses. In order to be able to meet the demands of the 21st century, the graduates are expected to provide emphasis on the incidence of SPS training in their studies. The mainstreaming of SPS-exercises is not only given to face-to-face activities, but can be given in the form of structured assignments.

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