The Effect of Electronic Portfolio Assessment Model to Increase of Students' Generic Science Skills in Practical Inorganic Chemistry

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Abstract

Electronic portfolio assessment (EPA) is an assessment procedure based assessment for learning which a collection of student work collected digitally is. The purpose of this research was to determine the effect of implementation of the EPA model to increase students' generic science skills (GSS) in Practical Inorganic Chemistry. Research was conducted at Chemistry Education Department on preservice teacher programme. The research design was a Pre-test Post-test Control Group Design. Research subjects each consisted of 30 students in the experimental and control Group. Data was collected using GSS test given at pre-test and post-test. Data were analyzed by SPSS version 17.0. The result show that students who used EPA model in the assessment process have increased GSS (mean of N-gain= 0.41) better than those used conventional portfolio assessment (mean of N-gain = 0.14).

Keywords: *electronic portfolio assessment; generic science skills; practical inorganic chemistry*

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Introduction

The importance of the role of assessment in improving the effectiveness chemistry learning in college makes assessment strategies become an integral part of the curriculum design model (O'Connor, 2006). In this case, assessment that included in the assessment strategy is formative assessment, summative assessment, and continuous assessment. Related with the assessment role, Arifin (2011) asserts that the assessment made by the teachers should be comprehensive and continuous. It means that, assessment by educators covering all aspects of competency by using appropriate evaluation techniques, the ability to monitor the progress of learners. Portfolio assessment is one of the example based on classroom assessment that can be used to determine the level of achievement and competence development of learners based on a collection of work from over time.

The implementations of portfolio assessment in teaching at college have been conducted by several researchers (Birgin, 2011; Birgin and Baki, 2007). When it compared with other forms of performance assessment, portfolio assessment has the privilege because it provides a set of processes and documents as evidence of student learning outcomes (Davis and Ponnamperuma, 2005).

Nevertheless, conventional portfolio assessment still has some weakness, such as requiring a lot of storage for documents, a lot of time to provide feedback so it cannot be implemented in a short time and immediately (Wulan, 2009). To overcome these weaknesses, portfolio assessment can provided via the web called electronic portfolio assessment. This assessment can record and monitor the progress of learners (Wyllie, 2010; Pelliccione and Dixon, 2008).

Electronic portfolio is a collection of students which collected by digitally and done systematically and continuously during a certain time period. Implementation of electronic portfolio assessment in learning has been used by several previous researchers (Khoo et al., 2011; Abrami and Barrett, 2005). Khoo et al. (2011) using electronic portfolios to improve the generic skills of communication, critical thinking and problem solving, and team work skills. In this case, implementation of the frame by using the electronic portfolio process cycle "Plan-Do-Review".

The results showed that the practice of assessment in learning can be used to improve the students' generic skills. On science learning, generic skills called generic science skills (GSS). Liliasari (2007) defines GSS as the ability to think and act that the students based on its knowledge of science. The importance of GSS is procured to students' chemistry in college, then Mitchel (2005) asserts that these skills are integrated in the chemistry curriculum. Other researchers (Revelation, 2010; Sudarmin, 2007; Liliasari, 2007, and Suyanti, 2006) are developing GSS through chemistry learning.

Among these studies, the implementation of electronic portfolio assessment has not been used to improve students' GSS. This is the reason why the research conducted.

Research Method

The research design was a Pre-test Post-test Control Group. The research conducted at Chemistry Department on pre-service teacher programme in Palangkaraya. The number of students involved in this study, respectively 30 students in the experimental and the control grou. EPA models was implemented in the experimental Group, while the control Group using conventional portfolio assessment. The components of EPA was implemented in the experimental group that are prior knowledge quiz (PKQ), practiceal journal, student worksheet (SW), and practice report. PKQ and SW were done by online, whereas journal and practice report were being uploaded to exabis E-Portfolio module that is add-on into Moodle system through website http://courses.kimiawan.org. Each task gets feedback, followed by reflection and self-assessment. In the experimental group, data collected by using GSS test provided by online, while in the control group GSS test provided by using paper and pencil test. The test was given pre and post-learning. The subject matter in Practicl Inorganic Chemistry are: (1) synthesis and characterization of sodium thiosulfate pentahydrate; (2) synthesis and characterization complex cis- and trans- potassium diaquodioksalatochromium(III); and (3) determination of coordination number of copper (II) complex. The GSS attainment counted by using N-gain is formulated, that is, $N-\text{gain} = \frac{S_{post}-S_{pre}}{S_{max}-S_{pre}}$, which N-gain is gain normalization, S_{pre} is pre-test score; S_{post} is post-test score; and S_{max} is maximum score. The result obtained is supervised based on category N-gain, that is, $g > 0.7$ (high); $0,3 \leq g \leq 0.7$ (medium); and $g < 0.3$ (low). (Hake, 1999). Data analysis using SPSS version 17.0 with t-test (independent sample t-test) (if the data were normally distributed) or the Mann Whitney test (if the data is not normally distributed) at the significance level $\alpha = 5\%$.

Result and Discussion

The effect of EPA model to increase of students GSS

The effect of APE model to increase students' GSS by calculating GSS students N-gain GSS experimental group and control group, GSS test scores of students both before and after the implementation of the APE Model. Overall data obtained beforehand tested normality. Test results obtained more described as follows. Increase in the mean score of the experimental group GSS is from 29.40 to 58.13, while the control group the mean score was increased from 26.93 to 37.67. Based on the calculation of N-gain (Hake, 1999), N-gain (%) obtained experimental group was 40.80 and 13.63 for the control group as shown in Figure 1.
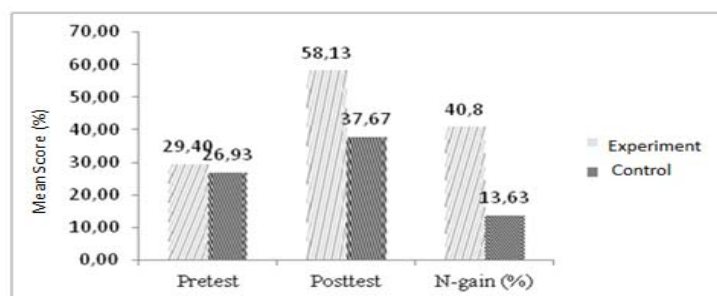

Figure 1 The Mean Score of Pre-test, Post-test , and N-gain Experimental and Control Group

The GSS test results mean difference pre-test, post-test, and N-gain between the experimental group and the control group using SPSS version 17.0 are presented in Table 1. Based on the results of statistical tests found that the average pre-test experiment with the control group did not differ significantly. Instead, the test results and post-test N-gain between the experimental group and the control group showed a significant difference in the $\alpha = 0.05$. Thus can be said that the implementation of APE model affect the increased of students' GSS.

Table 1. Test Results Mean Differences Pre-test, post-test , and N-gain of GSS Score Experiment and Control Group at $\alpha = 0.05$

Class	N	*Pretest*		*Posttest*		*N-gain*	
		Mean	Dev. Std.	Mean	Dev. Std	Mean	Dev. Std
Experiment	30	29,40	7,83	58,13	17,88	0,41	0,24
Control	30	26,93	5,25	37,67	6,95	0,14	0,07
ρ-*value* difference test		0.158*		0.000**		0.000**	
Conclusion		Did not different significantly		Significantly different		Significantly different	

Note: *Independent Test of sample test* (Sig. different< 0,05)
   **Mann-Whitney Test* (Sig. different< 0,05)

The Improvement of Student GSS on Each Indicator

The GSS test results of the improvement for the each indicators shown in Table 2. Indicator one to eleven that are skill of: 1) direct observation; 2) indirect observation; 3) sense of scale; 4) symbolic language; 5) logical frame; 6) logical consistency; 7) causality; 8) modeling; 9) logical inference; 10) abstraction, and 11) spatial.

Table 2 shows the acquisition of mean value of pre-test, post-test , Dev. Std. and N-gain score of experimental group and the control group on all GSS indicators. At the table looked all GSS indicators increased in the experimental group, characterized by a positive value at % N-gain. Similarly, in the control group, in general almost all indicators of GSS increased, except logical frame indicators that have % N-gain is negative.

Table 2. *Pre-test, Post-test* , dan % *N-gain* GSS Mean Score of the Experimental and Control Group

GSS Indic.	Experimental Group					Control Group				
	Pretest		*Posttest*		*N-gain* (%)	*Pretest*		*Posttest*		*N-gain* (%)
	Mean	Dev. Std.	Mean	Dev. Std.		Mean	Dev. Std.	Mean	Dev. Std.	
1	31.67	19.74	50.56	31.40	27.65	26.11	18.43	45.00	20.13	25.57
2	26.67	22.68	47.50	25.72	28.41	23.33	18.49	32.50	24.70	11.96
3	18.33	18.49	60.83	25.16	52.04	31.67	21.71	54.17	22.82	32.93
4	23.33	18.49	73.33	28.57	65.21	38.33	18.26	44.17	20.43	09.47
5	41.11	28.61	43.33	35.18	03.77	51.11	20.96	37.50	31.26	-27.84
6	35.00	19.25	52.78	25.17	27.35	22.78	16.66	28.33	13.94	07.19
7	36.67	22.49	62.50	21.53	40.79	33.33	18.95	34.17	21.27	01.26
8	26.00	18.31	62.67	23.33	49.55	26.67	19.18	36.00	21.27	12.72
9	33.81	16.56	61.43	24.36	41.73	21.90	14.40	37.62	15.23	20.13
10	23.33	20.69	56.67	30.04	43.49	10.83	14.21	19.17	21.46	09.35
11	22.22	23.71	70.00	28.16	61.43	21.11	23.95	25.56	22.63	05.64
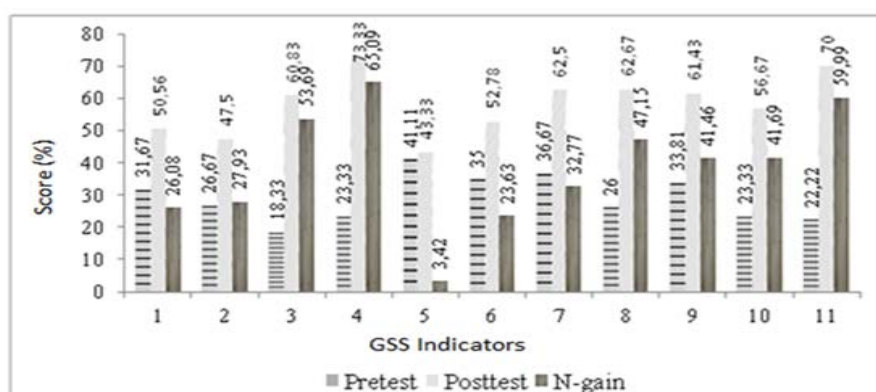
Remark.:

1: Direc Observation	5: Logical frame	9: Logical Inferences
2: Indirect Observation	6: Logical Consistency	10: Abstraction
3: Sence of Scale	7: Causality	11: Spatial
4: Symbolic Language	8: Modeling	

Figure 2. *Pre-test, Post-test* and % *N-gain* GSS Mean Scores of Experimental Group

In the experimental group the highest post-test mean is in symbolic language indicator (73.33) followed by spatial indicator (70.00) and modeling (62.67). Furthermore the biggest % N-gain mean in the symbolic language indicator (65.21%, medium category), followed by spatial indicator (61.43%, medium category) and sense of scale (52.04%, medium category). The mean value of the lowest post-test is the logical frame indicators (43.33) and smallest % N-gain in the experimental group was also the logical frame indicators which are % N-gain of 3.77 with the low category. Description achievements of GSS in the experimental group are shown in Figure2.

Description of the mean percentage score of the pre-test, post-test, and N-gain of control group can be seen in Figure 3. The Figure appears the highest post-test mean on the sense of scale indicators (54.17), followed by direct observation indicator (45.00) and symbolic language (44.17).

The biggest % N-gain achieved by the control group on sense of scale indicator (32.95% medium category), and followed by direct observation indicator (24.36%, lower category) and logical inference (21.14%, category low). While the mean of lowest post-test is on abstraction indicator (19.17) and insight into the space (25.56). The mean percentage of lowest % N-gain is on logical frame indicators (-27.84 %, lower category) and spatialindicator (5.64%, lower category).
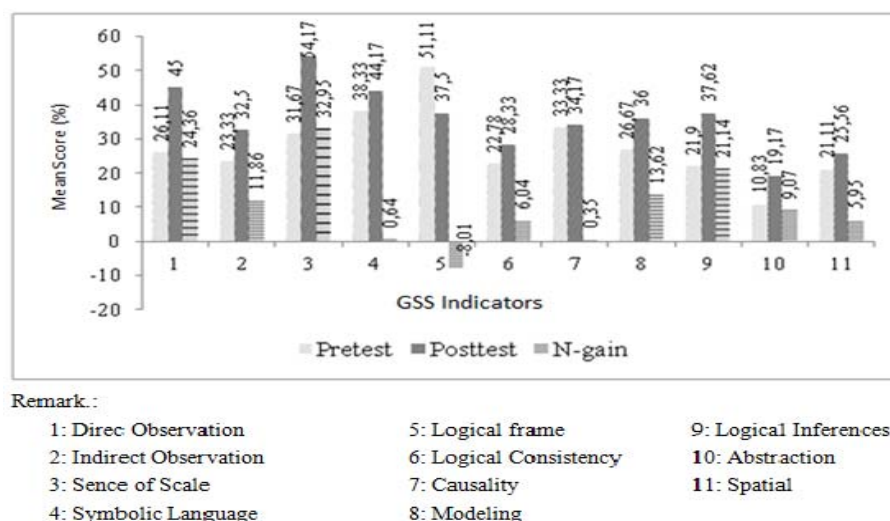
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Figure 2 *Pre-test, Post-test* and % *N-gain* GSS Mean Scores of Control Class

Results of data analysis showed that the model implemented on the APE lab Inorganic Chemistry lectures more effective in improving student GSS Chemistry than using conventional assessment. APE model implementation can be increase the maximum student activity in the portfolio tasks independently and systematically. Through comments / critical feedback given by the assistant / lecturer encourages students to reflect on a systematic and continuous. The role of feedback in electronic portfolios can promote student reflection skills in accordance with the results of Peacock et al. (2011); JISC (2008); Faulkner and Aziz (2011). The existence of feedback given to students to make them more able to overcome difficulties and push theirself to reflect on their learning (JISC, 2008). Thus, students can complete their tasks properly to achieve the expected competencies. APE model can improve better GSS (N-gain = 0.41) than the conventional assessment (N-gain = 0,14). GSS improvement through the implementation of APE models according to some research that researchers have developed several types of generic skills through the implementation of electronic portfolio assessment (Khoo et al., 2011; Peliccione and Dixon, 2008).

In the experimental group, GSS improvement through the implementation of electronic portfolios can be increase the maximum student learning activities through the completion of the task than the control class. The tasks completed by the student gradually, structured, and continuously through a systematic process of reflection at all the times during the learning process. The findings are in accordance with the statement Zubizarreta (in Barrret, 2005) that the reflection done systematically to develop the attitudes, skills, and habits of students who emerges from critical reflection.

APE model implementation in practical subjects could be spurring the increase of student GSS integrated on course assignments. Through feedback given to encourage their duties, they perform of self-assessment as they can prepare for the next tasks well. This means that students GSS can increase in line with the more frequent student tasks associated with GSS. This finding is consistent with the statement Starcic (2008) that the generic skills should be taught as an integral part of the learning activities students and assessed as part of the overall assessment of subject content.

APE model implementation in learning, encourage students to be more active during learning process, especially in preparing the portfolio tasks. The preparation is an ongoing basis so that students can advance their learning. The fact is consistent with some previous research (Wang, 2009; Pelliccione and Dixon, 2008; Bhattacharya and Hartnett, 2007).

In this research, the implementation of APE model can improve GSS symbolic language with N-highest gain. This increase was related to the integration of these indicators at some tasks and quizzes in the portfolio components. Settlement in the matter of MFIs that demands accuracy especially on the writing formulas, symbols, and chemical equations has a significant contribution to improve the GSS.

GSS indicators such symbolic language like write the chemical formula of sodium thiosulfate and complex cis-and trans-potassium dioksalatodiakuokromat (III), using symbolic language to write the equation of the synthesis reaction of sodium thiosulfate pentahydrate, complex cis-and trans-potassium dioksalatodiakuokromat (III) and synthesis of complex copper (II). Experienced a significant increase. While the quantitative skills to understand the meaning of the unit and the amount of a

formula and the equation is not significantly increased because students already have prior knowledge about the experiment to be performed.

The increased of students' GSS among others are also supported by using of IT in the APE implementation. Using computers when working on portfolio tasks facilitate students in making representations to the material for learning process. This is consistent with the results of the study Miliszewska et al. (2009) which states that the generic IT skills focused on the development of critical evaluation, and the use of text, figures and electronic information.

Student activity tasks of portfolio components facilitate them in developing GSS symbolic language. GSS indicator symbolic language is an essential skill needed in learning chemistry. This is consistent with the statement Danili and Reid (2004) that the chemical symbols, formulas and chemical equations are very necessary in teaching chemistry because it is one form of the three levels representation in learning chemistry i.e. macroscopic level, microscopic, and symbolic.

APE models utilize one of the advantages that computers can be used to visualize the structure of the molecular geometry. The advantages of supporting a high increase in the indicator <g> GSS modeling. This is consistent with some previous research (Sudarmin, 2007; Kaberman and Dori, 2008). Indicator modeling generic science skills developed in this studies are: (i) describe the molecular structure of sodium thiosulfate, (ii) interpret the meaning of the molecular structure of the chemical sodium thiosulfate, (iii) describe the structure of the complex geometry of *cis* potassium dioksalatodiakuokromat (III), and (iv) describe the structure of the complex geometry of copper (II).

The use of computer as media in the APE model implementation easier for prospective teachers to understand, describe model of the molecular geometry. Webfolio use in supporting learning in multi-media format has been carried out by Faulkner and Azis (2011). Consolidation and reflection on the tasks in college activities such as drawing, 3D models, photographic images and animations of another computer program called SolidWorks. The result shows that the electronic portfolio can improve the ability of self-evaluation and reflection skills of the students.

There is support in the implementation of technology in the APE model of Inorganic chemistry lab course to support achievement of N-high gain in modeling. GSS insight into space is one of the indicators that have N-GSS high gain. GSS insight indicators describe the skill positions include a ligand-ligand complexes cis-and trans-potassium dioksalatodiakuokromat (III) on the coordinate axes. The use of computers as a medium in the APE model implementation allows students to describe the position of the ligands in complex compounds.

GSS indicator logical frame is an indicator that experienced the lowest increase. Indicator logical frame is a generic ability to think systematically, based on the regularity of the phenomenon (Brotosiswojo, 2001). This indicator was developed through the skills of physical and chemical characteristics distinguish between sodium sulfite as the reagent with sodium thiosulfate as a result of the reaction, the distinguishing characteristic of the complex chemistry between *cis* and trans-potassium dioksalatodiakuokromat (III), and distinguish between complex chemical characteristics tetraakuatembaga (II) complexes with tetraamintembaga (II). The third indicator of the skills can not be improved through the implementation of the APE.

APE model that requires the students to be more active in completing tasks related to the practice of adaptive enough academic achievement for all groups. The student at the bottom of the group can improve their competence in the N-gain medium category. Likely, more motivated student group under the model used. Most (63%) students felt that utilize the advantages of the model ChemSketch program tool in solving practical journals and approximately 54% of students consider that the provision of feedback on the model of APE can improve their competence. This finding is consistent with the results of the study Huang et al. (2012) and Chang and Peng (2008).

Conclusions

The conclusions that can be drawn from the results achieved in this research that are implementation of electronic portfolio assessment has a positive effect on increasing generic science skills of students, and electronic portfolio assessment model effective to increase GSS indicator especially symbolic language, visual spatial, modeling, causality, and logical inference.

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