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Investigation Science Process Skills Among Chemistry Education Student Through the Law of Mass Conversation Experiment

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Abstract
Science process skills (SPS) are important skills that students need to master through practical activities. The purpose of this study was to identify students' SPS in the aspects of observing, classifying, interpreting, using tools and materials, and communicating in practical activities related to the law of conservation of mass. This study employed a descriptive quantitative method with 30 chemistry education students from the Faculty of Teacher Training and Education, Tanjungpura University, as the research subjects. Data were collected through observation and documentation in the form of laboratory reports. The research instrument was an observation sheet. Data was collected through observation and documentation in the form of laboratory reports. The science process skills observation sheet was validated by two experts, showing a validity value of 0.91, which falls into the very high category. The research data was analyzed quantitatively. The research results showed that the average percentage obtained for each KPS indicator for students in the observation aspect reached 87% (very good), classification 83% (very good), interpretation 69% (good), use of tools/materials 83% (very good), and communication aspect 79% (good). Overall, the average percentage of SPS based on student observation was 80% with a good category. Thus, chemistry education students have the ability to conduct scientific investigations, which is an important foundation for prospective chemistry teachers.

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INTRODUCTION

The challenges of the 21st century have driven changes in teaching methods in the Indonesian education system. Factors influencing the success of 21st-century learning include qualified teachers, relevant and integrated curricula, and appropriate assessment tepat (Ilma & Nursia, 2022).To address these challenges, Teacher Education Institutions are striving to produce competent educators capable of developing learning that aligns with the needs of this era (Lepiyanto, 2017). TEIs play a crucial role as key institutions in producing quality educators (Yuanita, 2018). An educator must possess the ability to design and implement learning that aligns with the demands of the 21st century. One skill that needs to be developed is scientific process skills (SPS), which can assist students in conducting scientific investigations and expanding their scientific knowledge (Hulyadi, 2022).

Scientific process skills are a complex set of abilities commonly used by scientists in conducting scientific investigations (Manu & Nomleni, 2018). In addition, scientific process skills (SPS) are used by researchers to discover new things through scientific activities such as research (Manu & Nomleni, 2018). This aims to encourage students to be more active in understanding and mastering various scientific steps, such as observing, classifying,

interpreting, predicting, formulating hypotheses, designing experiments, and presenting results (Prasasti, 2018). By applying KPS, students can expand their knowledge. In general, KPS is the ability to think logically in a scientific context, encouraging students to be more involved in the learning process (Suryaningsih, 2017). Scientific process skills are scientific skills for discovering something (A. H. Rahayu & Angg, 2017). Therefore, students being prepared as prospective educators need to develop and apply KPS in learning activities. By developing process skills, the concepts obtained by students as prospective educators will be more meaningful because their thinking abilities will be more developed. Science process skills include cognitive or intellectual, manual, and social skills (Khery et al., 2019).

Science process skills (SPS) are divided into two categories, namely basic skills and integrated skills (Darmaji et al., 2019). Basic skills are the fundamental abilities required to conduct scientific research or investigations (Tanti et al., 2020). Basic science process skills include observation (observing), classification (grouping), measurement, drawing conclusions, prediction, and communication (Dari & Nasih, 2020). Meanwhile, integrated skills include more complex abilities, such as formulating hypotheses, controlling variables, planning experiments, conducting experiments, analyzing data, and applying concepts (Adiningsih et al., 2019). In addition, KPS also plays an important role in helping students solve research problems (Syazali et al., 2021), deepen their understanding of concepts, and enhance their creativity and innovation skills (Febriyanto, 2016). In studying science, students are required to master basic skills to understand how scientific knowledge is obtained (Putri & Muhartati, 2019).

According to Emda (2017)), practical work can increase students' enthusiasm for learning and stimulate their curiosity. This is very helpful in the process of investigation or research because students are more motivated to seek and discover new knowledge. Practical work itself is carried out at various levels of education, especially in higher education, with the aim of providing opportunities for students to try and conduct experiments directly (Emda, 2017).

Practical work plays an important role in the learning process, especially in the field of chemistry. Chemistry is a science that belongs to the field of science, where chemistry is an experimental science (Sumarti et al., 2018). This is because chemistry is an experimental science that cannot be fully understood by reading, writing, or listening alone (Matsna et al., 2023). The basic chemistry laboratory course is one form of learning that emphasizes practical activities in the laboratory, with the aim of assessing students' scientific process skills (SPS). The SPS of chemistry education students can be seen through the assessment of laboratory reports. These reports serve as a form of presenting facts based on the direct experiences of students during laboratory activities (Sakinah et al., 2018).

Previous research on science process skills has been conducted by Rahayu (2020) with the title "Analysis of Science Process Skills of Students in Basic Analytical Chemistry Practicum" at the University of Sembilanbelas November Kolaka with 20 students. The results of the study showed a percentage of science process skills of 63.43% in the good category. Furthermore, research conducted by Siti Murlia with the title "Science Process Skills (KPS) of Chemistry Education Students in the Basic Analytical Chemistry Practicum Course on Titration" at Halu Oleo University involved 14 students, with the research results showing a KPS of 55.01% for students, categorized as adequate (Murlia et al., 2020). The data indicates that science process skills need to be improved through involvement in laboratory practice. According to Khery et al., (2019), through laboratory practice, students as future chemistry teachers are guided to find their own answers to the problems they face, thereby making learning more meaningful.

However, current assessments focus only on practicum reports, neglecting direct observations of student performance during lab activities. Based on the report value of the 2022 batch of students who have taken the basic chemistry practicum, it is known that the average student

value in each experiment is the experiment of introducing laboratory equipment 75.3; solution making experiment 73.3; Separation of mixtures 69.7; Law of conservation of mass 69.6; Stoichiometry 72.5; Chemical bond 82.1; Enthalpy of reaction 85.5 from these values it is known that the lowest is in the experiment of the law of conservation of mass which is 69.63. This encourages researchers to make observations of science process skills in the law of conservation of mass experiment with the aim of knowing the difficulties faced by students in this experiment and to evaluate the science process skills (SPS) possessed by chemistry education students.

Based on data on basic chemistry practical activities carried out by students and assistants, it was found that assessments focused only on practical reports. Reports are only one part of scientific process skills (SPS), while other aspects of these skills were not assessed. Although practical assignments and reports were assessed, these assessments did not fully reflect the SPS competencies possessed by students. This prompted the researcher to conduct observations by creating an SPK assessment rubric consisting of aspects such as observing, classifying, interpreting, using tools/materials, and communicating in the mass conservation law experiment with the aim of identifying the difficulties faced by students in the mass conservation law experiment.

METHOD

This study used a quantitative descriptive method involving 30 students from the chemistry education program at Tanjungpura University as research subjects. The data collection technique in this study was direct observation during laboratory sessions by six assistant observers using an observation rubric that included assessment formats and KPS criteria to be observed and documentation techniques in the form of practicum reports. The instrument used in this study was an observation sheet. The assessment in this observation sheet used a Likert scale to measure the attitudes, opinions, and perceptions of individuals or groups toward a social phenomenon (Sugiyono, 2016). Each observed science process skill indicator is scored based on five categories of the assessment scale, that is 5 very good categories ,4 good categories, 3 sufficent categories, 2 deficient categories, and 1 very deficient.

The instruments used in this study were modified based on the research by Cahya et al. (2023) and were validated before use. The validity test used the Gregory formula. The validation results showed a value of 0.91, indicating high validity criteria. In this study, the data on the observation sheet were used as data to be analyzed quantitatively, then analyzed by calculating the percentage value for each aspect based on the calculations described (Murlia et al., 2020). The data obtained from the calculations were summarized based on the value interpretation criteria in Table 1 (Murniati et al., 2021)

$$NP = \frac{R}{MS} \times 100\%$$

Description: NP = percent score sought; R = avarage score for each aspect of student SPS; MS=: maximum score; 100 % = fixed number.

Table 1. Interpretation Criteria

Interpretation (%)	Criteria
80-100	Very Good
61-80	Good
41-60	Sufficent
21-40	Deficient
0-20	Very Deficient

Based on Table 1, there are 5 score interpretation criteria including very good, good, sufficient, deficient, and very deficient.

RESULTS AND DISCUSSION

The results showed that the five aspects of KPS, namely observing, classifying, interpreting, using tools/materials, and communicating, were displayed in a diagram showing a summary of students' science process skill scores in Figure 1.

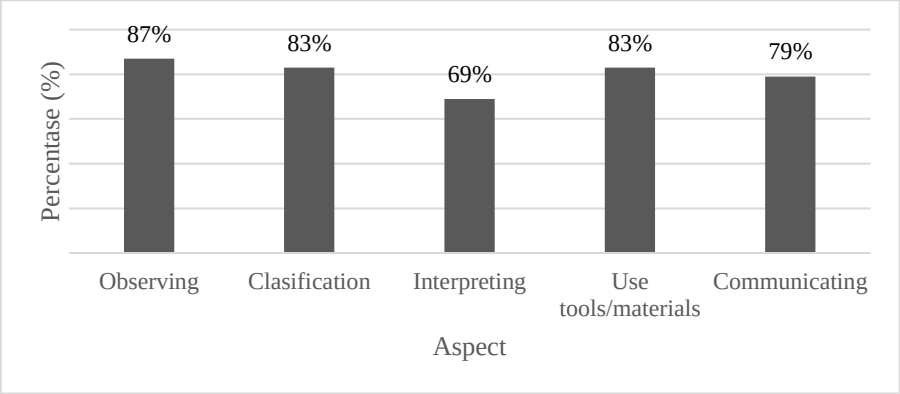

Figure 1. Recapitulation of students' science process skills

Figure 1 shows that the aspects of KPS observing, classifying, and using tools/materials are classified as very good criteria, while interpreting and communicating are classified as good criteria. Based on the figure, the highest aspect is observation with a percentage of 87%, followed by classification and using tools/materials with a percentage of 83%, communication with 79%, and interpretation with a percentage of 69%.

The observation aspect in this study was measured by the number of observations made by the senses. The observation aspect is a basic scientific process skill that students must possess. The percentage for the observation aspect was 87%, which is classified as very good. Chemistry education students demonstrate caution when conducting reactions or mixing materials in the law of conservation of mass experiment to observe the changes that occur. This aligns with the research findings of Muntari et al. (2017), who state that observation is an activity to seek information involving all senses (reading, hearing, listening, seeing, watching, etc.) with or without tools. The results of observations from the aspect of observing, with the indicator of conducting observations using multiple senses, can be concluded that students' ability to use their senses in experiments on the law of conservation of mass is very good. This is supported by Rahayu (2020) research, which found that students conducted observations well and correctly using appropriate senses, enabling the observation process to proceed smoothly and students to record the results of their observations.

The classification aspect (grouping) with indicators records each observation separately, looks for differences and similarities, and compares them in the law of conservation of mass experiment. The percentage for the classification aspect reached 83% with an very good criterion. This classification aspect is categorized as a basic science process skill, and as stated by Yunita & Nurita (2021), classification is a skill that must be frequently practiced. According to Lestari & Diana (2018), grouping something must be based on existing characteristics. Based on the research, the indicator of recording each observation separately is the highest, while the indicator of comparing is the lowest in the classification aspect, as many students were not accurate in comparing the results of the experiment that stood out in the experiment on the law of conservation of mass.

The interpretation aspect uses indicators to connect observation results and draw conclusions in the mass conservation law practical. These indicators are used to assess the extent to which students can observe the results of the observations they have conducted (Ovilia et al., 2024).. The percentage obtained in the interpretation aspect is 69%, which falls within the good criteria. In this aspect, some students were less accurate in linking the results of the experiment, which affected the assessment in the interpretation aspect. This is similar to the research by (Cahya et al., 2023), which showed that many students were less accurate in linking the results of observations. However, many students were also less accurate in the conclusion indicator in this aspect. According to Nurliani et al. (2018), students tend to draw conclusions by searching the internet. If students can interpret the results of the practical session accurately, they will find it easier to communicate or present findings related to the practical session material, as these two skills are interrelated. In this study, the interpretation aspect and the communication aspect are interrelated and classified as good.

The aspect of using tools/materials with indicators of using tools/materials and knowing how to use tools/materials in experiments on the law of conservation of mass. The percentage obtained in this aspect is 83%, which is classified as very good. This is because students are accustomed to using tools and materials in conducting practical work, so they understand the uses of the tools and materials used. However, some students are less familiar with how to use chemical tools/materials. This finding aligns with the results of a study conducted by (Cahya et al., 2023), which indicated that the percentage score for the aspect of using tools/materials falls under the "very good" category. The indicators of tool usage observed in this experiment were measuring cups, analytical balances, Ohauss balances, Y-tubes, and knowledge of how to use tools and materials. The indicators for using materials in this study were HCl solution, KI solution, $Pb(NO_3)_2$ solid, and $NaHCO_3$ solid. Based on the percentage obtained, it falls under the very good criteria, although there are still some shortcomings, such as inaccuracies in weighing and lack of precision in measuring volume.

The aspect of communicating with indicators of giving/describing empirical data from experiments with tables/graphs/diagrams, preparation and submission reports systematically and clearly, and explaining the results of experiments on the law of conservation of mass. The percentage obtained in the communicating aspect is 79% which is classified as good. This shows that most students are able to compile the final practicum report in a structured manner and can describe the experimental data in the interim report. This communicating aspect is closely related to the interpreting aspect, because both involve writing scientific theories in practicum reports. Through reports, students can train themselves in finding theoretical topics that are relevant to the problems discussed, and help students who have difficulty in conveying ideas verbally (Rahayu, 2020). In the aspect of communicating, students are not good at explaining the results of their experiments. In this aspect, there are some students who are less precise in explaining the results of their experiments. This is similar with research (Effendi et al., 2021) namely in his research the lack of scientific literacy, so that what is conveyed is less detailed associated with existing scientific facts.

Based on the analysis of data in each aspect of science process skills in the experiment on the law of conservation of mass, it can be seen that the highest aspect is observation at 87% with a very good criterion, while the lowest aspect is interpretation at 69% with a good criterion. Overall, the average science process skill percentage is 80% with a good category. This finding is similar to the research conducted by (Cahya et al., 2023) that the science process skills of chemistry education students at UIN Syarif Hidayatullah Jakarta have a percentage of 72%, which is classified as good. Based on the research results, it is known that the science process skills of students classified as good are influenced by several factors, namely mastery of basic science concepts, laboratory skills and learning activities that can shape scientific attitudes that

are important for prospective professional chemistry teachers. Additionally, it indicates that students in the chemistry education program have good science process skills to perform activities related to science (Effendi et al., 2021).

CONCLUSION

The science process skills of students in the chemistry education study program are good, with a percentage of 80% having a positive impact, especially in improving basic science concepts, laboratory skills, and learning activities that can shape scientific attitudes that are important for prospective professional chemistry teachers. In addition, students can also carry out activities related to scientific investigation.

RECOMMENDATIONS

Based on the research conducted, the researchers suggest that future studies should integrate science process skills (SPS) indicators more into practical work, especially in the interpretation aspect, which is the foundation of scientific thinking.

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