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How Are The Science Process Skills of Prospective Science Teacher Students: Studies in Inorganic Chemistry and Gender

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ABSTRAK

Mahasiswa calon guru harus mampu merancang praktikum agar proses pembelajaran bermakna. Keterampilan yang dibangun mahasiswa dalam melakukan penemuan ilmiah yaitu menerapkan suatu konsep, kaidah, dan sifat yang ada dalam sains, disebut keterampilan proses sains (KPS). Oleh karena itu, dalam membangun pengetahuan peserta didiknya mahasiswa harus memiliki keterampilan proses dalam mengajar sehingga dapat mengajar secara efektif serta harus memiliki pemahaman konsep yang baik serta keterampilan proses yang kuat. Penelitian ini bertujuan untuk mendeskripsikan KPS mahasiswa calon guru pendidikan IPA melalui mata kuliah kimia anorganik setelah melalui pembelajaran dengan model discovery learning. Penelitian ini menggunakan pendekatan kuantitatif dengan metode penelitian pre-experimental design one-shot case study. Hasil penelitian menunjukkan KPS mahasiswa secara keseluruhan berada pada kategori tinggi dengan persentase rata-rata 59,71%. Analisis SPS pada kelas A, B, dan C, masing-masing memiliki rata-rata persentase sebesar 58,23%, 62,66%, dan 58,24% dengan kategori tinggi. Analisis SPS berdasarkan gender menunjukkan masing- masing persentase mahasiswa laki-laki 53,89% dengan kategori sedang dan perempuan 59,81% dengan kategori tinggi.

ABSTRACT

Prospective teacher students must be able to design practicums so that the learning process is meaningful. The skills that students develop in carrying out scientific discoveries, namely applying concepts, rules, and characteristics that exist in science, are called science process skills (SPS). Therefore, in building students' knowledge, students must have process skills in teaching so they can teach effectively and must have a good understanding of concepts and strong process skills. This research aims to describe the SPS of prospective science education teacher students through inorganic chemistry courses after going through learning with the discovery learning model. This research uses a quantitative approach with a pre-experimental design one-shot case study research method. The research results show that student SPS as a whole is in the high category with an average percentage of 59.71%. SPS analysis in classes A, B, and C, respectively, has an average percentage of 58.23%, 62.66%, and 58.24% in the high category. SPS analysis based on gender shows that the respective percentage of male students is 53.89% with the medium category for women and 59.81% for the high category.

1. INTRODUCTION

In this era of globalization, quality human resources will become the foundation of a nation to accelerate economic growth needed to improve people's welfare. Strengthening human resources towards superior humans has a close correlation with increasing work productivity, in winning the competition amidst rapid changes in the business world, political economy and culture. As a result, producing an educated generation has become a primary focus for education, particularly through the avenue of higher education. Higher education encompasses different faculties, including the faculties of mathematics and

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natural sciences. The science education study program is a study program at the faculty of mathematics and natural sciences that produce graduates who are skilled in various aspects of competency such as knowledge, attitudes and skills thereby producing a generation that is superior, and globally competitive (Ramlawati, 2020).

Skills competency is a competency that science education students must have. Science process skills must be possessed by students as prospective professional teachers. One way a person acquires and develops a set of knowledge is through practical activities (Misbah et al., 2018). Nwagbo & Chukelu (2011) stated that practical activities are more effective in fostering students to acquire science process skills. Shahali et al. (2017) also say that education in the field of science aims to develop students' skills in investigation supported by scientific knowledge. The skills needed to develop scientific work are scientific process skills (Tilakaratne & Ekanayake, 2017).

Students must have science process skills as prospective professional science teachers. Hidayah & Imaduddin (2015) said that as prospective teachers, they must be able to design practicums so that the learning process is meaningful, so they must have science process skills. The skills that students build in carrying out scientific discoveries, namely applying concepts, rules and characteristics that exist in science, are called science process skills (Putri et al., 2022). Science process skills consist of two levels, where the basic level includes the activities of predicting, classifying, communicating, predicting, concluding and identifying. At a high level it includes manipulation, interpretation, operational definition, modeling, experimental design, hypothesis generation, and drawing conclusions. Meanwhile, skills through mental processes carried out by students through managing information from observations, then analyzing it by their minds and producing output as problem solving are critical thinking skills (Changwong et al., 2018). Hulyadi (2021) states that there are nine science process skills which include formulating problems/hypotheses, controlling/identifying variables, defining variables operationally, designing investigations/experiments, preparing tools and materials needed to carry out investigations, organizing investigation data, analyzing data, draw conclusions, and communicate experimental results. Rusmini et al. (2021) states that there are nine science process skills that must be developed in students studying chemistry, namely determining the purpose of the experiment, creating a problem formulation, formulating a hypothesis, determining experimental variables, determining experimental tools and materials, determining the experiment, creating an experimental data table, analyzing experimental results, and draw conclusions. In the inorganic course (Cahya et al., 2023) stated that indicators of science process skills are observation, classification, interpretation, using tools/materials, applying concepts, communicating, and conducting experiments. Meanwhile, according to Mellyzar et al. (2023), namely observing, asking questions, making hypotheses, planning experiments, using tools and materials, applying concepts, classifying, predicting, interpreting data, and communicating.

Wola et al. (2023) stated that the science process skills of prospective science teachers in practical activities were included in the sufficient category. The same thing was explained by Setiawan & Sugiyanto (2020) that the low science process skills profile of science teachers in the professional teacher program was in the aspects of interpreting skills and communication skills. This is due to the short years of teaching experience of science teachers and the educational background of science teachers that is not linear with their competencies. So we need a learning process that can improve the science process skills of prospective science teachers.

In order to optimize scientific process skills, one way to overcome students' lack of scientific process skills is to use the Discovery learning model. Discovery Learning or discovery learning emphasizes learning by exposing students to various problems related to scientifically designed learning experiences, including: Observing, making assumptions, proving assumptions, presenting or communicating results, and drawing conclusions. These problems are solved through the learning process in class. The use of the discovery learning model strengthens students' scientific process skills who are faced with learning tasks that raise questions and differences of opinion during the problem solving process. Therefore, the discovery learning model can encourage students to think critically, ask questions, and participate actively in the learning process, improving their scientific process skills (Sinaga, 2020). The Discovery Learning phase is an effective step to improve students' learning performance and science process skills because each phase involves practicing process skills and developing students' cognitive skills. In the first phase, namely stimulation; students are trained to develop observation and comprehension skills. In the 2nd phase of the problem statement; students ask questions, make predictions and hypotheses, and try to understand the problems they face. In the 3rd phase of data collection; includes skills in using tools and materials, designing experiments, interpreting data, and classifying and understanding information. Students in the 4th phase of data processing; Students are trained in processing the data and information obtained. In the 5th phase of verification; students carry out comprehensive tests to prove whether a hypothesis is correct, based on alternative findings combined with the results of data processing. In Phase 6 generalization; includes the

ability to draw conclusions, apply concepts, and understand and apply the knowledge gained. Therefore, the discovery learning stage comprehensively trains various aspects of students' science process skills and allows them to apply their knowledge to real-world situations (Herawati, 2021).

Through this learning model, students are empowered to actively participate in scientifically designed learning activities and independently discover and research knowledge. This gives students the opportunity to develop a variety of desired scientific process skills. Students are trained to actively learn and acquire new knowledge. By focusing on knowledge exploration and discovery, students develop critical, analytical, and creative thinking skills. Therefore, the use ozf the discovery learning model provides an effective solution for improving students' engineering process skills (Supriyanto, 2019).

Syamsiah et al. (2020) SMP Negeri 05 Poleang Timur shows that applying the Discovery Learning model to science learning can improve scientific process skills. In cycle I the average value of science process skills was predicately sufficient at 51.73, while in cycle II the average value of science process skills was 51.73. The skill score increased to 80.41 which is considered good. Further related research was also conducted by Yuliati and Susianna (2023) that learning science using the Discovery Learning model can improve scientific process skills. The average value of science process ability in cycle I was 54.60, in cycle II it increased to 79.60, and in cycle III it became 87.64.

Science process skills are considered to provide meaningful learning experiences to students because they help students to achieve higher level thinking (Tilakaratne & Ekanayake, 2017). (Özgelen, 2012) revealed that mastering science process skills allows students to acquire the skills needed to solve everyday problems because science process skills are thinking skills used to process information, solve problems and draw conclusions. Murni (2018) wrote that developing process skills in students will help students discover and develop their own facts and concepts as well as the attitudes and values required. Meanwhile, Herawati (2021) said that science process skills are needed to show how to acquire scientific concepts.

Teachers are professional educators who have the task of guiding, training and building students' knowledge. Therefore, in building students' knowledge, a teacher and prospective teacher must have process skills in teaching (Hulyadi, 2021). Chabalengula et al. (2012) In order to teach effectively, a teacher must have a good understanding of concepts and strong process skills. A teacher and the knowledge and materials needed to teach science process skills Hidayah & Imaduddin (2015). In addition, the scientific process has competencies that can be used as a means to obtain knowledge and understand how that knowledge was obtained (Rampean et al., 2022). A teacher in the field of science or a prospective teacher in the field of science who does not have process skills, then when learning takes place the teacher can only explain theory using conventional methods Darmaji et al. (2019). According to Murni (2018), in the traditional science education process, students tend to treat physics as a collection of knowledge and only acquire scientific concepts without understanding the process by which these concepts emerge. Apart from that, students will also not be able to imagine scientific events concretely and accurately, so the learning that takes place there will feel boring.

In the world of education, differences between individual students include differences in race/ethnicity, gender, environment and culture. The existence of gender differences can influence student performance in learning activities (Rahmadanty & Wasis, 2020). Asimilar statement was also made by (Gasila et al., 2019) stated that female students tend to have lower scientific process skills than male students when studying science. This is because female students have better mastery of everything related to health and environmental issues, while male students who have spatial skills are better at numeracy skills related to measurement and science (Dami & Purwanto, 2020). On the other hand, Gasila et al. (2019) and Widdina et al. (2018) stated that the average percentage of SPS scores for female students is higher than male students, with the high category for women and medium for men, this is in accordance with research by Rahmadanty & Wasis (2020) also states that female students have a higher average science process skills score than male students. Cahya et al. (2023) stated that the results of the analysis based on gender show that the percentage of male and female students are in the good category.

Therefore, it is necessary to prove whether there are differences in scientific process skills and conceptual understanding between male and female students. Remember, scientific process skills can help students develop a scientific mindset that helps them discover concepts and theories. Data retrieval of students' science process skills thru inorganic chemistry practicum things to do in the scan on the homes of the alkaline earth elements.

It can be inferred from the description above that fostering science process skills at the higher education level should remain a priority, as there are still numerous student teachers in this area who have yet to fully develop these skills. Therefore, it is necessary to carry out research to describe students' process skills through inorganic chemistry courses, the results of this research can then be used as initial data for further science process skills research at Universitas Negeri Makassar.

2. METHOD

This study employs a quantitative methodology using a pre-experimental one-shot case study design. The research was conducted in the Science Education Laboratory at the Faculty of Mathematics and Natural Sciences, Universitas Negeri Makassar, during the odd semester of the 2023/2024 academic year. The participants in this study consisted of all 91 students enrolled in the inorganic chemistry course within the science education program. The sampling technique used in this research was a total sampling technique. The total sampling technique is a sampling technique if all members of the population are sampled (Sugiono, 2016). The sample consisted of 91 students who were formed into several groups with each group consisting of four to five prospective teacher students . Every future teacher candidate receives guidance during their practicum, utilizing the discovery learning model. Following that, teacher candidates in each group conducted their practicums using the tools and materials supplied by the researchers.

The instrument used in this research was a science process skills test in the form of 27 multiple choice questions. Multiple choice tests are used to obtain an overview of students' science process skills. The data obtained will be analyzed using descriptive statistics and the percentage of each indicator will be looked for and then expressed in several categories, namely the very low category if it is below 24.95%, the low category with a range of 24.96–41.65%, the medium category with a range of 41.66-58.35%, the high with a range of 58.36-75.05%, and the very high category with a value range greater than 75.06%. The percentage of mastery of science process skills for each category can be seen in Table 1. The scientific process skills highlighted in this study are fundamental skills that encompass establishing experimental goals, formulating problems, formulating hypotheses, determining experimental tools and materials, observing, using tools and materials , apply concepts, predict, and draw conclusions.

Table 1. Categories of Mastery of Science Process Skills

No	Interval (%)	Kategori
1	75.06 < X	Very high
2	58.36 < X ≤ 75.05	High
3	41.66 < X ≤ 58.35	Moderate
4	24.96 < X ≤ 41.65	Low
5	X ≤ 24.95	Very low

(Elvanisi et al., 2018).

3. RESULT AND DISCUSSION

Result

The analysis in this research was carried out focusing on nine aspects of scientific process skills, namely determining experimental objectives, formulating problems, formulating hypotheses, determining experimental tools and materials, observing, using tools and materials, applying concepts, predicting, and making conclusions. Analysis is carried out based on class, cognitive ability, and general SPS analysis. The following describes the three analyses:

SPS Analysis Based on Class

This analysis was carried out by giving 27 multiple choice questions to fifth semester science students who were taking the inorganic chemistry course with a total of 91 students consisting of classes A, B and C, with 35, 30 and 26 students in each class. The aim of this analysis is to describe the SPS. The results of research data analysis can be seen in Figure 1.

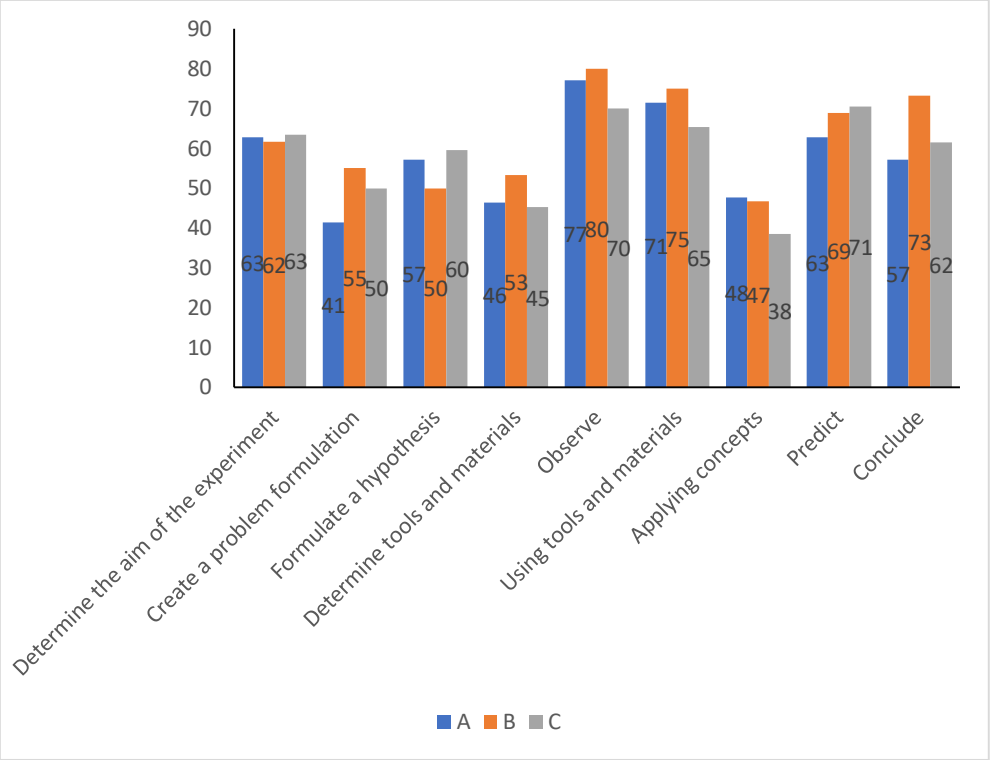

Figure 1. SPS analysis based on class

Based f the nine indicators, there are 4 indicators which are considered moderate, namely making conclusions, predicting, using tools and materials, observing. The results of the research show that the percentage of the average SPS indicator which is the highest and is in the very high category is the observing indicator in class B at 80% as well as in class A with the observing indicator at 77% while in class C the percentage of SPS indicators is the highest, namely predicting at 71%. with high category. Of the nine aspects studied by class A, the three aspects with the lowest percentage and were in the not good category were the aspect of formulating a problem; determine experimental tools and materials; and applying the concept respectively, namely 41%, 46%, and 48% with medium categories. The three aspects with the highest percentage in the not good category in class B are aspects of applying concepts; formulate a hypothesis; and determining experimental tools and materials respectively, namely 47%, 50% and 53% in the medium category. Meanwhile, class C is also in the not good category, namely applying concepts; determine experimental tools and materials; and formulate the problem respectively, namely 38%, 45% and 50% in the low to medium category.

SPS Analysis Based on Gender

This analysis was carried out to see the influence of gender differences regarding SPS for science students in carrying out inorganic chemistry practicum. The analysis was carried out in three classes, namely A, B, and C with the number of female and male students being 80 and 11 people respectively. This analysis was carried out to describe the science process skills of male and female students based on their respective percentages. The results of research data analysis can be seen in Figure 2.

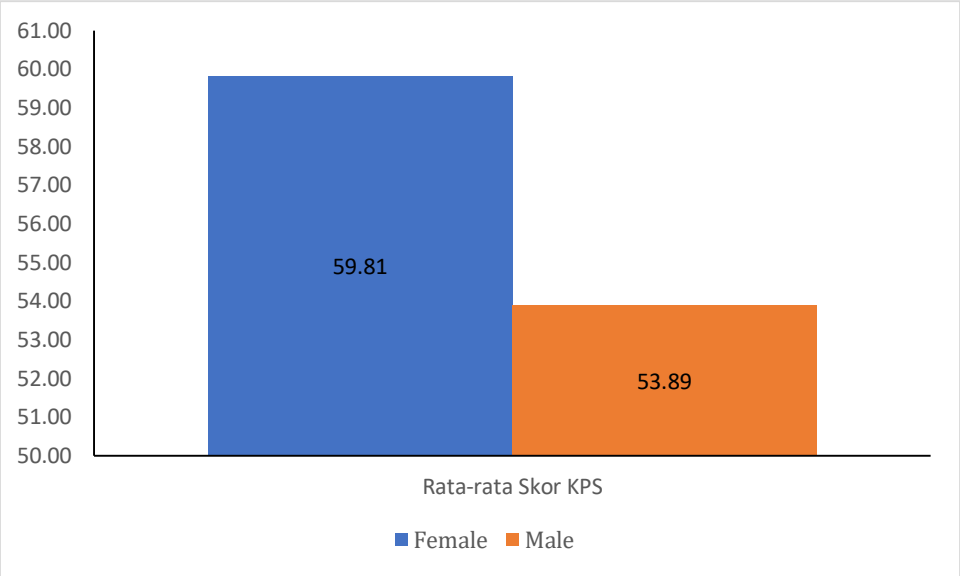

Figure 2. SPS analysis based on gender

The research results show that the overall average SPS percentage for male and female students is 53.89% and 59.81%. The average percentage of SPS scores of female students is in the high category compared to male students who are in the moderate category.

Discussion

From the research findings obtained, it can be said that the percentage of SPS students who program in inorganic chemistry is growing at the secondary level. However, if you look closely at the SPS percentage of students, it turns out that there are still many students whose SPS levels are in the medium to high category. In general, the nine SPS indicators studied in all three classes were below 50%, namely the concept application indicator. This is because the average student still lacks the ability to connect experimental results with relevant scientific facts that can be taken from various existing sources. This is in accordance with research by Effendi et al. (2021) stated that the SPS aspect of applying this concept aims to enable students to apply scientific concepts to new situations, environments and events that are still interconnected with practicum activities, and so that students can explain practicum results with relevant concepts.

The second lowest SPS indicator is the indicator for determining experimental tools and materials where the three classes are at a percentage of 55%, this shows that the average student in the three classes is in the high category in determining the tools and materials to be used during the practicum, this is because students have not yet be introduced to relevant scientific theories and facts. This may be due to not looking for references or reading from various available sources such as academic journals. The lack of reference materials used is due to a lack of scientific capacity. According to Danianty & Sari (2022), scientific literacy is the ability to use scientific knowledge, identify questions, and summarize theories and facts in the context of human life.

The third lowest SPS indicator is making a problem formulation where the three classes have a percentage of less than 60%, this shows that students in the three classes still have not mastered this research variable as evidenced by the students' ability to formulate research questions. Students' inability to formulate research variables influences students' inability to determine and document the components observed in research data. These poor student skills prevent students from organizing data well. These results show that SPS has an impact on reducing students' thinking abilities. If thinking skills are low then the quality of the questions students make will also be low (Hulyadi, 2021).

The student SPS indicator which has a percentage in the very high category, at a percentage of 70-80%, is an observing indicator. The SPS observing indicator is included in the good category. This is because the average student uses his five senses to visualize and explain his observations. This is in accordance with Murni (2018) research which shows that observation skills are included in the SPS indicators. Observation skills are included in the very high category, allowing practitioners to describe objects of observation based on the results of using their senses and being able to explain changes in existing events.

The next SPS indicator that has the largest percentage is the indicator of using tools/materials which is at a percentage of 65-75%. From the overall analysis results, this aspect was found to be included

in the high category, although the percentage values varied. The tools used are everyday household items, the materials used are simple and do not contain dangerous chemicals. This is in accordance with research by Salosso et al. (2018) shows that the percentage value of the tool/material use dimension is classified as very good because practitioners are already accustomed to using practical tools and materials. Therefore, they already know how to use certain tools and materials. The indicators for making conclusions fall into the high category with a percentage of 57-73%. This is because the average student has the ability to connect experimental results with relevant scientific facts that can be taken from various sources. which exists. This is in accordance with research by Effendi et al. (2021) stated that the SPS interpretation aspect is intended to help students understand practical data, relate research results between variables carefully, and draw conclusions from practical results. Afrizon et al. (2012) explained that KPS has an important role for students as a basis for using scientific methods to develop scientific knowledge in terms of obtaining updated knowledge and developing existing knowledge.

Based on gender, the average percentage of SPS scores for female students is higher than male students, with the high category for women and medium for men, this is in accordance with research by Gasila et al. (2019) in their research found that the proportion of observation and classification aspects was higher for female students than for male students, because these two skills are the most basic skills and the influence of gender differences is visible in science learning. The level of success in learning for women in gender studies is higher at SPS. Women's learning performance is lower than men's because women are better at everything related to the environment and health, while men are better at physics, mathematics and chemistry with spatial awareness skills. However, in the research of Widdina et al. (2018) found that the proportion of male and female SPS was greater in several aspects, but the classes they studied were the same, and had the same time and teachers, making it impossible to differentiate their abilities. Research conducted by Rahmadanty & Wasis (2020) also states that female students have a higher average science process skills score than male students.

Based on these result, developing scientific process skills requires good reading and writing skills so that students can apply and develop scientific concepts in everyday life. However, of course there are factors that cannot be reached by researchers, such as external environmental factors that exist outside the individual student. This is in accordance with research by Anisah et al. (2018) stated that factors that influence performance in the scientific process are external factors, namely factors that exist outside the individual, even in the form of the social environment (teachers, friends, community, parents, family, neighbors) and non-social (learning materials, places). and learning atmosphere). Therefore, these external factors can have a very strong influence on students' ability to carry out experiments and write practical reports, and these factors are also likely to contribute to SPS abilities, especially influencing aspects of predicting, formulating hypotheses and determining goals. test.

4. CONCLUSION

The science process skills of Universitas Negeri Makassar science education students in inorganic chemistry practicum are in the high category with an average percentage of 59.71% dan analysis based on gender shows that the percentage of male students in the medium category is 53.89% and the percentage of female students in the high category is 59.81%.

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