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Generic Science Skills Profile of High School Students in Working on Chemistry Questions Based on Gender

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ABSTRAK

Eksplorasi keterampilan generik sains dalam menyelesaikan soal kimia dapat dipengaruhi banyak aspek, salah satunya adanya bias gender siswa dalam proses pembelajaran. Penelitian ini bertujuan mengukur keterampilan generik siswa dalam memecahkan masalah kimia berdasarkan gender. Penelitian ini merupakan penelitian deskriptif kuantitatif dengan metode pre-experiment dengan rancangan One-Shot Case Study. Sampel terdiri dari 20 siswa kelas XI, dengan rincian 10 siswa laki-laki dan 10 siswa perempuan, yang dipilih berdasarkan berbasis gender dan materi yang telah diajarkan. teknik pengumpulan data dilakukan dengan teknik pengukuran, teknik observasi, dan teknik wawancara. Teknik analisis data yang digunakan yaitu deskriptif kuantitatif. Hasil penelitian menunjukkan perbedaan nilai keterampilan generik sains antara siswa perempuan dan laki-laki. Siswa perempuan memiliki nilai yang lebih tinggi dalam indikator pengamatan langsung (80vs79) dan inferensi logika (83vs79). Namun, tidak ada perbedaan signifikan dalam indikator hukum sebab akibat (74vs74). Sedangkan, siswa laki-laki memiliki sedikit keunggulan dalam indikator abstraksi (67vs66) dan membangun konsep (76vs74). Dari kelima indikator yang dikaji dalam bentuk tes, indikator abstraksi memperoleh nilai yang terendah, sedangkan nilai tertinggi pada indikator inferensi logika. Dari hasil ini belum menunjukkan perbedaan signifikan keterampilan generik sains siswa laki-laki dan perempuan.

ABSTRACT

The exploration of generic science skills in solving chemistry problems can be influenced by various factors, one of which is gender bias in the learning process. This research aims to measure students' generic skills in solving chemistry problems based on gender. This study is quantitative descriptive research with a pre-experimental method using a One-Shot Case Study design. The sample consists of 20 eleventh-grade students, with 10 male students and 10 female students, selected based on gender and the taught material. Data collection techniques include measurement techniques, observation techniques, and interview techniques. The data analysis technique used is quantitative descriptive analysis. The results of the research show difference in the scores of generic science skills between female and male students. Female students have higher scores in direct observation indicators (80 vs. 79) and logical inference (83 vs. 79). However, there is no significant difference in the cause-and-effect law indicator (74 vs. 74). Meanwhile, male students have a slight advantage in the abstraction indicator (67 vs. 66) and concept building (76 vs. 74). Of the five indicators examined in the form of tests, the abstraction indicator obtains the lowest score, while the highest score is in the logical inference indicator. From these results, there is no significant difference in the generic science skills of male and female students.

1. INTRODUCTION

In the 21st century, someone is expected to master various skills so they can compete in life. Therefore, educational institutions need to prepare students with learning, innovation, use of information technology, work and survival skills. A framework for the demands of 21st century learning that includes the knowledge, skills and expertise needed for students to be successful in this era. 21st century skills are an important demand in education and require the role of educators to develop learning that integrates these skills in preparing students as citizens who are ready to answer the challenges of life in this era (Salmia & Yusri, 2021). 21st century skills development aims to equip students with confidence in facing

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the opportunities and challenges of this era (Astutik et al., 2022; Herianto & Wilujeng, 2020; Widyastuti et al., 2018). Because 21st century skills are very important for students, the education students receive must be adapted so that they can develop into skilled individuals through an appropriate learning process (Surya, 2017; Yudha et al., 2018). One way to achieve this goal is through innovation in the learning process, which can improve students' 21st century skills. Appropriate learning innovations are expected to not only improve learning outcomes in terms of cognitive value, but also generally improve students' abilities or skills in various aspects. This can be achieved through choosing the right learning model, approach, and learning methods or media. Certain learning models can improve student skills (Ardithayasa et al., 2022; Novellia, 2018; Suryani et al., 2020). The role of teachers as educators has a very important and practical role. As educators, teachers are required to be able to produce and prepare students to be able to live and compete in a very competitive era. A future full of competition cannot be faced just by having a diploma and numbers in a learning progress book, but must be answered by forming the abilities that are truly needed. Therefore, changes are needed in the reward system and learning process that does not only pay attention to respect for numbers, but also respect for students' abilities (Ardithayasa et al., 2022; Astutik et al., 2022).

Teachers can shape students' abilities or skills through classroom learning, especially in science subjects. Proper learning in this subject can help form generic skills that are useful for students to apply in the future. Generic skills are the qualities that a person has in achieving success in learning and career, and with optimal mastery of these skills, a person can achieve a successful future. Generic skills are a combination of various abilities in cognitive, affective and psychomotor aspects that can be given to each student. This ability will grow and develop if it is honed continuously. Generic skills are the basis for developing other abilities, such as cognitive, personal and interpersonal skills. Generic skills need to be evaluated with exclusive values because students tend to only pay attention to things that are related to their interests. Therefore, it is important for students to have generic skills, especially in science learning, and be able to apply them in everyday life (Sarkar et al., 2020). Generic science skills play an important role in developing students' higher-order thinking skills in science learning (Herianto & Wilujeng, 2020; Hill et al., 2019). Therefore, it is important to include generic science skills as part of science learning so that students can develop critical, creative and reflective thinking abilities. The right learning model can help train students' high-level thinking skills by utilizing generic science skill indicators as a guide in implementation. Chemistry is a field of science, and therefore, chemistry subjects can be a tool for developing learning processes that can improve students' generic skills. These generic skills are basic or generic abilities that can be built through the learning process, so that they can help students develop their careers in a wider field.

The importance of developing generic skills for students through the learning process. There are nine types of generic science skills that can be taught to students. These skills include direct observation, indirect observation, awareness of scale, symbolic language, logical frameworks, logical inference, laws of cause and effect, mathematical modelling, and the ability to build concepts. However, this will not be achieved if students' basic abilities have not been formed. The development of students' cognitive abilities and skills through learning activities can be influenced by several factors, including the environment where students grow up, gender, birth order, social and economic status. Gender is an interesting factor to research because there are biological and social differences between men and women which can influence the learning process. In learning, teachers need to pay attention to gender differences because each gender brings different characteristics. Gender reflects the dimensions of differences that arise from the social formation of men and women (Sele et al., 2021; Wegemer & Eccles, 2019). There are differences in the development of the right and left brain between men and women, where men tend to be superior in logical, abstract and analytical thinking abilities due to the dominance of the left brain, while women tend to be superior in artistic, holistic, imaginative thinking abilities. intuitive, and some visual abilities due to his right brain dominance (H Hodiyanto et al., 2020; Hodiyanto Hodiyanto, 2017). Gender differences between male and female students in terms of ability are the focus of several previous studies. Gender on students' creative thinking abilities in biology learning. Analytical thinking abilities of high school students in solving science problems based on gender. The guided inquiry learning model influences students' science process skills depending on their gender.

Research findings related to generic skills state that implementing collaborative task-ranking can improve students' generic skills (Martiningsih et al., 2018; Rosidah et al., 2017). In addition, (Faradilla et al., 2018) also stated that guided inquiry-based student worksheets are effective in improving students' generic science skills (Faradilla et al., 2018). Inquiry learning methods can influence generic science skills based on students' level of creativity (Razali, Halim et al., 2020). Laboratory activity-based learning can improve generic science skills in the concept of sensory systems (Hayati et al., 2021). With the many benefits that can be obtained through generic science skills, it can be concluded that the role of generic

science skills is very important in learning science, especially chemistry. Therefore, further research needs to be done to develop students' skills. The aim of this research is to analyse students' generic skills in solving chemistry problems based on gender. This issue is considered important to be aware of gender bias and provide equal opportunities to male and female students in learning.

2. METHOD

This research uses quantitative descriptive research. Quantitative descriptive research is describing, examining and explaining something studied as it is, and drawing conclusions from phenomena that can be observed using numbers (Sugiyono, 2019). The research results describe actual situations and conditions and do not intend to test a hypothesis. This research uses a pre-experimental research design with a one-shot case study design, and research procedures are carried out in accordance with the predetermined research design. The aim of this research is to analyse generic science skills between male and female students. The research subjects were students and students attending Alkhairaat Kalukubula High School, Sigi, Central Sulawesi. The research subjects consisted of 20 class has been taught, namely material on the polarity of electrolyte and non-electrolyte compounds and solutions. Data collection methods in this research are measurement techniques, observation techniques and interview techniques. Measurement techniques are used to measure students' generic science skills through description tests. The test uses 5 descriptive questions with 5 indicators of generic science skills, namely direct observation, logical inference, law of cause and effect, abstraction, and building concepts. The research instrument grid is presented in Table 1.

Table 1. Kisi - kisi Generic Science Skills Test Instrument

No.	Aspect	Indicator
1	Direct Observation	1. Able to use the five senses to observe scientific phenomena. 2. Able to describe the results of observations using the five senses. 3. Able to distinguish various objects or phenomena using the five senses
2	Logical Inference	1. Able to explain a particular problem based on the chemistry concepts they have 2. Able to argue using logical thinking
3	Law of Cause and Effect	1. Able to explain the causes of a certain phenomenon based on the concepts, theories and principles of chemistry they have
4	Abstraction	1. Describe and analogize abstract chemical concepts or events into forms of everyday life
5	Building Concepts	1. Able to make conclusions 2. Able to solve unstructured problems

(Brotosiswoyo, 2001)

The test is carried out by giving scores on the test sheet and calculating the total score for each indicator according to the rubric that has been created. The scores for each indicator are then grouped based on student gender and presented in graphical form. The data obtained was then carried out a quantitative descriptive analysis of students' generic science abilities. The observation technique is carried out by directly observing students' generic science skills when working on chemistry questions. Finally, the interview technique was carried out using open interviews to determine the consistency of answers on students' generic science skills tests. The data analysis technique used is quantitative descriptive.

3. RESULT AND DISCUSSION

Result

Generic science skills are very important for students in practicing scientific work skills so that they can understand concepts, solve problems, and carry out other scientific activities, as well as study themselves effectively and efficiently. In this research, there are seven aspects of generic science skills that are measured, such as direct observation, logical inference, cause and effect laws, abstraction, and building concepts. These generic skills are measured using a science generic skills sheet which reflects the student's learning process. The results of the recapitulation of student scores on the generic science skills sheet for each aspect are collected and presented in Figure 1.

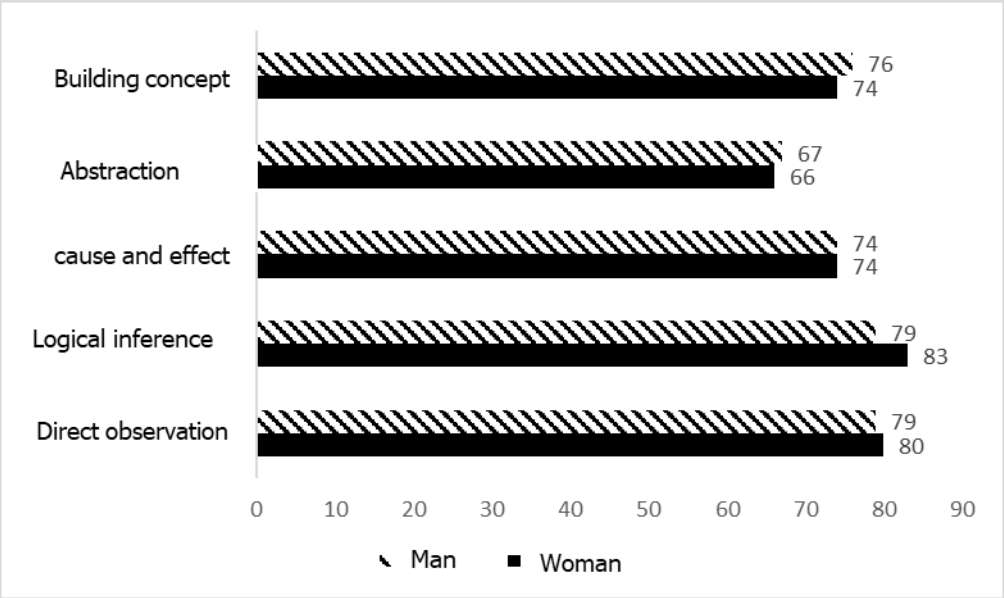

Figure 1. Recapitulation of Generic Science Skills Values for Each Indicator

The results of the analysis of measuring generic science skills for each aspect are as follows. The average score for the direct observation aspect is 80 for female students and 79 for male students. These results indicate that there is no significant difference between the scores of male and female students. The results of measuring the logical inference aspect obtained an average score of 83 for female students and 79 for male students. There is a significant difference between the scores of male and female students, where female students tend to have better logical inference abilities compared to male students. The results of measurements on the legal aspect of cause and effect obtained an average score of 74 for female and male students, which shows that there is no significant difference between the scores of the two gender groups. In terms of students' abstraction abilities, they are still low, with an average score of 66 for female students and 67 for male students. There is no significant difference between the scores of male and female students, which indicates that students' generic science skills in the abstraction aspect still need to be improved. The results of calculations for the concept building aspect show that the average score of female students in the concept building aspect is 74 while male students have an average score of 76. From these results, it can be concluded that there is no significant difference between the scores of male students. and women in building concepts in chemistry subjects.

Discussion

Based on the results of the data analysis that has been carried out. In the aspect of direct observation, it is a natural phenomenon and behaviour that can be observed by humans. To make direct observations, humans need the ability to see and look for causal relationships from these observations. The indicator measured in the direct observation aspect is the ability to collect facts from experiments or natural phenomena with the help of images (Herianto & Wilujeng, 2020; Hill et al., 2019). From the results of data analysis in the direct observation aspect, it shows that there is no significant difference between the scores of male and female students. These results indicate that students' generic science skills in the aspect of direct observation are quite good, and students are able to use their five senses to observe scientific phenomena and look for causal relationships from these observations. Logical inference ability or logical consistency is a general ability used to solve a particular problem based on scientific concepts that have been studied previously by students (Boelt et al., 2022; Hayati et al., 2021). The explanation or interpretation is based on observation or research, or in the form of a logical conclusion from a new problem. The logical inference aspect is measured by explaining a chemical phenomenon or problem based on the chemical rules or laws that have been studied. Students are taught to understand a symptom or problem in a chemistry problem, then from the data and facts presented in the problem, students are asked to explain the problem using the chemical concepts or laws that have been studied previously (Haviz et al., 2018). From the results of this measurement, there is a significant difference between the scores of male and female students, where female students tend to have better logical inference abilities compared to male students.

There are several male students who still have difficulty explaining the problems in the questions given. This is likely caused by students' lack of conceptual understanding of the subject matter received.

Therefore, if the concept is not fully understood by students, it will be difficult to explain a problem in learning (Ardithayasa et al., 2022; Faradilla et al., 2018). Assessment of indicators of the law of cause and effect is carried out by identifying the causes of a phenomenon based on concepts, theories and chemical principles that have been studied previously. This allows students to relate these concepts to phenomena that occur in everyday life. The indicator used to measure this ability is how accurately students are able to estimate the causes and effects of commonly encountered natural phenomena (Nastiti et al., 2018; Pujani et al., 2018). Students must be able to explain the causes of a phenomenon by utilizing the chemical concepts, theories and principles they have studied previously, for example explaining why water and oil cannot be mixed or explaining the role of electrolyte drinks in the body. In assessing students' generic science skills abilities, the cause-and-effect law indicator has the lowest value of the five indicators evaluated. The average value obtained shows that there is no significant difference between the values of the two gender groups. Therefore, it can be concluded that students' generic science abilities in terms of cause-and-effect laws are still in the realm of being quite good, where students are able to explain chemical phenomena that often occur in everyday life in language that is easy to understand. This ability shows that understanding basic concepts is very important to be able to explain a concept in the context of a contextual phenomenon (Haviz et al., 2018; Herianto & Wilujeng, 2020; Siahaan et al., 2019).

Abstraction is the ability to understand abstract concepts beyond doubt, such as the structure of the atom, which can be done in the imaginary mind or the real world. In chemistry, some materials are considered abstract, so they need to be illustrated or made analogies with concepts or events in everyday life (Edwin et al., 2021; Ramdhani et al., 2020). One of the indicators used to measure students' abstraction abilities is their ability to describe or analogize abstract concepts or events in everyday life. Students are given test questions to explain how a light flame occurs in an electrolyte solution with the help of an abstract image and explain how the polarity of a compound occurs based on the distribution of electrons and the electronegativity value of the compound. However, the research results show that there is no significant difference between the scores of male and female students, which indicates that students' generic science skills in the abstraction aspect still need to be improved. Students seem to have difficulty analogizing abstract concepts into everyday life that can be understood easily. Students' abstraction abilities depend on the concepts they build to understand the subject matter so they can explain it contextually (Hill et al., 2019; Nastiti et al., 2018). Concept building is a process of expanding the idea of an object or process in order to understand a complex natural phenomenon (Siahaan et al., 2019). The indicator used to measure this ability is the student's ability to summarize previous concepts and develop new concepts. Students are given questions that aim to build new concepts that students do not yet know or understand. The calculation results show that it can be concluded that there is no significant difference between the scores of male and female students in building concepts in chemistry subjects. This shows that students' ability to understand chemistry subject matter has been well developed and there are no significant differences between students' gender.

The findings show that there is no significant difference between the average science generic skills scores of male and female students. However, it was found that female students had higher scores on the indicators of direct observation and logical inference, while male students were superior on the indicators of abstraction and concept building. This finding is reinforced by previous research stating that male students tend to develop more in the left brain which supports logical, abstract and analytical thinking abilities (Tang et al., 2021; Widyastuti et al., 2018). Male students have good mathematical creative thinking skills (Sholikhati & Sartika, 2022; Widyastuti et al., 2018). Women's ability to solve problems is less effective because they tend not to think analytically (Respati et al., 2018). Women's right brains are more developed, so they have a tendency to think artistically, holistically, imaginatively, intuitively, and have higher visual abilities. However, this research shows the dominance of female students in the direct observation aspect. Female students often make mistakes in analysing and providing answers to questions (Wei et al., 2021). Female students have good abilities in critical thinking (Azizah et al., 2018). The results of this research provide an important contribution to the development of the scientific field studied, namely generic science skills in the context of chemical problem solving.

These findings do not reveal the existence of significant gender bias in the learning process, which influences differences in generic skills between female and male students. In this study, female students showed higher scores in direct observation and logical inference, while male students had advantages in abstraction and concept building. This shows the need for awareness of gender bias in developing inclusive and equitable learning approaches for all students. In addition, this research highlights the importance of abstraction skills which need to be considered more intensively in chemistry learning. The use of various data collection methods, such as measurement, observation and interview techniques, has also proven effective in obtaining a more complete picture of students' generic skills. Although no significant differences were found between female and male students in generic science skills, the

implication is that further research is needed to deepen understanding of gender differences in learning specifically in student skills. It is hoped that future research with a larger sample size can provide more comprehensive insight into developing more inclusive and effective learning approaches for all students.

This study has several limitations that need to be noted. First, the sample size was limited, involving only 20 class XI students, consisting of 10 male students and 10 female students. This may not be sufficient to generalize the study findings to the student population as a whole. It is important to expand the sample size so that the research results can be more representative and can be better generalized. Second, the research method used, namely the pre-experiment method with a One-Shot Case Study design, can be a limitation. This research design may not provide a sufficient level of strength of evidence to conclude that there are differences in science generic skills between male and female students. It is recommended to use more robust research methods, such as randomized controlled experimental designs or longitudinal studies, which can provide stronger evidence of the relationship between students' gender and generic science skills. To overcome these limitations, it is recommended to make improvements in future research. First, it is necessary to expand the sample size by involving more students from various schools and levels of education. This will increase the validity of research results and allow wider generalization. Additionally, it is recommended to use more robust research methods, such as randomized controlled experimental designs or longitudinal studies, to provide stronger evidence of the relationship between students' gender and generic science skills. In addition, other factors that may influence students' skills, such as educational background, motivation, or previous experience, also need to be considered and controlled for in future research to gain a more comprehensive understanding of the factors that influence students' science generic skills.

4. CONCLUSION

The results of the research show that of the five indicators studied in the form of test questions, the abstraction aspect indicator received the lowest average value, while the logical inference indicator received the highest average value. The results obtained do not show any significant differences or gender bias between the average science generic skills scores of male and female students.

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