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INSIS
INTERDISCIPLINARY
UMSU
Volume. 1, No. 1, May 2026
https://jurnal.umsu.ac.id/index.php/insis
insisinterdisciplinary@umsu.ac.id

STUDENT SKILL LEVEL IN OPERATING TELESCOPES

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Abstract: *This study aims to analyze the level of students' skills in operating astronomical telescopes. The research employed a descriptive quantitative approach involving 16 students from the Astronomy (Ilmu Falak) Study Program at Universitas Muhammadiyah Sumatera Utara who had participated in astronomy practicum and sky observation activities. Data were collected using a structured questionnaire designed to measure students' technical skills, understanding, and practical experience in telescope operation. The collected data were analyzed using descriptive statistical techniques, including frequency distribution, percentages, mean values, and standard deviation. The results indicate that most students fall into the moderate to high skill categories, with 37 percent of respondents scoring in the range of 33–37 and 25 percent in the range of 38–42. The mean score of 37.8 suggests that, overall, students demonstrate an adequate level of competence in operating astronomical telescopes. Meanwhile, the standard deviation value of 6.3 indicates a moderate variation in skill levels among students. These findings show that students generally possess sufficient basic skills in telescope operation; however, differences in individual proficiency remain evident. Therefore, continuous improvement through more intensive practicum sessions, hands-on training, and structured observational activities is necessary to enhance students' technical skills and ensure more uniform competency.*

Keywords: *Student skills, astronomical telescope, astronomy practicum, sky observation, descriptive analysis.*

INTRODUCTION

Astronomy is a branch of science that studies celestial objects and phenomena beyond Earth's atmosphere. In astronomy education, observational activities play a crucial role in helping students understand theoretical concepts through direct experience (Percy, 2015). One of the most important instruments used in astronomical observation is the telescope, which enables observers to collect electromagnetic radiation and produce detailed images of distant celestial objects (Irvan & Hermawan, 2019). Hands-on learning using telescopes has been shown to improve students' conceptual understanding, motivation, and engagement in astronomy learning. Direct involvement in observational activities allows students to actively participate in scientific inquiry and enhances

their learning experiences (Privon et al., 2009;) Therefore, telescope-based practicum is an essential component of astronomy education. From the perspective of science education, practical activities are not only intended to improve conceptual knowledge but also to develop students' technical and operational skills. (Millar, 2004) stated that practical work enables students to acquire procedural and hands-on skills that cannot be achieved through theoretical instruction alone. (Mu, 2010) further emphasized that the effectiveness of practical learning should be evaluated based on students' ability to operate scientific instruments accurately. Operating an astronomical telescope requires specific technical skills, including identifying telescope components, assembling and setting up the instrument, aligning the telescope with celestial objects, adjusting focus, and conducting observations independently. Although several studies have discussed the benefits of telescope-based learning, many of them focus primarily on learning outcomes and student motivation rather than evaluating students' operational skill levels.

In the context of observational practices, studies in Islamic astronomy demonstrate that successful astronomical observations depend heavily on precise telescope operation and technical competence. (Firdaus et al., 2022) showed that accurate crescent observations require proper telescope alignment, optimal instrument configuration, and skilled operators. However, such studies emphasize observational results rather than assessing students' skills in operating telescopes.Based on the existing literature, there is a lack of empirical studies that specifically assess students' skill levels in operating astronomical telescopes, particularly in higher education settings. Therefore, this study aims to evaluate students' skill levels in operating astronomical telescopes using a descriptive quantitative approach. The findings of this study are expected to contribute to the improvement of astronomy practicum by emphasizing the importance of developing and assessing students' technical skills in telescope operation.

LITERATURE REVIEW

Astronomy education emphasizes not only the understanding of theoretical concepts but also the development of observational skills through direct interaction with celestial phenomena. Observational astronomy allows students to engage in scientific inquiry by observing, interpreting, and analyzing astronomical objects using appropriate instruments (Percy, 2015). Telescopes, as primary observational tools, play a crucial role in facilitating this experiential learning process. Research in astronomy education highlights the importance of hands-on observational activities in improving students' learning experiences. (Bailey & Slater, 2009) reviewed astronomy education research and concluded that direct observation significantly enhances students' understanding and engagement compared to passive learning methods. Similarly, Slater, Slater, and Lyons (2010) emphasized that active involvement in astronomical inquiry enables students to develop essential observational and technical skills required in astronomy learning. In science education more broadly, practical activities are recognized as essential for developing students' procedural and operational skills. (Millar, 2004) argued that laboratory and practicum activities help students acquire hands-on skills that cannot be achieved through theoretical instruction alone. (Mu, 2010) further noted that effective practical learning should be evaluated based on students' ability to operate scientific instruments accurately, not merely on conceptual understanding. Several studies have demonstrated that practical engagement improves students' scientific skills and competencies. found that experimentation and hands-on activities significantly contribute to students' conceptual understanding and procedural skills in science learning. emphasized that scientific literacy includes the ability to use scientific tools and conduct investigations effectively, highlighting the importance of operational skills in science education. In the context of astronomy learning, operating telescopes requires specific technical competencies, including assembling the instrument, aligning it with celestial objects, adjusting optical components, and conducting observations independently.

(Trumper, 2006) emphasized that effective astronomy education should integrate observational practices to develop both conceptual understanding and practical skills. However, many educational studies focus primarily on students' conceptual achievements, while systematic evaluation of students' telescope operation skills remains limited. Based on the reviewed literature, there is a clear research gap regarding the assessment of students' skill levels in operating astronomical telescopes. Although previous studies emphasize the importance of observational activities and practical skills, few have specifically measured students' operational competencies in telescope use. Therefore, this study aims to address this gap by evaluating students' skill levels in operating astronomical telescopes within an educational observatory setting.

METHODS

a. Research Design
This study employed a descriptive quantitative research design to assess students' skill levels in operating astronomical telescopes. Descriptive quantitative research is appropriate for studies aiming to describe conditions, characteristics, or skill levels of participants based on numerical data without manipulating variables (Creswell, 2014; Fraenkel et al., 2012).

b. Research Location
The research was conducted at the Observatory of Islamic Astronomy (Observatorium Ilmu Falak / OIF), Universitas Muhammadiyah Sumatera Utara (UMSU). This location was selected because telescope-based observational practicum activities are routinely conducted, providing an appropriate environment to evaluate students' telescope operation skills.

c. Participants
The participants consisted of undergraduate students who had participated in astronomical observation practicum sessions involving telescope use. Participants were selected using purposive sampling, with the criterion that students had prior experience operating astronomical telescopes. Purposive sampling is suitable when participants are selected based on specific characteristics relevant to the research objectives (Etikan et al., 2016).

d. Research Instrument
Data were collected using a questionnaire designed to measure students' skill levels in operating astronomical telescopes. The questionnaire was developed based on practical skill assessment frameworks in science education (Millar, 2004; Abrahams & Millar, 2008). A five-point Likert scale was used, ranging from 1 (very low skill) to 5 (very high skill), which is widely applied in educational skill and perception studies (Joshi et al., 2015). The assessed skill indicators included:
1. Identifying telescope components
2. Assembling and setting up the telescope
3. Aligning the telescope with celestial objects
4. Adjusting focus and eyepiece settings
5. Conducting astronomical observations independently
These indicators reflect essential operational competencies in observational astronomy (McLean, 2012; Slater et al., 2010).

e. Data Collection Procedure

Data collection was conducted after students completed telescope-based practicum activities. Participants were asked to complete the questionnaire based on their actual experiences during telescope operation. This procedure ensured that the data accurately represented students' operational skill levels (Cohen et al., 2018).

f. Data Analysis Technique
The collected data were analyzed using descriptive statistical techniques, including mean scores and percentage distributions. Students' skill levels were categorized into low, moderate, and high based on predetermined score intervals. Descriptive statistical analysis is commonly used to summarize and interpret quantitative data in educational research (Field, 2018).

RESULTS AND DISCUSSION

This study was conducted to determine students' skill levels in operating astronomical telescopes after participating in observational practicum activities. The assessment of students' skills was based on several indicators directly related to telescope operation. The results show that, in general, students demonstrated moderate to high skill levels in operating astronomical telescopes. The strongest skills were found in students' ability to identify telescope components and assemble and prepare the telescope before use. This indicates that students have a good understanding of the basic structure and functions of the telescope. Moderate skill levels were observed in the ability to align the telescope with celestial objects and adjust the focus and eyepiece. These skills require accuracy and experience, as students must adjust the telescope according to sky conditions and the position of observed celestial objects. Therefore, these skills are not easily mastered in a short period of time.

The lowest skill level was found in the ability to conduct independent observations. Some students still experienced difficulties when performing observations without guidance, especially in locating faint celestial objects and maintaining stable observations. This suggests that students still need support to develop confidence and technical accuracy when operating the telescope independently.Overall, the results indicate that astronomy practicum activities have provided students with adequate basic skills in operating astronomical telescopes. However, advanced operational skills, particularly independent observation skills, still need to be improved. Therefore, it is recommended that astronomy practicum activities place greater emphasis on repeated practice and hands-on experience to help students develop stronger and more independent telescope operation skills.

Figure 1. Telescope Training Activities

Therefore, to be able to analyze the telescope on student development, accurate and structured data is needed. The data is collected and presented in several forms of descriptive statistical analysis, namely: distribution tables, frequencies, pie charts, mean values, and standard deviations.

Table 1. Data on Student Skill Levels in Operating Astronomical Telescopes

Nilai Angket	Total	Banyak Mahasiswa
25-29	I	1
30-34	III	3
35-39	V	5
40-44	VII	7
45-49	II	2
50	II	2
JUMLAH		40

Based on the data presented in Table 1, the researcher concludes that the majority of students already possess the ability to operate an astronomical telescope. This is indicated by approximately 75% of students being classified in the category of being able to operate the telescope. Meanwhile, about 25% of students have not yet fully understood the procedures and techniques for operating an astronomical telescope. These findings indicate that although the overall level of student ability is generally good, there are still some students who require guidance and reinforcement to improve their understanding of telescope operation. To obtain a more comprehensive picture of the students' ability levels, the researcher did not limit the analysis to percentage calculations alone but also conducted further statistical analyses. These analyses included presenting the data in the form of a pie chart to visually illustrate the proportion of students in each ability category more clearly and intuitively. In addition, the mean value was calculated to identify the general tendency of students' skill levels in operating the telescope. Furthermore, the standard deviation was calculated to examine the degree of variation or dispersion in students' abilities. This measure is important for determining whether the students' skills are relatively homogeneous or show considerable differences among individuals. By combining percentage analysis, mean, and standard deviation, the researcher aims to provide a more objective and in-depth description of students' ability to operate an astronomical telescope.

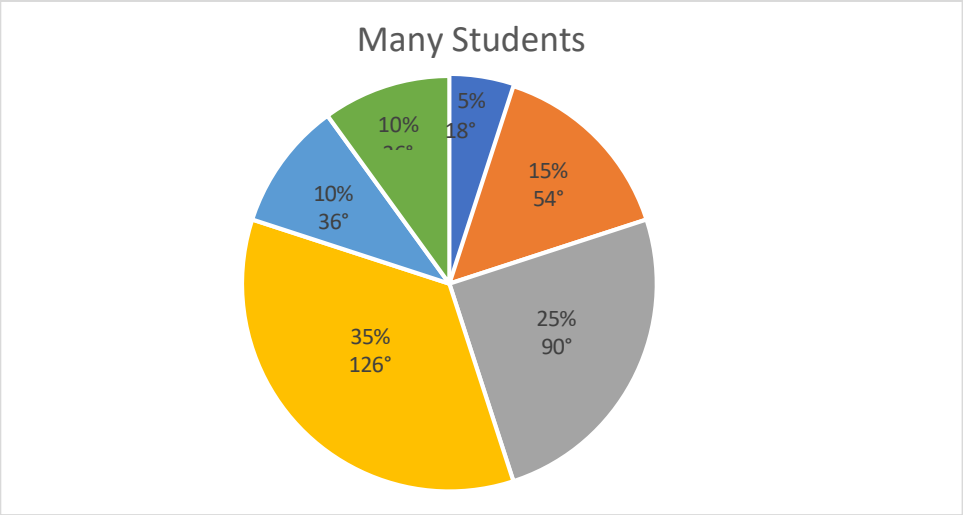

Figure 2. Pie Chart of Data on Students' Skill Levels in Operating Astronomical Telescopes

The pie chart presented above illustrates the distribution of skill levels among 20 university students in operating an astronomical telescope. The data were obtained through a questionnaire designed to measure the extent of students' understanding and ability to use a telescope as the primary instrument in astronomical observation activities. The diagram provides a visual overview of the variation in students' skill levels, ranging from very low to high.The analysis results indicate that the group of students with a high level of skill is the most dominant, accounting for 35% or 7 students. The dominance of this category suggests that a portion of the students has acquired a strong mastery of both basic and advanced telescope operation techniques. These abilities include identifying the main components of the telescope, adjusting the focus, determining the position of celestial objects, and independently operating the instrument during observation sessions. This finding can be interpreted as a positive outcome of the learning process and practical sessions that have been implemented, particularly for students who are active and engage in more frequent practice. In addition, 25% of the students, or 5 individuals, fall into the moderately skilled category. Students in this group generally understand the basic principles of telescope operation but still require guidance in certain technical aspects, such as precision in positioning and accuracy in observing celestial objects. This category indicates a considerable potential for improvement, especially through increased practice time and more structured mentoring. Furthermore, 15% of the students, or 3 individuals, are classified as having an average level of skill. This group typically possesses theoretical knowledge regarding telescope usage but encounters difficulties when applying it directly in field observations. Challenges such as determining the direction of celestial objects and adjusting the telescope's lighting indicate a gap between conceptual understanding and practical skills.

Meanwhile, students categorized as less skilled and low skilled each account for 10% or 2 individuals, while those in the very low category represent 5% or 1 student. These findings show that a small number of students have not yet mastered the basic functions of the telescope. Students in this group tend to require intensive assistance and step-by-step guidance to effectively participate in observation activities. This condition may be caused by limited practical experience, lack of self-confidence, or insufficient opportunities to directly operate the telescope. Overall, the data distribution shows that approximately 60% of students have achieved skill levels classified as good to fairly good. This indicates that the astronomy learning and practicum activities conducted have generally contributed positively to improving students' abilities in operating astronomical telescopes. However, around 40% of students still require special attention through more adaptive

learning strategies, such as increased practice duration, demonstration-based learning, and individual assistance during observation sessions. In conclusion, the overall level of students' skills in operating astronomical telescopes can be categorized as good, although the equal distribution of practical competence remains a challenge. Therefore, continued guidance and optimization of practical activities are necessary to ensure that all students can achieve a more uniform and optimal level of skill in using astronomical telescopes.

Table 2. Mean Data on Students' Skill Levels in Operating Astronomical Telescopes

Nilai Angket	*f*i	xi	*f*ixi
25-29	1	27	27
30-34	3	32	96
35-39	5	37	185
40-44	7	42	294
45-49	2	47	94
50	2	77	154
JUMLAH	20		850

Based on the results of processing the questionnaire data regarding students' skill levels in operating an astronomical telescope, a frequency distribution was obtained as presented in the table above. The table contains the score intervals, the frequency of each interval (fi), the midpoint values (xi), and the products of frequency and midpoint (fixi). This data presentation serves as an important basis for statistical analysis, particularly in determining the mean value as a general indicator of students' overall skill levels. The calculation results show that the total number of respondents in this study is 20 students, with the total product of frequency and midpoint values amounting to $\sum fixi = 850$. Based on the calculation of the mean using the grouped data formula, the mean value obtained is 42.5. This value indicates that, in general, students' skill levels in operating an astronomical telescope fall within the good or relatively high category. A closer examination of the frequency distribution reveals that the score interval of 40–44 has the highest frequency, with 7 students. This condition indicates that the majority of students are clustered around a relatively similar skill level and are close to the mean value. Therefore, this group can be considered the dominant representation of the overall student capability. On the other hand, a small number of students still fall into the low skill category, as indicated by one student in the 25–29 score interval. In addition, there are also students with very high skill levels, represented by two students who achieved the maximum scores in the highest interval.

The mean value of 42.5 suggests that students generally possess a fairly good understanding and basic skills in operating an astronomical telescope. These skills include identifying telescope components, understanding the calibration process, and performing simple observations of celestial objects. However, the presence of varying scores across the intervals indicates that students' skill levels are not yet evenly distributed. This variation in skill levels implies differences in experience and practice intensity among students. Factors such as the frequency of involvement in observation activities, prior hands-on experience, levels of interest and motivation in astronomy, as well as the effectiveness of instructor guidance during practicum sessions are believed to contribute to these results. Students who are more frequently involved in direct practical activities tend to demonstrate higher skill levels compared to those with more limited involvement. Overall, the analysis of the mean value indicates that students' skill levels in operating astronomical telescopes are at a reasonably adequate level and show positive development. Nevertheless, the findings also emphasize the need for further efforts to improve the equalization of skills,

particularly for students who remain in the lower categories. The optimization of practicum activities, increased intensity of telescope usage, and more structured mentoring are expected to encourage all students to achieve a more uniform and optimal level of mastery in supporting future learning and research activities in astronomy.

Table 3. Standard Deviation of Data on Student Skill Levels in Operating Astronomical Telescopes

No Urut	Nilai Angket	*f*i	xi
1	25-29	1	27
2	30-34	3	32
3	35-39	5	37
4	40-44	7	42
5	45-49	2	47
6	50	2	77
JUMLAH		20	262

Based on the results of processing the questionnaire data on students' skill levels in operating astronomical telescopes, a frequency distribution was obtained as presented in the table above. The table contains the score intervals of the questionnaire, the frequency for each interval, the midpoint value (xi), and the product of frequency and midpoint (fixi). These data were used as the basis for calculating the mean value, which serves as a general indicator of students' overall skill levels. The total number of respondents in this study was 20 students who were directly involved in practicum activities or astronomy learning using telescopes. Based on the calculation results, the total value of ∑fixi was 262. Using the mean formula, a mean score of 13.1 was obtained. This mean value indicates that, in general, the students' skill levels fall within the moderate to good category, depending on the scoring scale applied in the questionnaire. The mean score suggests that most students already possess a basic understanding of how to operate astronomical telescopes, including recognizing the main components of the instrument, understanding the working principles of telescopes, and performing the initial steps of astronomical observation. However, this average value also indicates that students' skill mastery is not yet evenly distributed, as there are still noticeable differences in skill levels among individuals. Further examination of the frequency distribution shows that the score interval of 40–44 has the highest frequency, with 7 students. This condition indicates that students within this interval represent the dominant group of overall student ability. In other words, the majority of students are at a relatively stable skill level and close to the average. On the other hand, there is still 1 student in the 25–29 score interval, which reflects a low level of skill. The presence of this group indicates that not all students have gained the same level of understanding and practical experience during the learning process.

In addition, there are 2 students who achieved the highest score (50), indicating that a small proportion of students have mastered telescope operation skills at a very high level. Students in this group are likely to have more intensive practical experience, a higher level of interest in astronomy, or stronger independent learning abilities compared to other students. Overall, the pattern of data distribution shows that most students are at a medium to high level of competence, while only a small proportion remain in the low category. This can be interpreted as evidence that the astronomy learning and practicum activities that have been implemented have had a positive impact on improving students' skills in operating astronomical telescopes. Nevertheless, the visible differences in skill levels among students indicate the need for further efforts to improve

skill equity. Thus, the results of the mean analysis not only reflect the average level of students' skills but also reveal variations in skill mastery that require attention. Optimizing learning methods, increasing the amount of hands-on practice, and providing more intensive guidance for students with lower skill levels are expected to enhance both the quality and the equitable distribution of students' abilities in operating astronomical telescopes more effectively.

CONCLUSION

This study concludes that students generally possess moderate to high skill levels in operating astronomical telescopes after participating in observational practicum activities. Students demonstrate good basic skills, particularly in identifying telescope components and preparing the telescope for use. These findings indicate that practicum-based learning plays an important role in developing foundational operational skills. However, the study also reveals that more advanced skills, especially the ability to conduct independent astronomical observations, remain relatively limited. This suggests that while students understand basic operational procedures, they still require further practice to apply these skills independently and confidently. Therefore, it is recommended that astronomy practicum programs emphasize repeated hands-on training and gradual transitions from guided practice to independent observation. Such efforts are expected to enhance students' telescope operation skills and support more effective learning in observational astronomy.

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