

Applying Physics in Mountaineering: Analyzing the Interplay between Education, Experience, and Physics Concept Awareness

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Abstract: This study evaluates the influence of education and climbing experience on the awareness and understanding of physics concepts among mountain climbers. Climbing requires an understanding of physics concepts such as air pressure, friction, potential energy, and heat transfer. Using a descriptive quantitative survey method, this study involved 109 climbers with diverse educational backgrounds and levels of experience. The questionnaire assessed the relationship between awareness of physics concepts, climbing experience, and respondents' educational levels, employing regression analysis. The results indicated that climbing experience does not significantly affect physics awareness, showing a very weak negative correlation between the duration and frequency of climbing and physics understanding. Formal education also did not show a significant influence on the awareness or application of physics concepts in climbing. However, there was a weak positive correlation between physics awareness and the ability to overcome physical challenges. It is recommended to enhance education and outreach regarding the relevance of physics in climbing, including practical guides and applicable training programs to improve climbers' skills and safety.

Keywords: Awareness of physics concepts; climbing experience; Physics.

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Introduction

Mountain climbing is a physically and mentally challenging outdoor activity involving interaction with various natural phenomena. Climbers must understand challenges such as weather changes, rough terrain, and extreme conditions (Rahman et al., 2017). Although often unnoticed, physics knowledge plays a vital role in facing this challenge. Physics concepts such as air pressure, friction force, potential energy, and heat transfer are relevant. For example, decreasing air pressure with increasing altitude affects the body's ability to absorb oxygen, causing hypoxia (Andhini & Mustriwi, 2021). The friction force between the shoe and the ground prevents slipping, and gravitational

potential energy determines the effort to climb or descend from a height.

One of the main challenges in climbing mountains is the decrease in air pressure as altitude increases, which reduces oxygen for the body and causes symptoms such as dizziness and fatigue (Rahmi & Djunaidi, 2021). Understanding air pressure and body response is crucial to the climbing strategy. The friction force between shoes and the ground helps with balance and prevents slipping, so choosing the proper footwear and technique for moving on different terrain is very important. Gravitational potential energy influences climbing or descending efforts, so managing energy and optimizing power is essential for travel efficiency. According to Romdhoni (2022), ensuring

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that nutritional intake through food supplies remains adequate during the climb is crucial.

Climbers must understand how the body loses heat through conduction, convection, radiation, and evaporation and how to reduce it to prevent cold (Andhini & Mustriwi, 2021). Choosing the proper clothing and equipment and strategies for maintaining body temperature are very important in preparing for the climb. Effective learning includes theoretical understanding and practical application, helping students connect theory with real experience. This research evaluates the extent to which formal physics learning influences climbers' awareness of physics concepts, hoping that climbers with a background in studying physics can better recognize and apply these concepts.

Many climbers may need help understanding the application of physics concepts to climbing, focusing more on fitness, equipment, and navigation (Romdhoni, 2022). Therefore, it is essential to explore their awareness of physics concepts and their impact on the climbing experience. Physics learning often focuses on abstract theories, which seem irrelevant daily. However, applying these concepts to climbing can provide valuable insight into the application of theoretical physics to solving real problems. Various climbing experiences can improve a climber's understanding of physics. This research explores the relationship between climbing experience and physics awareness and its implications for the ability to face physical challenges. Identifying factors that influence physics awareness can provide recommendations for improving training and education for climbers, from beginners to experienced.

This research has the potential to make a valuable contribution to the development of climber education and training. Understanding the relationship between education, experience, and physics awareness can help improve a climber's preparation for challenges. Recommendations from this research can be utilized by coaches, climbing organizations, and educational institutions to improve curricula and training programs that integrate physics concepts. The results provide in-depth insight into the influence of formal education and practical experience on understanding physics in climbing. This can be used to develop more effective education and training programs, combining physics theory with practical applications to improve safety and efficiency in climbing.

Method

This research uses a descriptive quantitative design with a survey method via questionnaire. The questionnaire was designed to measure the

respondents' awareness of physics concepts, climbing experience, and education level. The research population was mountain climbers from various educational backgrounds and levels of experience, with a random sample of 109 respondents. The research instrument consists of four parts: demographic data, climbing experience, awareness of physics concepts, and application of physics in climbing. Data was collected online for two weeks at the end of May 2024, with participants recruited through climbing communities and social media. Data analysis uses descriptive and inferential statistical techniques, describing demographic characteristics and distribution of answers. In contrast, correlation analysis evaluates the relationship between education level, climbing experience, and awareness of physics concepts. Regression analysis is used to determine significant relationships between existing variables.

Result and Discussion

This research reviews the relationship between physics awareness and climbing experience and the impact of education level on physics awareness in climbing activities. The research objectives include an analysis of how knowledge of physics can help overcome physical challenges during climbing. The research also explores climbers' views on the importance of knowledge of physics and the efforts that can be made to improve their understanding of physics concepts in climbing. Based on the instruments distributed, it was found that most respondents were aged 20-24 years with a Diploma/S1 education. Most climbers have between 1-3 years of climbing experience. Most climbers know mountain climbing involves physics concepts such as potential energy, air pressure, and temperature changes. Many of them consider these physics concepts when climbing and feel that knowledge of physics helps them face physical challenges. Most climbers also expressed interest in learning more about how physics can be applied to mountain climbing.

The results of the analysis show several exciting findings. First, there is a very weak negative correlation between the length of climbing experience and physics awareness (-0.095) and between climbing frequency and physics awareness (-0.030). This weak negative correlation suggests that knowledge of physics is not much influenced by how long or often a person climbs. This can be caused by several factors, such as a lack of education that links climbing activities with physics concepts and climbers' subjective experiences that rely more on intuition and practical experience than physics theories that climbers may have studied. Variations in climbing experience may also influence these results, as

not all aspects of mountain climbing require direct application of physics concepts.

Case studies from various climbers show that climbers often rely on experience and practical techniques to face climbing challenges. For example, techniques for dealing with strong winds or using specific equipment are learned more through direct experience than theoretical physics. In some cases, climbers may not realize that the climber is applying physics concepts to the climber's actions. For example, when climbers adjust their body position to reduce the load on their legs or choose a safer path based on observations of the terrain, they apply basic physics principles.

Furthermore, this research also analyzes the influence of education level on physics awareness. The analysis results show that the correlation between the last level of education and awareness of physics is 0.032, while the correlation between the last level of education and assistance from physics lessons is 0.109. This weak correlation suggests that formal education does not significantly increase physics awareness in the climbing context. Several factors that influence these results include an educational focus that emphasizes theory over practical application and an individual's interest in physics. An education system emphasizing theory may mean that the physics concepts learned at school are not directly linked to activities such as mountain climbing. On the other hand, awareness and application of physics may be more influenced by personal interests and individual efforts to understand the application of these concepts in daily activities.

However, the study also showed that climbers with more education were slightly more likely to feel helped by physics lessons while climbing. This suggests that formal education needs to provide more benefit in helping climbers understand their physical challenges. However, these benefits are still limited and not significant enough to influence the overall level of physics awareness among climbers. Furthermore, this research also analyzes whether knowledge of physics helps climbers face physical challenges. The analysis results show that the correlation between physics awareness and the help of physics knowledge in facing

physical challenges is 0.203. This weak positive correlation suggests that there is some benefit from knowledge of physics in facing climbing challenges. This could mean that climbers who are aware of physics concepts may be better able to use this knowledge to overcome challenges such as changes in temperature, air pressure, and gravitational forces. Physics concepts such as potential energy, friction force, and the principles of thermodynamics can help climbers plan climbing trips and use equipment more effectively. This aligns with research by Rahmi and Djunaidi (2021), which found that experience and knowledge influence safety during mountain climbing.

Climbers who understand potential energy can manage their power better when climbing steep grades. Awareness of friction forces helps choose the proper footwear to avoid slipping. Knowledge of air pressure and temperature prepares climbers for extreme conditions, for example, by avoiding altitude sickness through proper acclimatization and maintaining body temperature in cold conditions through understanding heat conduction and convection.

Analysis of respondents' suggestions and comments identified the importance of physics lessons, practical application of physics concepts, equipment, preparation, and climbers' personal experiences and observations. Many climbers feel there is a need for better education and practical guidance. Respondents suggested increased education about physics concepts for safety and efficiency, the importance of weather-appropriate equipment, and understanding signs of weather changes and safe types of terrain. Recommendations include increasing education and dissemination of physics concepts through training programs and practical guides that link physics to real situations. Use social media, easy-to-understand guides, and training programs that include theory and practice sessions. Better education about the physics of mountain climbing can improve safety and efficiency and provide a more satisfying and safe experience.

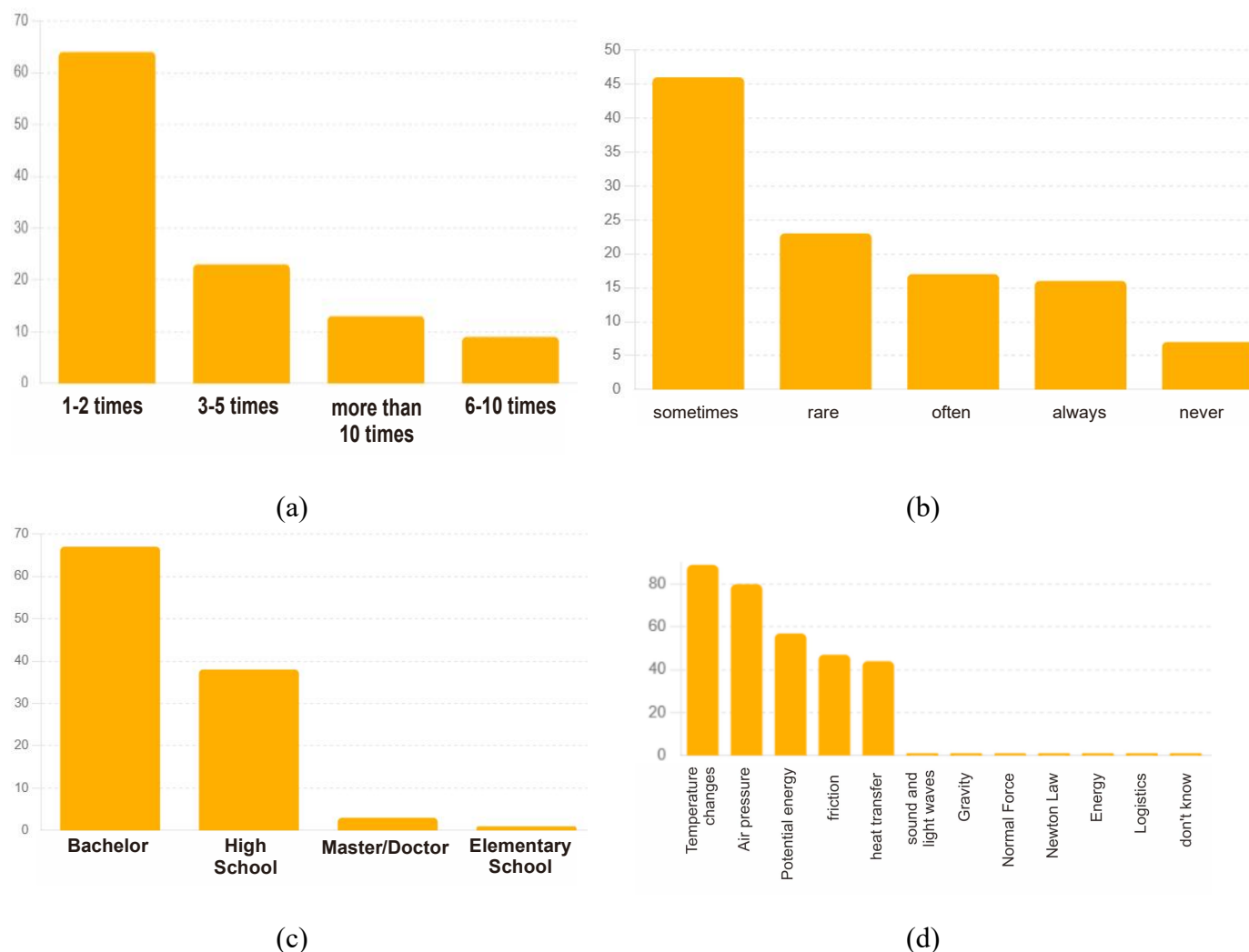


Figure 1. (a) Frequency of Mountain Climbing in the Last Two Years; (b) Frequency of Consideration of Physics Concepts when Climbing a Mountain; (c) Distribution of Respondents' Last Education; (d) Known Physics Concepts Involved in Mountain Climbing.

Climbers are expected to be better prepared to face mountain challenges and optimize their climbing experience by understanding physics concepts. Education via social media, practical guides that are easy to understand, and special training programs can be practical steps to achieve this goal (Primanda & Maftuh, 2022). This research provides important insights into the relationship between awareness and application of physics concepts and various aspects of the mountain climbing experience. It provides recommendations that can be implemented to improve climbing safety and efficiency.

Apart from understanding physics through formal education and practical experience, modern technology in mountain climbing can help apply physics concepts effectively (Fauziah & Sulisworo, 2022). GPS navigation devices and digital altimeters provide real-time

information regarding position and altitude, helping climbers understand changes in air pressure (Alfinnas, 2024). The climbing-specific mobile app provides an interactive physics guide on friction and potential energy. Wearable technology such as smartwatches with health sensors monitor climbers' vital signs, providing critical data that is analyzed using the principles of physics and biology. This data is helpful for climber safety and research into human body adaptation at extreme altitudes. The implementation of this technology benefits individuals and local communities, improving the skills of mountain guides, opening up job opportunities, and supporting the local economy through tourism (Yunanto et al., 2021; Yudhi et al., 2018).

Tabel 1. Correlation between climbing experience, climbing frequency, education, awareness of physics concepts, and knowledge of physics in assisting climbing

	Climbing experience (years)	Climbing frequency	Education Degree	Physics awareness	Knowledge of physics helps with climbing
Climbing experience (years)	1.000	0.25	0.082	-0.095	0.038
Climbing frequency	0.25	1.000	-0.047	0.03	-0.063
Education Degree	0.082	-0.047	1.000	0.032	-0.05
Physics awareness	-0.095	0.03	0.032	1.000	0.2
Knowledge of physics helps with climbing	0.038	-0.063	-0.05	0.2	1.000

By integrating science and technology in education and daily activities such as climbing, we can prepare a more competent and innovative generation of young people. This aligns with Lestari (2021), who explains that mountain climbing activities can develop positive student attitudes, such as planning, cooperation, responsibility, respect, togetherness, gratitude, honesty, caring, courage, toughness, tolerance, and alertness. Physics learning that is applicable and supported by modern technology can motivate students to apply their knowledge in authentic contexts, foster interest in STEM (Science, Technology, Engineering, and Mathematics) (Scalettar & Abney, 2023), and produce a ready golden generation for the Indonesian archipelago. Compete on the global stage. This is also in line with efforts to downstream knowledge, where knowledge is developed at the academic level and applied for practical and economic benefits (Rosnawati et al., 2021).

Conclusion

Based on the results and discussion, this research shows that physics awareness among mountain climbers is not significantly influenced by climbing experience or level of formal education. However, an understanding of physics concepts can help overcome physical climbing challenges. Therefore, it is recommended that education and outreach regarding the relevance of physics in climbing be increased. Developing practical guides and training programs that link physics concepts to real situations in the field can improve climbers' skills and safety.

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