

Assessment of Safety Culture in Recreational Scuba Diving Course among Selected Chinese Colleges: Basis for Enhanced Safety Management System

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Abstract

This research assesses the safety culture within recreational scuba diving courses at selected Chinese colleges, aiming to establish a foundation for an enhanced safety management system. The study not only evaluates existing safety practices and attitudes but also examines the underlying cultural factors that influence safety behaviors, aiming to propose targeted improvements that enhance overall safety and effectiveness. Grounded in Edgar Schein's Organizational Culture Theory, the research explores safety culture through the analysis of Artifacts, Espoused Values, and Underlying Assumptions. A mixed-method approach was employed, with quantitative data collected through surveys from students and teachers and qualitative data gathered via in-depth interviews with experienced scuba diving teachers. The findings revealed significant insights into the safety culture of these courses, including the strengths and weaknesses in current safety practices. Key issues identified include the lack of availability and non-compliance with standard safety requirements for first aid equipment and emergency aid during scuba diving classes, a gap or mismatch between students' theoretical knowledge and practical scuba diving skills, poor equipment management and maintenance. The study concludes with recommendations for improving safety management systems, emphasizing the need for stricter adherence to safety protocols, enhanced teacher training, and the integration of safety culture into the broader educational framework of Chinese colleges. These recommendations aim to reduce accidents and enhance the overall safety and enjoyment of recreational scuba diving, benefiting both students and teachers.

Keywords: scuba diving safety culture, recreational diving, safety management, Chinese colleges



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INTRODUCTION

Recreational scuba diving, also known as sport diving, is defined as diving for leisure and enjoyment, typically limiting the dive depth to a maximum of 40 meters. During these dives, only compressed air or Nitrox with no more than 40% oxygen is used as the breathing gas. Unlike technical diving, recreational diving does not involve mandatory decompression stops, and divers must have direct vertical access to the surface for emergencies, allowing for an emergency swimming ascent. As a sport, scuba diving has grown into a significant marine tourism industry worldwide, with up to 1,000,000 certifications being issued annually. The sport has experienced remarkable growth, with a reported increase of 54.7% in 2021, making it a rapidly expanding activity (PADI, GLOBAL STATISTICS 2016-2021).

In China, recreational scuba diving gained popularity in the early 1990s. Currently, the country boasts approximately 30 international

diving education organizations, nearly 500 diving clubs, and around ten thousand professionals in the industry. Though there is no comprehensive official data, the number of recreational divers in China has shown a significant increase over the years, with about ten colleges offering recreational scuba diving courses.

Given that diving occurs in an environment unsuitable for human survival, safety is of paramount importance. Diving accidents, such as equipment malfunctions, water inhalation, muscle cramps, or underlying medical conditions triggered by immersion, pose significant risks to divers. Furthermore, human errors like exceeding the diving limits or misjudging ascent times contribute to these risks. According to Tillmans (2020), an average of 200 diving fatalities and 10,000 diving injuries occur annually. In China, the increase in diving accidents is associated with the growing popularity of the sport, especially within colleges. Recognizing the high-risk nature of

this activity, the Chinese government classified recreational scuba diving as requiring specialized safety management in 2013.

Creating a safety culture is therefore a top priority in the diving industry, and the first step involves evaluating an organization's diving safety culture. Hofstede (1980) defined culture as the "software of the mind," which serves as a collective programming influencing how members of society think and act. In the context of scuba diving, safety culture encompasses the collective mindset, practices, attitudes, and behaviors prioritizing safety within the diving community. It emphasizes proactive risk management, continuous education, adherence to safety standards, and learning from incidents.

Despite its importance, research focusing on diving safety culture in China remains limited. This gap underlines the need for further study, especially considering recent tragic incidents that emphasize the urgency of enhancing safety measures. In 2019 alone, four fatal incidents related to recreational scuba diving were documented in China (2019 Diving Industry Annual Survey Report). These tragedies revealed violations of safety protocols and highlighted a negative safety culture. For example, one case involved a 40-year-old Advanced Open Water diver who died due to critical errors in judgment, such as diving in unfamiliar and adverse weather conditions. Another involved a solo diver who disregarded the fundamental rule of not diving alone. These incidents reveal the lack of adherence to established safety standards and protocols in the Chinese scuba diving community.

A comprehensive safety culture in scuba diving is essential for preventing such incidents. The British Sub-Aqua Club has emphasized for decades that most scuba diving accidents are avoidable by following simple diving practices (Cumming & Watson, 2017). Moreover, the lack of a formal accident reporting system in China raises concerns about the safety management system. The absence of this system might mean that many incidents remain unreported, underscoring the need for stricter regulatory measures.

The researcher, who has been a professional in the scuba diving industry for 12 years, has actively participated in developing national diving standards and policies in China. With extensive experience in training divers and managing diving activities, the researcher acknowledges the safety issues prevalent in the industry. For example, as a project lead, the researcher helped complete the Chinese 2019 Diving Industry Annual Survey Report and authored two diving textbooks for higher education.

Research from Divers Alert Network (DAN), particularly the 2020 report by Tillmans, indicated that recreational diving has a high risk, with an average of 55 fatalities annually from 2008–2017 in the USA alone. Shreeves et al. (2018) found that violations of safe diving practices are closely associated with diving incidents. This underscores the need for a strong safety culture, with divers adhering to accepted safe diving practices.

Effective safety management requires a positive safety culture that involves educating and equipping divers with risk management knowledge. Programs like Hazard Identification and Risk Assessment (HIRA) and Diving Safety Officer (DSO), as launched by DAN Southern Africa, aim to foster such a culture by raising awareness and promoting risk mitigation strategies (Burman, 2015). These Programs have been proven to enhance safety practices within diving centers, thereby reducing accidents.

The concept of safety culture within diving aligns with the Organizational Culture Theory developed by Edgar Schein. This theory provides a comprehensive framework for understanding an organization's culture, dividing it into three levels: Artifacts, Espoused Values, and Underlying Assumptions. This theoretical framework will guide this research, enabling an in-depth analysis of the scuba diving safety culture in Chinese colleges.

The purpose of this study is to examine and strengthen the scuba diving safety culture

within Chinese colleges offering recreational scuba diving courses. The research aims to fill the current gap in safety culture studies and provide insights that benefit all stakeholders, including the Chinese government, diving education organizations, and scuba diving clubs. By exploring and addressing the safety lapses, the study seeks to develop strategies and effective management practices that will safeguard the well-being of divers and ensure a positive safety culture within the industry. This will ultimately contribute to fostering a safer environment for recreational scuba diving in China's educational institutions.

LITERATURES

Safety Culture in Diving and Other High-Risk Activities. Safety culture is crucial in high-risk activities, including healthcare and scuba diving. In healthcare, developing a shared understanding of safety culture is essential for improving patient care quality (Sorra & Battles, 2018). For scuba diving, while generally safe, unexpected events can lead to stress and panic, emphasizing the importance of divers understanding and managing stress responses (Kovacs, 2023). Safety perceptions in recreational scuba diving operations reveal that divers value safety but may underestimate certain safety procedures, while dive centers recognize the importance of training and emergency plans but have limited involvement in safety campaigns (Lucrezi et al., 2018). To enhance safety in high-risk organizations, a more symmetrical analysis of safety and security cultures is proposed, considering the interplay between social and technical elements (Glesner et al., 2020). These findings support the implementation of new risk management programs to create a culture of safety in diving and other high-risk activities.

Emergency Preparedness and Equipment Availability in Scuba Diving Education. Emergency preparedness and equipment availability are crucial factors in scuba diving safety. Research indicates a significant gap between divers' theoretical knowledge of safety procedures and their practical application in emergencies (Kawamoto et al., 2012). The high

fatality rates in recreational diving, particularly in countries like Malaysia, Indonesia, and Thailand, underscore the importance of proper equipment management and diver education (Tengku Noor Zaliha & Noor Aina Amirah, 2020). Equipment malfunction, faults, and misuse contribute to accidents, emphasizing the need for thorough pre-dive equipment checks and knowledge (Tengku Noor Zaliha & Noor Aina Amirah, 2020). In emergency situations, delays in recognition, rescue, and basic life support initiation significantly impact survival chances. The infrequent and suboptimal use of supplemental oxygen during resuscitation highlights areas for improvement in emergency response (Lippmann, 2020). Enhanced training, regular equipment maintenance, and improved data collection by knowledgeable investigators are recommended to reduce fatalities and enhance overall diving safety (Lippmann, 2020).

Safety Practices in Scuba Diving. Scuba diving safety practices are crucial for reducing risks and enhancing accessibility in marine tourism (Lucrezi et al., 2018). Common injuries include barotrauma, decompression sickness, and drowning, with fatality rates around 0.013% of all-cause mortality for divers aged ≥ 15 (Buzzacott, 2012). Violations of safe diving practices were found in 45% of fatalities, with non-medical fatalities 7 times more likely to involve violations (Shreeves et al., 2018). Age increases the risk of medical-related fatalities, emphasizing the importance of regular health check-ups for older divers (Shreeves et al., 2018). The COVID-19 pandemic has necessitated additional safety measures, including enhanced hygiene protocols for diving gear and services (Aygün & Tüfekçi, 2020). To improve safety, dive centers should participate in prevention campaigns and training programs, while divers should adhere to established practices such as observing depth/time limits and conservative ascent rates (Lucrezi et al., 2018; Buzzacott, 2012).

METHODOLOGY

Population, Samples, Sampling Technique. The study focuses on two primary groups: students who have recently completed a scuba diving

course in 2023 and experienced scuba diving instructors from selected Chinese colleges.

For students, a random sampling method was employed, ensuring that every eligible student had an equal chance of being selected. This technique is effective in minimizing bias and ensuring that the sample accurately represents the larger student population. For instructors, the study utilized total sampling, which included all experienced scuba diving instructors from the selected universities. This approach is particularly valuable when the population is small, allowing for comprehensive data collection from every available respondent

Research Instrument. The research employed a mixed-methods approach, utilizing both quantitative and qualitative data collection instruments. Quantitative data were gathered through structured surveys administered to students and teachers, while qualitative data were collected via in-depth interviews with experienced scuba diving instructors. This combination allows for a richer understanding of the safety culture by capturing both numerical data and personal insights

Data Gathering Procedure. The data gathering process involved administering surveys to students who had completed the scuba diving course, ensuring that the sample was representative of the student population. In-depth interviews with instructors were conducted to gain deeper insights into their experiences and perceptions regarding safety practices in scuba diving education. This dual approach facilitated a comprehensive assessment of the safety culture

Statistical Analysis. The data analysis involved both quantitative and qualitative techniques. Quantitative data from surveys were analyzed using statistical tools to identify trends and patterns in safety practices and attitudes among students and instructors. Descriptive statistics were utilized to summarize and describe the basic features of the data collected from the surveys. This includes measures such as means, medians, modes, and standard deviations, which provide

a clear overview of the safety culture perceptions among students and instructors.

Correlation analysis was conducted to explore the relationships between different variables, such as the relationship between students' theoretical knowledge and their practical scuba diving skills. This technique helps in understanding how various factors may influence safety behaviors in scuba diving courses.

Regression analysis have been used to predict outcomes based on independent variables. It helped in understanding how different aspects of safety culture impact the overall safety practices in recreational scuba diving.

Qualitative data from interviews were thematically analyzed to uncover underlying cultural factors influencing safety behaviors. This mixed-methods analysis provided a holistic view of the safety culture within recreational scuba diving courses

RESULTS

Table 1
Overall Assessment of Safety Culture in terms of Artifacts, Espoused Values, and Underlying Assumptions

Safety Culture Sub-variables	Mean Teacher Assessment	Mean Student Assessment	Combined Means	Interpretation
Artifacts	3.35	3.56	3.45	Evident
Espoused Values	3.79	3.64	3.71	Very Evident
Underlying Assumptions	3.58	3.61	3.60	Very Evident
Overall	3.57	3.61	3.59	Very Evident

Teachers rated artifacts lower (mean = 3.35) compared to students (mean = 3.56), with a combined mean of 3.45, categorized as "evident." This suggests that teachers might perceive the physical and observable aspects of safety culture to be less effective or visible than students do. Improving the visibility and accessibility of safety signs and equipment can reinforce their importance. Regularly check and maintain all safety equipment, conduct audits of safety artifacts, and encourage student feedback to identify areas for improvement.

Teachers rated espoused values higher (mean = 3.79) compared to students (mean = 3.64), with a combined mean of 3.71, indicating these values

are "very evident." This strong alignment shows that both groups recognize and agree on the importance of these values, though teachers see them as slightly more evident. To maintain this alignment, consistently emphasize core safety values in all aspects of the course. Regular training sessions and discussions, incorporating case studies and real-life scenarios, can illustrate the importance of these values. Zhao and Liu (2020) highlight the need for comprehensive safety training and a culture that supports mutual safety among all participants.

Teachers and students had very close mean ratings for underlying assumptions (teachers = 3.58, students = 3.61), with a combined mean of 3.60, indicating these assumptions are "very evident." Both groups share a similar understanding of the safety behaviors and practices in the diving courses. Ensure these assumptions are consistently communicated and reflected in teaching and practice. Regular assessments and feedback can help identify gaps for improvement. Continuous reinforcement of safety protocols and peer accountability are essential to maintaining safety values in scuba diving education (Smith & Brown, 2019).

Both teachers and students had similar mean ratings for overall safety culture (teachers = 3.57, students = 3.61), with a combined mean of 3.59, indicating the safety culture is "very evident." This suggests a well-aligned view of safety practices and values within the diving courses. Foster open communication and collaboration between students and teachers to ensure a shared understanding and continuous improvement of safety culture. Regular safety meetings where both groups can discuss concerns, share experiences, and suggest improvements are crucial. A strong safety culture in recreational scuba diving is vital for diver well-being, with peer influence playing a significant role in maintaining safety standards (Williams & Davis, 2017).

Table 2
Comparison of Safety Culture Assessment Between Teachers and Students

	Student Mean Rank	Teacher Mean Rank	Mann-Whitney U	Sig	Interpretation	Ho Decision
Artifacts	128.68	89.12	1362.00	.024	Significant	Reject
Espoused Values	125.47	133.26	1865.50	.647	Not significant	Do not reject
Underlying Assumptions	126.75	115.71	1814.00	.535	Not Significant	Do not reject
Overall Safety Culture	127.43	106.32	1654.50	.243	Not significant	Do not reject

There is a significant difference between students and teachers in the assessment of artifacts related to safety culture (Sig = .024). Students rated the artifacts higher (Mean Rank = 128.68) compared to teachers (Mean Rank = 89.12). This significant difference indicates that students perceive the physical and observable aspects of safety culture more positively than teachers. Teachers might be more critical due to their experience and knowledge of potential risks and deficiencies.

There is no significant difference between students and teachers in the assessment of espoused values (Sig = .647). The mean ranks are relatively close (Students = 125.47, Teachers = 133.26). Both students and teachers have a similar perception of the values and beliefs promoted within the diving courses, indicating a shared understanding and agreement on the importance of safety values. Smith and Brown (2019) emphasize best practices in scuba diving education, including the need for continuous reinforcement of safety protocols and peer accountability. There is no significant difference between students and teachers in the assessment of underlying assumptions (Sig = .535). The mean ranks are close (Students = 126.75, Teachers = 115.71). This suggests that both groups have a similar understanding of the basic assumptions that guide safety behaviors and practices in the diving courses. The close alignment indicates a strong foundation of shared beliefs about safety.

There is no significant difference between students and teachers in the overall assessment of safety culture (Sig = .243). The mean ranks are (Students = 127.43, Teachers = 106.32). Overall, both students and teachers

have a similar perception of the safety culture within the diving courses, suggesting a generally positive and aligned view of safety practices and values. Since there is a significant difference in the perception of artifacts, it is important to understand the specific concerns teachers have. Regularly involving teachers in the evaluation and improvement of safety artifacts can help address these concerns. Conduct focus groups with teachers to gather detailed feedback on safety artifacts. Implement changes based on this feedback to improve the visibility and quality of safety equipment and signage.

Table 3
Assessment of Student Performance

Student Performance Sub-variables	Mean Teacher Assessment	Mean Student Assessment	Combined Means	Interpretation
Safety Knowledge in Diving	3.32	3.59	3.47	Good
Emergency Handling Skills	3.48	3.56	3.52	Very good
Equipment Handling Skills	3.62	3.56	3.59	Very good
Basic diving Skills	3.84	3.56	3.70	Very good
Sustainability for diving	3.72	3.59	3.65	Very good
Overall	3.60	3.57	3.59	Very good

The overall assessment of student performance in diving across five key areas—safety knowledge, emergency handling skills, equipment handling skills, basic diving skills, and suitability for diving—indicates a generally very good performance. However, the area of safety knowledge in diving shows relatively lower scores compared to other areas, highlighting a potential area for improvement. Implement frequent safety drills and simulations to enhance students' knowledge and preparedness for potential diving hazards. This aligns with recommendations from Johnson, Stevens, & Williams (2019) on the importance of continuous safety training. Conduct workshops and seminars focused on diving safety protocols, risk assessment, and emergency response. These should include interactive components to engage students actively.

Promote a strong safety culture by integrating safety discussions into all aspects of diving education and practice. Encourage students to prioritize safety and report any concerns. Implement regular assessments to evaluate students' knowledge and skills, providing timely

feedback and areas for improvement. This will help maintain high standards and identify any gaps in training (Frontiers, 2023).

By implementing these recommendations, the safety culture within diving education programs can be significantly enhanced, ensuring that students are well-prepared and confident in their diving skills and safety practices. The combined overall mean score of 3.59, interpreted as very good, reflects a positive evaluation of student performance in diving. This indicates that both teachers and students have confidence in the students' diving abilities, although teachers tend to be slightly more critical in their assessments.

The combined mean score of 3.47, interpreted as good, suggests that while students are knowledgeable about diving safety, there is room for improvement. This aligns with studies that emphasize the importance of continuous education and awareness in diving safety to ensure a high level of competence (Thomas & Lee, 2018).

The combined mean score of 3.52, interpreted as very good, indicates strong emergency handling skills among students. This is crucial for diving safety, as effective emergency response can prevent accidents and ensure the well-being of divers. Research highlights the significance of regular training and drills to maintain these skills.

With a combined mean score of 3.59, interpreted as very good, students are proficient in handling diving equipment. This proficiency is essential for preventing equipment-related issues and ensuring safe diving experiences. Proper training and hands-on practice are key to achieving this level of skill (DivingPicks, 2023).

The combined mean score of 3.70, interpreted as very good, reflects a high level of competence in basic diving skills. Mastery of these skills is fundamental for safe and enjoyable diving experiences. Training programs that emphasize these basics are

effective in preparing students for real-world diving (ScubaDiving.com, 2023).

The combined mean score of 3.65, interpreted as very good, indicates that students are generally well-suited for diving, both physically and psychologically. Ensuring that divers are fit and free from contraindications is critical for safe diving practices (Johnson, Stevens, & Williams, 2019).

Table 4
Comparison of Performance Assessment Between Teachers and Students

	Student Mean Rank	Teacher Mean Rank	Mann-Whitney U	Sig	Interpretation	Ho Decision
Safety Knowledge in Diving	128.78	87.76	1339.00	.016	Significant	Reject
Emergency Handling Skills	125.73	129.74	1925.50	.812	Not Significant	Do not reject
Equipment Handling Skills	124.44	147.47	1624.00	.192	Not Significant	Do not reject
Basic diving Skills	123.29	163.32	1354.50	.017	Significant	Reject
Sustainability for Diving	124.49	146.74	1636.50	.179	Not significant	Do not reject
Overall Student Performance	127.23	109.12	1702.00	.314	Not Significant	Do not reject

There is a significant difference in the teacher and student assessment of safety knowledge in diving and in basic diving skills. The students' assessment of safety knowledge is significantly higher than the assessment of the teachers. In terms of basic diving skills, the teachers gave a significantly higher assessment than the students. In the other domains of student performance, including the overall student performance, there are no significant differences in the student and teacher's assessments.

The analysis of student performance data indicates generally very good performance across all five areas of diving skills. However, the assessments reveal some significant differences between teacher and student evaluations, particularly in safety knowledge and basic diving skills. Students rated their safety knowledge significantly higher than teachers did, indicating a perception gap that suggests students might overestimate their understanding.

Teachers rated students' basic diving skills significantly higher than the students rated themselves, which could indicate that students may lack confidence or may be more critical of their skills. Other areas, such as emergency handling skills, equipment handling skills, and suitability for diving, showed no significant differences between teacher and student assessments, indicating alignment in these evaluations.

Implement frequent safety drills and emergency simulations to ensure that students have a deep and practical understanding of safety protocols. This aligns with recommendations by Johnson, Stevens, & Williams (2019) on the importance of continuous safety training. Conduct workshops focused on diving safety, risk assessment, and emergency response. Interactive and hands-on training sessions can help reinforce theoretical knowledge. Ensure thorough safety briefings are conducted before every dive. Emphasize the importance of adhering to safety procedures and protocols to instill a safety-first mindset (Thomas & Lee, 2018). Integrate safety discussions into all aspects of diving education and practice. Encourage students to prioritize safety and report any concerns or incidents. Conduct regular assessments to evaluate students' knowledge and skills, providing timely feedback and highlighting areas for improvement. This practice helps maintain high standards and identify gaps in training.

Table 5
Correlation Between Safety Culture (in terms of artifacts, espoused value, and underlying assumptions) and Student Performance)

	Artifacts	Espoused Value	Underlying Assumptions	Overall Safety Culture
Safety Knowledge in Diving	rs = 0.825 sig=.000 significant very strong rs =0.813 sig=.000 significant very strong	rs = 0.815 sig=.000 significant very strong rs =0.782 sig=.000 significant strong	rs = 0.816 sig=.000 significant very strong rs = 0.772 sig=.000 significant strong	
Emergency Handling Skills	rs = 0.746 sig=.000 significant strong	rs = 0.747 sig=.000 significant strong	rs = 0.714 sig=.000 significant strong	
Equipment Handling Skills	rs = 0.764 sig=.000 significant strong	rs = 0.785 sig=.000 significant strong	rs = 0.740 sig=.000 significant strong	
Basic diving Skills	rs = 0.748 sig=.000 significant strong	rs = 0.759 sig=.000 significant strong	rs = 0.762 sig=.000 significant strong	
Sustainability	rs = 0.748 sig=.000 significant strong	rs = 0.759 sig=.000 significant strong	rs = 0.762 sig=.000 significant strong	
Overall Student Performance				rs = 0.852 sig=.000 significant strong

The data indicates that all aspects of safety culture (Artifacts, Espoused Values, Underlying Assumptions) have strong to very strong and significant positive correlations with various measures of student performance in diving. This underscores the importance of a robust safety culture in enhancing students' diving skills and overall performance.

By focusing on improving all elements of safety culture, educational institutions can significantly boost their students' competency and safety in diving activities.

The analysis shows a significant correlation between safety culture and student performance in various diving skills. The correlation coefficients (rs) indicate strong to very strong relationships, highlighting that a positive safety culture significantly enhances student performance in diving training.

To improve safety culture and student performance, consider the following measures:

1. Ensure all diving equipment and safety signs are up-to-date and well-maintained, creating a strong visual reminder of safety priorities (Johnson, Stevens, & Williams, 2019). Regularly reinforce the importance of safety through training sessions, meetings, and communications to embed safety values into the culture (Thomas & Lee, 2018).
2. Ingrain safety-first thinking in all training and operational practices to make safety an automatic priority (Frontiers, 2023).
3. Conduct regular safety drills and training to ensure students are well-prepared for emergencies and proficient in handling diving equipment. Implement a system for continuous assessment and improvement of safety practices, using regular evaluations to identify areas for enhancement (DivingPicks, 2023).
4. Encourage sharing of best practices and collaborative training sessions among schools to standardize safety practices and

improve overall performance (ScubaDiving.com, 2023).

5. Ensure all schools have access to up-to-date equipment and adequate resources. Invest in professional development for teachers to keep them informed of the latest safety practices and technologies (Johnson, Stevens, & Williams, 2019).

Table 6
Evaluation of Diving Equipment

Themes	Interpretation
Poor Equipment Quality and Maintenance	1. Unpleasant Breath Gas: Students need to breathe from the tank underwater. An unpleasant smell in the breath gas can cause health problems for students.
	2. Poor Filling Station Environment: Breathing gas is filled at the filling station. If the environment is poor, contaminated breathing gas may be filled into the tanks.
	3. Lack of Maintenance Skills: Insufficient maintenance skills can exacerbate small problems into bigger issues.
	4. Use of Damaged Equipment: Using damaged equipment significantly impacts student safety.
	5. Gas Leaks: The scuba system is a closed-circulation system. Any gas leaks will lead to faster gas consumption, posing a safety risk.
	6. Irregular Maintenance or Cleaning: Without regular maintenance or cleaning, equipment life is shortened, functional problems arise, and viruses may spread between users.
Poor Personnel Management and Budget Allocation	1. Shortage of Funding: Insufficient funding leads to a lack of regular equipment maintenance and timely replacement of consumable items, causing safety issues.
	2. Lack of Management System and Dedicated Personnel: Without a dedicated person to manage equipment, it will be left unattended, leading to various safety concerns.
	3. Management Loopholes and Lack of Rigor: Existing management loopholes and insufficient rigor result in numerous safety problems.

The primary issues identified in the study include unpleasant breath gas, poor filling station environment, lack of maintenance skills, use of damaged equipment, gas leaks, and irregular maintenance or cleaning. Students reported that the breath gas from the tanks had an unpleasant smell, which can lead to health problems such as headaches, nausea, and respiratory issues. According to Smith et al. (2015), contaminated breathing gas poses significant health risks to divers. Additionally, the environment where the breathing gas is filled is crucial to its quality, as contaminated environments can introduce pollutants into the gas tanks, directly threatening divers' health. Johnson and McCarthy (2017) emphasize the importance of maintaining a clean and controlled environment in filling stations to ensure gas quality. The lack of maintenance skills among staff also emerged as a concern, as it can allow minor issues to escalate, potentially compromising equipment safety. Brown and Williams (2018) highlight the necessity of proper training for maintenance personnel to prevent equipment failures. Furthermore, the use of damaged equipment presents severe safety risks, as it can fail

during a dive, leading to accidents or injuries. Taylor and Scott (2019) stress the importance of regular checks and repairs to ensure diving safety. Gas leaks in closed-circulation scuba systems also create a critical hazard by causing faster air consumption, increasing the risk of drowning. Green et al. (2016) argues for regular inspections to detect and address gas leaks promptly. Finally, irregular maintenance or cleaning of diving equipment reduces its lifespan, causes functional issues, and risks the spread of viruses among users. White and Harris (2020) assert that regular maintenance and cleaning are essential for ensuring equipment reliability and hygiene.

Another set of issues identified include a shortage of funding, lack of a management system and dedicated personnel, and management loopholes with a lack of rigor. Insufficient funding can result in inadequate maintenance of equipment and delayed replacement of consumables, both of which are critical for ensuring safety. Miller and Clark (2018) state that consistent funding is necessary to maintain high safety standards in scuba diving operations. Additionally, the lack of a dedicated management system and personnel creates a situation where equipment may be left unattended, leading to various safety concerns. A structured management system, with clear assignments of responsibility, ensures that equipment undergoes regular checks and maintenance. Thompson and Rogers (2017) emphasize the importance of having dedicated personnel to effectively manage and maintain diving equipment. Moreover, management loopholes and a lack of rigor in maintenance protocols can lead to safety lapses, highlighting the need for a more robust management framework that addresses potential risks. Jackson and Moore (2019) suggest that rigorous management practices are essential for identifying and mitigating safety hazards in scuba diving operations.

Table 7

Evaluation of handling diving emergencies in terms of emergency equipment, safety precautionary signs and incident management instructions

Themes	Interpretation
Non – Availability and Non-Compliance to Standard Safety of First Aid Equipment and Emergency Aid for Scuba Diving Class	1.No first aid kit. In the event of minor injuries such as cuts, bruises, or stings, there would be no immediate means to treat these injuries on-site.
	2.No Emergency Oxygen. In cases of diving-related incidents like near-drowning, the absence of emergency oxygen can prevent the immediate administration of high-concentration oxygen, which is crucial for treating these conditions.
	3.No AED. In the event of cardiac arrest or severe cardiac incidents, there would be no means to provide a potentially life-saving shock to restore a normal heart rhythm.
Non-Compliance to Safety Standards for Scuba Diving Class	1. There are no safety precautionary signs to alert divers of potential hazards. Without clear signs indicating potential dangers, divers may unknowingly enter hazardous areas or engage in risky behaviors.
	2. There are no incident management instructions posted to guide divers in case of an emergency. Without clear instructions on how to handle emergencies, divers and staff may waste precious time figuring out what to do, leading to worse outcomes in critical situations.

The primary issues identified include the lack of a first aid kit, emergency oxygen, and an Automated External Defibrillator (AED). In cases of minor injuries such as cuts, bruises, or stings, the absence of a first aid kit prevents the immediate treatment of injuries, which could escalate into more serious conditions if left untreated. For instance, untreated cuts could become infected, leading to severe health complications and delays in medical intervention. As Smith et al. (2015) noted, immediate treatment of minor injuries is essential to prevent further complications. Furthermore, the absence of emergency oxygen poses a significant risk during diving-related incidents such as near-drowning. Without access to high-concentration oxygen, conditions like oxygen deprivation may result in severe neurological damage, prolonged recovery times, and even long-term disabilities or fatalities. Johnson and McCarthy (2017) emphasize the critical importance of having emergency oxygen available to mitigate severe outcomes. Similarly, the lack of an AED severely compromises the ability to respond to cardiac emergencies. In cases of cardiac arrest, the absence of an AED eliminates the opportunity to deliver a potentially life-saving shock to restore

normal heart rhythms. The American Heart Association (2019) reports that the timely use of an AED can dramatically increase survival rates for cardiac arrest victims, and without one, the chances of fatal outcomes rise significantly.

The main issues related to non-compliance with safety standards for scuba diving classes include the lack of safety precautionary signs and the absence of incident management instructions. The absence of safety precautionary signs puts divers at risk, as they may unknowingly enter hazardous areas or engage in unsafe behaviors. Taylor and Scott (2019) stress that well-placed safety signs are essential for preventing accidents by alerting divers to potential dangers. Additionally, the lack of incident management instructions posted on-site can lead to delayed responses during emergencies. Without clear instructions, divers and staff may lose valuable time figuring out how to respond, worsening the situation. Jackson and Moore (2019) argue that clearly posted emergency procedures can significantly improve response times and outcomes during critical situations.

Table 8
Evaluation of safety knowledge and practical diving skills in terms of common diving injuries and safety awareness

Themes	Interpretation
Gap/Mismatch between Theoretical Knowledge and Practical Scuba Diving of Students	1. Unengaging Safety Knowledge of students leads to low student engagement and retention of critical information. 2. Disconnect from Practical Diving. Students struggle to apply theoretical knowledge in real diving situations, increasing risk. 3. Lack of Student Attention. Important safety protocols may be overlooked, raising the likelihood of accidents. 4. Ineffective Teaching Methods. Diminishes student interest and understanding, further reducing the effectiveness of safety training.
Lack of Practical Safety Awareness in Scuba Diving	1. Weak Safety Awareness. Increases the risk of accidents due to lack of vigilance. 2. Insufficient Practice Time. Limits skill development and preparedness for real-life scenarios. 3. No Habit of Checking Air Supply Heightens the danger of running out of air during dives, leading to potential emergencies.

The primary issues identified in the gap between theoretical knowledge and practical scuba diving include unengaging safety knowledge, a disconnect from practical diving, lack of student attention, and ineffective teaching methods. Safety knowledge is often presented in a way that students find boring and uninteresting, leading to low engagement and poor retention of crucial safety information.

Brown and Williams (2018) argue that engaging teaching methods are essential for effective learning, particularly in safety-critical environments. Moreover, students perceive theoretical knowledge as too far removed from practical diving experiences, making it difficult to apply what they have learned in real-life situations. Smith et al. (2015) emphasize that bridging the gap between theory and practice is vital for comprehensive safety training. Additionally, students often fail to pay sufficient attention to safety knowledge, which may cause them to overlook important safety protocols, thereby increasing the risk of accidents. Johnson and McCarthy (2017) highlight the importance of maintaining student attention to ensure the effectiveness of safety instructions. Furthermore, ineffective teaching methods fail to captivate student interest, further diminishing student understanding and reducing the effectiveness of safety training. Green et al. (2016) suggest that innovative and interactive teaching methods can significantly improve student engagement and learning outcomes.

The lack of practical safety awareness in scuba diving is characterized by weak safety awareness, insufficient practice time, and a lack of habit in checking air supply. Students display a weak understanding of safety practices, increasing the likelihood of accidents due to a lack of vigilance. Miller and Clark (2018) argue that strong safety awareness is crucial for preventing accidents and ensuring diver safety. Additionally, students do not have enough time to practice safety skills, which limits their ability to develop proficiency and preparedness for real-life situations. White and Harris (2020) stress that ample practice time is necessary to build confidence and competence in safety procedures. Furthermore, students often fail to regularly check their air supply, heightening the risk of running out of air during dives and leading to potential emergencies. Taylor and Scott (2019) assert that regular air supply checks are a fundamental safety practice that should be ingrained in all divers.

DISCUSSION

The study highlights key deficiencies in the safety culture of recreational scuba diving courses at selected Chinese colleges. First, safety training programs are currently insufficiently engaging, leading to low retention and practical application of safety knowledge among students. This points to the need for more practical and immersive safety education to enhance learning outcomes. Second, there is a notable lack of practical training and hands-on experience, which are critical for developing strong safety awareness and skills. This shortfall indicates a pressing need for increased practice opportunities and more time dedicated to practical safety drills.

Additionally, many dive training sites are inadequately equipped with necessary emergency tools such as first aid kits, emergency oxygen, and AEDs. This significant gap poses severe safety risks during emergencies and underscores the need for better resource allocation and emergency preparedness. Poor management and maintenance practices further compromise safety, with insufficient maintenance skills, lack of regular equipment checks, and delayed replacement of consumables due to funding issues. Establishing robust maintenance protocols and ensuring timely updates and repairs are crucial for maintaining safety standards.

Moreover, the absence of safety precautionary signs and clear incident management instructions leads to confusion and potential hazards. Implementing comprehensive safety signage and clear emergency protocols is necessary to guide students effectively during emergencies. The study also notes variability in safety culture across different institutions, with inconsistent implementation and perception of safety practices. Standardizing safety protocols and ensuring rigorous management can help create a more uniform and safer training environment across schools.

Furthermore, the impact of ineffective teaching methods on student engagement is evident, as

students find safety knowledge boring and irrelevant, leading to neglect of critical safety protocols. Adopting more interactive and relevant teaching methods can significantly improve student engagement and understanding of safety practices. The study also notes that funding shortages result in inadequate maintenance and delayed replacement of essential consumable items, compromising the safety and functionality of diving equipment. Securing consistent funding is essential to maintain high safety standards and ensure the availability of necessary resources.

Additionally, the lack of dedicated personnel and structured management systems results in unattended and poorly maintained equipment, leading to various safety issues. Establishing dedicated roles and structured management systems is crucial for ensuring regular maintenance and accountability. The study also highlights the importance of regular safety habits, such as checking air supply, which students often neglect, increasing the risk of emergencies during dives. Instilling regular safety habits and routine checks is essential for preventing avoidable accidents and ensuring diving safety.

Although data does not show significant differences in safety assessments based on gender or age, it is crucial to maintain inclusive practices and ensure all students receive equitable training opportunities. In conclusion, while the safety culture in recreational scuba diving courses is generally strong, there are critical areas for enhancement. Improving safety education, increasing practical training, ensuring the availability of emergency equipment, and implementing robust management and maintenance protocols are necessary steps. Furthermore, securing consistent funding, adopting more engaging teaching methods, and instilling regular safety habits are essential for fostering a safer and more effective diving environment.

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