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The knowledge–behavior gap in occupational safety among vocational students during practical training: A literature review of individual, social, and environmental factors

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Abstract

The gap between occupational safety knowledge and safety behavior remains a concern in vocational practical activities, as understanding safety principles does not always translate into compliance with safety procedures. This study aims to analyze the relationship between occupational safety knowledge and safety behavior and to identify factors associated with this gap in vocational practical activities. A literature review was conducted using a narrative thematic synthesis of 15 research articles published between 2020 and 2026. The findings indicate that occupational safety and health (OSH) knowledge is important but insufficient to ensure consistent safe behavior. The gap is associated with individual factors, including attitudes and motivation; social factors, such as instructor leadership, peer influence, and safety climate; and environmental and institutional factors, including the availability of personal protective equipment (PPE) and OSH program management. This review contributes by mapping these factors to inform the improvement of OSH education through an integrated approach involving knowledge development, behavioral habituation, supervision, and a supportive practical learning environment.

Keywords: Occupational safety knowledge; Safety behavior; Vocational practical activities; Personal protective equipment compliance; Safety climate.

Abstrak

Kesenjangan antara pengetahuan dan perilaku keselamatan kerja masih menjadi persoalan dalam kegiatan praktikum pendidikan vokasional karena pemahaman tentang keselamatan kerja tidak selalu tercermin dalam kepatuhan terhadap prosedur keselamatan. Penelitian ini bertujuan menganalisis hubungan pengetahuan dengan perilaku keselamatan kerja serta mengidentifikasi faktor-faktor yang berkaitan dengan kesenjangan tersebut dalam kegiatan praktikum vokasional. Penelitian ini menggunakan kajian literatur dengan sintesis tematik naratif terhadap 15 artikel penelitian yang diterbitkan pada 2020–2026. Hasil kajian menunjukkan bahwa pengetahuan keselamatan dan kesehatan kerja (K3) merupakan aspek penting, tetapi belum memadai untuk menjamin perilaku keselamatan yang konsisten. Kesenjangan tersebut berkaitan dengan faktor individu, seperti sikap dan motivasi; faktor sosial, seperti kepemimpinan instruktur, pengaruh teman sebaya, dan iklim keselamatan; serta faktor lingkungan dan kelembagaan, seperti ketersediaan alat pelindung diri (APD) dan pengelolaan program K3. Kajian ini berkontribusi melalui pemetaan faktor-faktor tersebut sebagai dasar penguatan pendidikan K3 yang mengintegrasikan pengetahuan, pembiasaan perilaku, pengawasan, dan lingkungan praktikum yang mendukung keselamatan.

Kata Kunci: Pengetahuan K3; Perilaku keselamatan kerja; Praktikum vokasional; Kepatuhan penggunaan APD; Iklim keselamatan.

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Introduction

Occupational safety is an important concern for young people preparing to enter the workforce, including vocational education students. In their critical review of young worker safety, Turner et al. (2022) explain that this group's vulnerability is associated with individual development, job characteristics, limited training, managerial attitudes, and social influences. Such risks cannot be explained by age alone but are also shaped by working conditions and opportunities to access safety protection. Similarly, Sundstrup et al. (2025), in their review of 33 intervention studies on young worker safety, found that evidence regarding intervention effectiveness remains mixed and that further research of higher quality is needed. These findings indicate that safety education should begin before students enter the workplace, including during vocational practical training.

Vocational practical training differs from theoretical learning because students interact directly with equipment, materials, machinery, electricity, and working conditions that may pose accident risks. Ramesh and Norazahar (2024) investigated the safety climate and safety culture among chemical engineering students at Universiti Teknologi Malaysia, particularly those using the Separation Process and Fluid Mechanics laboratories. Their study identified safety climate and safety culture as important aspects of laboratory risk management. Meanwhile, Wu et al. (2023) conducted a survey of 335 students at Kunming University of Science and Technology in China. The results showed that the mean score for recognizing GHS pictograms was only 2.56, while the mean score for understanding emergency situations was 2.20. These findings demonstrate that practical training requires more than technical skills; students must also be able to recognize hazards and understand appropriate preventive measures.

Safety issues in practical training become more complex when knowledge and positive attitudes are not consistently translated into safe behavior. Wang et al. (2023) surveyed 959 students from four faculties at Tianjin University of Technology. Their findings indicated that most students had positive perceptions of the laboratory environment and safety awareness, although their safety attitudes still needed improvement. A similar gap was reported by Yanee et al. (2025) in a study involving 30 pre-service secondary school science teachers in Malaysia. Although 70% of respondents demonstrated high levels of safety knowledge and all reported positive attitudes, 23.3% reported only moderate adherence to safety practices. Furthermore, although 87.5% of safety facilities were available, only 32.7% were functioning properly. These findings suggest that knowledge and attitudes alone are insufficient to ensure the implementation of safe practices without the support of functioning facilities.

Research on safety education and behavior among young people has adopted various approaches. In their evaluation of the Safety Matters program involving 283 young

participants in Colorado, Okun et al. (2024) found that OSH knowledge increased from 62% to 85.3% in correct responses, while attitudes toward the importance of safety improved from 4.48 to 4.77 on a five-point scale. These results indicate that education can strengthen knowledge and attitudes, but do not establish whether such improvements translate into sustained behavior in actual work settings. Meanwhile, Yang et al. (2025) found that safety knowledge was associated with attitudes, whereas students' behavior was influenced by educational level, the quality of safety education, and attitudes. Both studies highlight the importance of OSH education; however, they do not specifically explain how the knowledge–behavior gap develops during vocational practical training or identify the factors associated with it.

In response to this gap, this study aims to analyze the gap between occupational safety knowledge and behavior in vocational practical training through a structured literature review. The analysis focuses on identifying forms of the gap reported in previous studies, explaining the relationship between knowledge and safety compliance and behavior, and examining individual, social, and environmental factors associated with OSH implementation. This review is important because the effectiveness of safety education depends not only on students' ability to explain procedures or recognize hazards but also on their consistency in applying safety practices when facing practical risks. By integrating empirical findings from previous research, this study is expected to provide a more comprehensive understanding of the factors that support or hinder safe behavior, while also informing efforts to strengthen OSH education, practical training supervision, and the development of a safety culture in vocational education settings.

Method

This study employed a structured literature review design with a narrative thematic synthesis approach to analyze the gap between occupational safety knowledge and behavior in vocational practical training. The data sources consisted of scientific journal articles addressing students' knowledge, attitudes, behavior, or safety-related factors in practical training, workshops, and laboratories. The review was limited to articles published between 2020 and 2026 in Indonesian or English. The inclusion criteria covered scientific journal articles with relevant research subjects and focus, whereas conference proceedings, undergraduate theses, reports, studies of industrial workers without an educational context, and articles that did not measure the specified safety aspects were excluded. The article selection process is presented in Figure 1, which adapts the structure of the PRISMA 2020 flow diagram (Page et al., 2021). This review did not follow the full PRISMA protocol and was not preregistered.

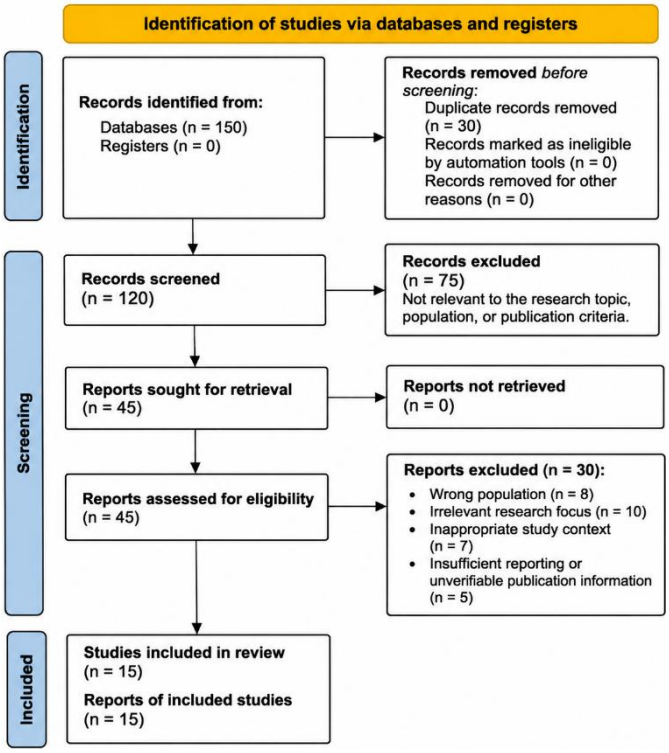


Figure 1. PRISMA Flow Diagram of the Study Selection Process

Source: Adapted from Page et al. (2021).

As shown in Figure 1, a total of 150 articles were identified through the initial search. After 30 duplicate articles were removed, 120 articles were screened based on their titles and abstracts, of which 75 were excluded because they did not align with the review's focus. The full texts of the remaining 45 articles were then assessed, and all were successfully retrieved. At the eligibility assessment stage, 30 articles were excluded because of an inappropriate population (8 articles), research focus (10 articles), research context (7 articles), or insufficient reporting or publication information (5 articles). Consequently, 15 articles were selected as the primary sources for synthesis. Articles were collected with the assistance of artificial intelligence tools, web search engines, and direct searches of journal websites. The search terms included "*hubungan pengetahuan K3 dengan perilaku keselamatan siswa SMK praktik bengkel*", "*vocational students safety knowledge attitude behavior*", "*workshop safety behavior*", and "*PPE compliance among vocational students*".

Data from each article were extracted using a matrix covering authors and publication year, research design, subjects, sample size, variables, instruments, analytical techniques, main findings, conclusions, and limitations. Metadata, including DOI, volume, issue, page numbers, and journal status, were verified through publisher websites or indexing databases where available. Article quality was assessed qualitatively based on six aspects: appropriateness of the research design, sample size and sampling technique, instrument validity and reliability, methods of behavioral measurement, reporting consistency, and journal status. The analysis employed

narrative thematic synthesis across six themes: the relationship between knowledge and behavior, forms of the knowledge–behavior gap, individual factors, social factors, environmental and institutional factors, and strategies for improvement. Findings were compared in terms of research design, sample, context, and measurement. Results from cross-sectional studies were interpreted as associations rather than causal relationships. Numerical discrepancies were re-examined and, where possible, recalculated; such results were identified as the authors' calculations rather than the original findings of the articles (Whittemore & Knafl, 2005; Snyder, 2019).

Results and Discussion

Characteristics of research on occupational safety knowledge, attitudes, and behavior in vocational education

This review covers 15 studies published between 2021 and 2026. The publication distribution indicates that research on occupational safety and health (OSH) in vocational education has been conducted continuously, although the number of publications has fluctuated from year to year. One study was published in 2021, followed by two studies in 2022, two in 2023, three in 2024, four in 2025, and three in 2026. This distribution suggests that OSH remains an important concern in vocational education, particularly in relation to students' preparedness to face risks during practical learning activities. In general, these studies examined OSH knowledge, safety attitudes, compliance with personal protective equipment (PPE) requirements, and the implementation of safe work behavior. The characteristics of each study are summarized in Table 1.

Table 1. Characteristics of research on OSH in vocational education

Author(s) (Year)	Research context	Design and sample	Main findings
Ismara et al. (2024)	OSH implementation at SMK Muhammadiyah Prambanan	Program evaluation; 258 students and 14 teachers	OSH implementation was assessed through the antecedent, transaction, and output components.
Vidariatma et al. (2026)	PPE compliance among vocational students in Tangerang Regency	Cross-sectional; 205 students	A total of 60.5% of students did not comply with PPE requirements; motivation and attitudes were associated with compliance.
Liu et al. (2023)	Laboratory safety among university students in China	Survey and SEM; 500 students	Knowledge and extrinsic motivation mediated the relationship between safety climate and safety compliance and participation.

Maulida et al. (2025)	OSH education among vocational students in Semarang	Quasi-experimental; 61 students	The e-learning intervention improved OSH knowledge, attitudes, and practices.
Abu-Siniyeh and Al-Shehri (2021)	Safety among medical laboratory students and workers in Saudi Arabia	Cross-sectional; 185 respondents	Training and understanding of safety signs were not necessarily accompanied by improved safety practices.
Amini et al. (2026)	Students' safety behavior during welding practice at SMKN 2 Wonosari	Ex post facto; 34 students	Knowledge was not significantly associated with OSH awareness behavior, whereas attitudes showed a stronger association.
Wu et al. (2023)	Laboratory safety practices among university students in China	Cross-sectional; 335 students	PPE use and risk assessment were not implemented consistently; training was associated with safety practices.
Setyawan and Surahmanto (2022)	OSH behavioral awareness among students at SMK Pangudi Luhur Muntilan	Ex post facto; 68 students	OSH knowledge was positively associated with OSH behavioral awareness.
Darmawang et al. (2024)	Safety behavior among vocational school students in Indonesia	Cross-sectional and PLS-SEM; 959 students	Knowledge, attitudes, teachers' safety leadership, and peers' safety behavior contributed to students' safety behavior.
Dewangga et al. (2025)	Students' OSH behavior during machining practice in a vocational school workshop	Correlational; 50 students	OSH knowledge was positively associated with safety behavior, although its contribution was relatively limited.
Sholikhah et al. (2025)	PPE compliance among mechanical engineering students at vocational schools in Surakarta	Cross-sectional; 338 students	OSH knowledge was significantly associated with PPE compliance.
Sayuti et al. (2024)	Students' safety culture during industrial work practice	Survey and regression; 36 informants	Workers' safety culture in industry was strongly associated with students' safety culture during industrial work practice.
Caner (2026)	Risk perception and safety compliance among vocational school students in Istanbul	Retrospective cross-sectional; 420 students	Students in technical programs demonstrated higher risk perception and safety compliance than those in social programs.

Sari et al. (2022)	OSH knowledge and attitudes among students in the Building Modeling and Information Design (DPIB) program at vocational schools	Correlational; 36 students	Knowledge and attitudes contributed to OSH implementation, with attitudes making a greater contribution.
Zengin et al. (2025)	Safety culture and OSH knowledge in vocational schools in Samsun, Türkiye	Descriptive cross-sectional; 9,517 students	Most students obtained relatively low OSH knowledge scores, while safety culture was at a moderate level.

Source: Compiled from the 15 research articles analyzed (2021–2026).

In terms of research context, most studies were conducted at the upper-secondary vocational education level, while four studies involved university students or participants in higher-level vocational education. Ten studies were conducted in Indonesia, and the remaining five were carried out in China, Saudi Arabia, and Türkiye. At the vocational school level, research primarily focused on practical activities involving direct occupational risks, such as welding, machining, PPE use, and industrial work practice. By contrast, studies in higher vocational education focused more on laboratory safety and technical learning environments. These contextual differences are important because the types of hazards and safety requirements vary across practical learning environments. Nevertheless, all these contexts demonstrate the need for vocational education to integrate OSH knowledge with the application of safe behavior during practical learning activities.

Methodologically, the studies were dominated by quantitative observational approaches, including cross-sectional, correlational, and ex post facto designs, as well as program evaluations. Most studies used questionnaires to measure knowledge, attitudes, risk perception, safety compliance, or safety behavior. Only the study by Maulida et al. (2025) explicitly employed a quasi-experimental design with treatment and control groups to assess the effects of an OSH education intervention. Sample sizes also varied considerably, ranging from 34 respondents in Amini et al. (2026) to 9,517 respondents in Zengin et al. (2025). These variations in research design and sample size should be considered when comparing findings across studies. In particular, cross-sectional and correlational studies can identify associations between variables but are insufficient to establish causal relationships. Therefore, the strength of conclusions should be interpreted in accordance with the research designs employed.

The variables examined across these studies also varied in terms of terminology and measurement. OSH knowledge was assessed through understanding of work procedures, hazard signs, safety symbols, and risk identification. Attitudes encompassed students' concern, perceptions, and evaluations of the importance of safety. Meanwhile, safety behavior was measured through PPE compliance, the

implementation of safe work procedures, risk awareness, and safety practices during laboratory or workshop activities. Differences in measurement instruments mean that findings across studies are not always directly comparable. Furthermore, the dominance of questionnaire-based measurements indicates that most findings reflect respondents' answers or perceptions rather than necessarily representing directly observed actual behavior. Overall, the characteristics of the reviewed literature indicate that research on OSH has developed across a relatively broad range of contexts and topics, but further efforts are needed to strengthen the measurement of actual behavior in vocational practical settings.

The relationship between OSH knowledge and safety compliance and behavior in practical training

Occupational safety and health (OSH) knowledge provides the foundation for students to identify hazards, understand procedures, and determine appropriate safety measures during practical training. However, findings from the 15 core studies indicate that the relationship between knowledge and safety behavior is not always consistent. Five studies reported positive associations: Setyawan and Surahmanto (2022), Sari et al. (2022), Darmawang et al. (2024), Dewangga et al. (2025), and Sholikhah et al. (2025). In contrast, Amini et al. (2026) and Vidariatma et al. (2026) found no statistically significant relationships. This pattern is consistent with Abdullah and Abd Aziz (2020), who identified an association between knowledge and safety behavior among laboratory students. Yusuf et al. (2025) also reported that knowledge contributed to behavior during practical activities. These findings confirm that OSH knowledge is important, but it does not necessarily ensure that students consistently behave safely.

Evidence of a positive relationship can be seen in the magnitude of knowledge contributions reported in several studies. Setyawan and Surahmanto (2022) found a correlation of 0.500, with a contribution of 25%, while Sari et al. (2022) reported an effective knowledge contribution of 23.4%. Darmawang et al. (2024) identified a direct effect of knowledge on behavior of 0.32 and a total effect of 0.481. Regarding PPE compliance, Sholikhah et al. (2025) reported an *OR* of 2.152 ($p = 0.005$). Dewangga et al. (2025) also found a positive but relatively weak relationship ($r = 0.289$; $p = 0.042$). These findings are supported by Abdullah and Abd Aziz (2020), who reported an association between knowledge and safety behavior of $\beta = 0.30$ ($p < 0.001$). Yusuf et al. (2025) found that combined understanding of OSH and legal knowledge contributed 25.1%, whereas legal knowledge alone contributed only 1.8%. Thus, knowledge contributes to safety behavior, although the strength of this contribution varies.

Not all studies have shown that students with better knowledge demonstrate higher levels of safety compliance or awareness. Amini et al. (2026) reported a knowledge coefficient of −0.589 ($p = 0.394$), while Vidariatma et al. (2026) found no significant

relationship between knowledge and PPE compliance (p = 0.644). These findings differ from those of Setyawan and Surahmanto (2022) and Sholikhah et al. (2025), indicating that the relationship between knowledge and behavior cannot be generalized in simplistic terms. Ali et al. (2022) provide an important illustration: although OSH learning was considered to have been implemented well and students generally demonstrated positive attitudes, only 20% of respondents had adequate OSH knowledge. Students also reported limited availability of PPE for practical activities. Yusuf et al. (2025) found that legal knowledge alone contributed only 1.8%. These findings indicate that mastery of specific knowledge does not sufficiently explain safety behavior without considering learning and practical conditions.

The relationship between knowledge and behavior may also operate through attitudes, motivation, and safety commitment. Darmawang et al. (2024) found an association between knowledge and attitudes of β = 0.502; the total effect of knowledge on behavior (0.481) was greater than its direct effect (0.32). This finding suggests the presence of an indirect pathway through attitudes. Liu et al. (2023) showed that knowledge mediated 18.8% of the total effect of safety climate, while extrinsic motivation mediated 46.9%. Abdullah and Abd Aziz (2020) also found that safety motivation was associated with behavior and that safety commitment acted as a mediator. Similarly, Abdullah et al. (2021) demonstrated the role of knowledge in the relationship between safety climate and laboratory behavior. Accordingly, OSH education needs to develop not only understanding but also the attitudes, motivation, and commitment required to implement safe procedures. Without the motivation to act, knowledge may remain merely theoretical.

The gap between knowledge and practice is evident in actions that require consistent implementation, particularly PPE use and risk assessment. Wu et al. (2023) reported that 52.54% of students always used PPE and 48.36% always conducted risk assessments. Abu-Siniyeh and Al-Shehri (2021) found that 60.5% of students always used PPE; training was associated with knowledge of safety signs but not with safety practices (p = 0.70). Vidariatma et al. (2026) also reported that 60.5% of students did not comply with PPE requirements. In contrast, Maulida et al. (2025) demonstrated improvements in knowledge and practice scores following an e-learning intervention. Rodrigues et al. (2018) further noted that different training methods produced varying effects on knowledge, risk acceptance, and intentions to behave safely. Ali et al. (2022) also showed that limited facilities may accompany knowledge-related problems. These findings emphasize that delivering information alone is insufficient; learning activities need to provide opportunities to practice, apply, and develop safety habits.

These findings indicate that safety behavior in vocational practical training develops through the interplay of individual, social, and environmental factors. The relationships among these components are summarized in Figure 2 as a conceptual

model derived from the synthesis of previous studies. The model positions OSH knowledge as a foundation associated with the development of attitudes and motivation, while all three components are related to observed safety behavior. Environmental and institutional factors, such as PPE availability, standard operating procedures (SOPs), and safety climate, are also connected to social factors, including role modeling by teachers and industry instructors, peer influence, and supervision.

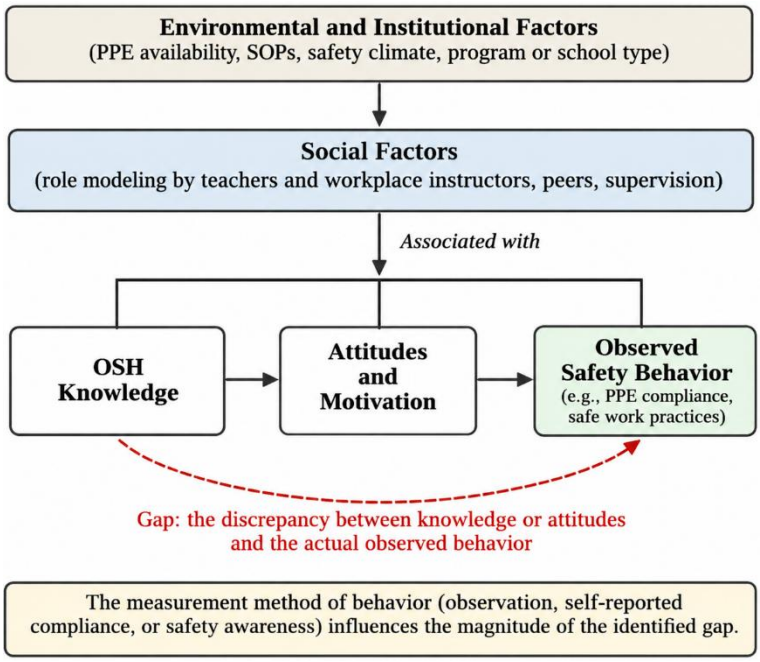


Figure 2. Conceptual Model of the Relationship between OSH Knowledge, Attitudes, Motivation, and Safety Behavior in Vocational Practicum

Source: Author's synthesis based on the 15 studies and six supporting references.

In the figure, the dashed lines represent the gap between knowledge or attitudes and the behavior actually demonstrated. The magnitude of this gap should also be interpreted in relation to the measurement methods used, including direct observation, self-reported compliance, and behavioral awareness. The model is consistent with Darmawang et al. (2024), who highlighted the roles of teachers and peers; Sayuti et al. (2024), who examined safety culture in industry; and Liu et al. (2023), who investigated safety climate. Marin et al. (2019) also emphasized the importance of considering students' perceptions of the laboratory safety climate. Thus, safety behavior cannot be adequately explained by knowledge alone; the social and institutional context must also be taken into account.

These findings have direct implications for the delivery of vocational education. OSH instruction needs to integrate theoretical explanations with demonstrations, simulations, repeated practice, and assessments of procedural implementation during practical training. Maulida et al. (2025) showed that educational interventions can improve knowledge and practice scores, while Rodrigues et al. (2018) demonstrated that the choice of training method is associated with differences in safety learning

outcomes. Yusuf et al. (2025) also emphasized the need for engaging teaching methods and continuous monitoring. Findings from Wu et al. (2023) and Abu-Siniyeh and Al-Shehri (2021) serve as a reminder that understanding and training do not always lead to consistent implementation. Therefore, the effectiveness of OSH education should not be assessed solely through knowledge tests or safety awareness questionnaires, but also through observable compliance and safe behavior. Individual, social, and environmental factors associated with such implementation are discussed further in the following subsection.

Individual, social, and environmental factors associated with occupational safety behavior and their implications for vocational education

Occupational safety behavior during vocational practical training is not shaped solely by students' knowledge of occupational safety and health (OSH) regulations. Rather, it results from interactions among individual characteristics, social influences, and the environmental conditions in which practical activities take place. Darmawang et al. (2024) found that knowledge had a direct effect on safety behavior of $\beta = 0.320$, while its total effect reached 0.481 when indirect pathways were taken into account. Liu et al. (2023) also found that safety climate was associated with safety compliance and participation, with knowledge and extrinsic motivation acting as mediators. This pattern is consistent with Neal and Griffin (2006), who found that group safety climate predicted changes in individual safety motivation, which were subsequently associated with changes in safety behavior. Thus, the development of safe behavior requires simultaneous support from multiple dimensions.

At the individual level, attitudes are among the factors most frequently found to be associated with OSH behavior or awareness. Amini et al. (2026) reported that attitudes explained 58.1% of the variation in students' safety behavior during welding practice, while Sari et al. (2022) found an effective attitude contribution of 38.4% to OSH awareness. Setyawan and Surahmanto (2022) also reported an attitude contribution of approximately 27%, whereas Darmawang et al. (2024) identified an effect of attitudes on behavior of $\beta = 0.321$. However, these relationships were not consistently significant. Dewangga et al. (2025) obtained a p-value of 0.398, while Sholikhah et al. (2025) reported a p-value of 0.058. Findings by Wahrini et al. (2019) further extend this explanation: the roles of teachers and the OSH climate were reported to contribute 43.30% and 43.40%, respectively, to students' OSH awareness. This suggests that attitudes and awareness need to be developed through learning experiences and a supportive environment.

In addition to attitudes, motivation, risk perception, and self-efficacy help explain why students are or are not willing to comply with safety regulations. Vidariatma et al. (2026) found that students with low motivation were 2.381 times more likely to fail to comply with personal protective equipment (PPE) requirements than those with

higher motivation (p = 0.006). Liu et al. (2023) showed that extrinsic motivation mediated 46.9% of the effect of safety climate on compliance and participation, whereas intrinsic motivation did not demonstrate a significant mediating effect. More specific evidence was provided by Mubarok et al. (2026) in a study involving 95 machining engineering students. Risk perception was correlated with PPE compliance (r = 0.578), while self-efficacy showed a stronger correlation (r = 0.645); together, these two variables explained 54.3% of the variation in compliance. Neal and Griffin (2006) also demonstrated that motivation served as a link between safety climate and safety behavior. These findings emphasize that OSH education needs to develop risk awareness and students' confidence in their ability to act safely, rather than merely communicate prohibitions.

Social factors also determine whether safety knowledge and attitudes are applied when students encounter practical situations. Teachers and instructors serve both as sources of guidance and as role models in PPE use, hazard identification, and compliance with procedures. Darmawang et al. (2024) found a total effect of teacher safety leadership of 0.405 and a total effect of peers' safety behavior of 0.420. In the context of industrial work practice, Sayuti et al. (2024) reported a strong relationship between workers' safety culture and students' safety culture during industrial work practice (*Praktik Kerja Industri* or Prakerin), with a coefficient of β = 0.858. Findings by Banurea et al. (2024) further emphasize the importance of supervision. Among 113 vocational school students in Medan, 84.1% were categorized as engaging in unsafe acts; supervision was significantly associated with these acts (p = 0.012), and poor supervision was associated with 3.937 times higher odds of engaging in unsafe acts. However, Vidariatma et al. (2026) found no significant relationships between supervision or peer influence and PPE compliance. This indicates that the quality of social interactions, rather than merely the presence of supervision, needs to be considered.

Findings on individual and social factors indicate that no single factor operates independently or produces consistent results across all educational contexts. Attitudes and motivation are associated with students' readiness to act safely, while teachers, peers, and safety culture provide examples and norms that influence the implementation of safe practices. Meanwhile, facility conditions and school management determine whether safe actions can be consistently performed. Differences across studies also need to be considered: some factors show significant associations, whereas others are not significant or are supported by only a limited number of studies. Therefore, these findings should be interpreted as a body of evidence with varying levels of strength, rather than as a list of factors with equivalent effects. To clarify these patterns, Table 2 presents a synthesis of individual, social, environmental, and institutional factors, together with empirical findings from the core studies and the implications drawn from each factor group.

Table 2. Synthesis of factors associated with occupational safety behavior in vocational education

Factor group	Factors examined	Findings from the studies	Synthesis
Individual	Attitudes toward OSH	Attitudes were significantly associated with OSH behavior or awareness in Amini et al. (2026), Sari et al. (2022), Setyawan and Surahmanto (2022), and Darmawang et al. (2024). In contrast, the relationship was not significant in Dewangga et al. (2025), while Sholikhah et al. (2025) reported a *p*-value of 0.058.	Attitudes are an individual factor that is relatively often associated with OSH behavior, although the strength and significance of the relationship vary across studies.
Individual	Safety motivation	Vidariatma et al. (2026) found that students with low motivation were 2.381 times more likely to fail to comply with PPE requirements (p = 0.006). Liu et al. (2023) found that extrinsic motivation mediated 46.9% of the effect of safety climate on safety compliance and participation.	Motivation may help explain students' engagement in safety behavior, although direct evidence is still limited to two studies.
Individual	OSH knowledge and awareness	Darmawang et al. (2024) found a direct effect of knowledge on behavior of β = 0.320 and a total effect of 0.481. Amini et al. (2026) found no significant effect of knowledge on behavior.	Knowledge may contribute to behavior, including through attitudes, but knowledge mastery alone does not always result in compliance.
Social	Teacher/instructor leadership and safety climate	Darmawang et al. (2024) reported a total effect of teacher safety leadership of 0.405. Liu et al. (2023) found that safety climate was associated with compliance (β = 0.131) and safety participation (β = 0.311).	Teachers' roles and safety climate constitute social contexts that can support the development of students' safety behavior.
Social	Peer influence and supervision	Darmawang et al. (2024) reported a total effect of peers' safety behavior of 0.420. However, Vidariatma et al. (2026) found no significant relationships between supervision (p = 1.000), peer	Social influences do not always produce consistent findings. The forms of supervision, peer interactions, and measurement methods need to be considered

		influence (p = 0.570), and PPE compliance.	when interpreting the results.
Social	Workplace safety culture	Sayuti et al. (2024) found an association between industrial workers' safety culture and students' safety culture during Prakerin (β = 0.858). In contrast, safety documentation showed no significant association (β = −0.034; p = 0.774).	Role modeling and safety practices in industrial settings may provide important social experiences for students during workplace training.
Environmental and institutional	PPE availability	Vidariatma et al. (2026) found PPE compliance rates of 44.5% among students with available PPE and 32.6% among those without available PPE. However, the relationship was not statistically significant (OR = 1.663; p = 0.113).	Facility availability needs to be considered, but this study does not provide sufficient statistical evidence to establish its relationship with compliance.
Environmental and institutional	OSH program management and implementation	Ismara et al. (2024) found an association between the antecedent and transaction components (β = 0.927), as well as between transaction and output (β = 0.480), with an output R^2 of 0.859.	The implementation of OSH programs in schools is associated with the implementation outcomes assessed in that study. However, these findings cannot be directly interpreted as effects on individual student behavior.
Environmental and institutional	Program and school characteristics	Zengin et al. (2025) found the lowest safety culture score in industrial-type schools (3.45), compared with other school types (3.56–3.85). Caner (2026) reported higher compliance scores in technical programs than in social programs (4.30 versus 2.90).	Program characteristics and educational environments may be associated with differences in safety culture or compliance, but the findings across studies cannot be compared as equivalent measures of effect.

Source: Compiled from the 15 research articles.

As summarized in Table 2, environmental and institutional factors provide the conditions that enable safe behavior to be implemented in practice. PPE availability, for example, remains important even though Vidariatma et al. (2026) found no statistically significant relationship with compliance (p = 0.113). A difference in

compliance was still observed between groups with and without available PPE, at 44.5% and 32.6%, respectively, although the estimated relationship was not sufficiently strong statistically. Ismara et al. (2024) showed that the components of OSH program implementation were associated with school-level implementation outcomes, but these results should not be equated with measurements of individual student behavior. Salazar-Escoboza et al. (2020), in a survey of 438 students from three higher education institutions, found a moderate relationship between laboratory safety climate and reported accidents. Wu et al. (2007) also showed that the presence of safety managers and committees, as well as training, was associated with laboratory safety climate. These findings emphasize that facilities, management, and institutional commitment need to operate alongside the development of safe behavioral habits.

This synthesis has direct implications for the delivery of vocational education. OSH education should not be limited to the delivery of instructional materials and knowledge testing; rather, it needs to integrate the development of attitudes, motivation, hazard recognition skills, and consistent PPE use. Maulida et al. (2025) showed that the Youth4OSH e-learning intervention among vocational school students increased knowledge scores from 8.35 to 14.74, attitude scores from 8.00 to 9.45, and practice scores from 7.48 to 9.77. However, practice was measured using a questionnaire at the end of the intervention session, and therefore the findings do not establish whether the behavior was sustained over time. During practical training and Prakerin, teachers and industry supervisors need to serve as role models while providing consistent supervision. Schools also need to provide PPE, work procedures, and practical environments that support safe practices. Thus, the effectiveness of OSH education should be assessed not only in terms of what students know but also their ability to repeatedly apply safe practices in actual practical situations.

Conclusion

This review shows that the gap between occupational safety knowledge and behavior in vocational practical training is not caused solely by students' limited understanding of occupational safety and health (OSH), but also by the fact that knowledge is not always internalized into attitudes, motivation, and safe behavioral habits. This gap emerges when the ability to recognize risks is not accompanied by PPE compliance, the implementation of safety procedures, and consistent behavior during practical activities. This occurs because safety behavior is also influenced by role modeling by teachers and instructors, peer influence, industrial safety culture, and the availability of facilities and OSH management in schools. Accordingly, the development of safe behavior requires an integrated approach that connects knowledge-based learning with hands-on practice, habituation, supervision, role modeling, and the provision of a supportive practical learning environment. These findings emphasize that the

success of OSH education should not be measured solely by mastery of the subject matter, but also by the consistent application of safety practices.

This review contributes by integrating empirical evidence on the OSH knowledge–behavior gap and categorizing the associated factors into individual, social, and environmental dimensions, thereby providing a basis for understanding the development of safety behavior in vocational education. However, the conclusions should be interpreted in light of several limitations, including variations in research contexts, instruments, and indicators across studies; the predominance of questionnaire-based measurements; and the limited number of studies involving direct and repeated behavioral observations. Some factors are also supported by only a small number of studies, making it difficult to establish the broader strength of their associations. Future research should employ longitudinal or intervention designs, observe behavior in workshops and laboratories, and measure safety compliance over longer periods. For vocational schools, OSH evaluation should combine knowledge tests, attitude assessments, practical observations, and workplace audits to ensure that learning outcomes are reflected in actual and sustained safe behavior.

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