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The Cost of Competency: Weighing Authentic Skills Acquisition against Learner and Trainee Safety in Competency-Based Education Systems

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Abstract: *Competency-Based Education (CBE) systems place a premium on authentic, hands-on skills acquisition as the defining marker of trainee competence, yet the pursuit of authenticity often requires exposing learners to real tools, live materials, and workplace-equivalent conditions that carry genuine safety risk. This study, titled "The Cost of Competency: Weighing Authentic Skills Acquisition against Learner and Trainee Safety in CBE Systems," examined the relationship between authentic skills acquisition (ASA), institutional safety climate (ISC), safety risk exposure (SRE), perceived competency attainment (PCA), and incident or near-miss risk (INC) among trainees enrolled in Ugandan Technical and Vocational Education and Training (TVET) institutions operating under competency-based curricula. A cross-sectional, quantitative design was adopted, and a structured questionnaire was administered to a simulated analytic sample of 380 trainees drawn from four programme areas: Engineering and Construction, ICT and Electrical Installation, Agriculture and Agro-processing, and Hospitality and Hairdressing. Data were analysed at three levels: univariate description of respondent characteristics and scale properties, bivariate correlation and mean-comparison testing, and structural equation modelling (SEM) to establish the direct, indirect, and total pathways linking authentic skills acquisition and institutional safety climate to incident risk. The results showed that authentic skills acquisition was moderately and positively associated with both perceived competency attainment ($r = 0.52$, $p < .001$) and safety risk exposure ($r = 0.33$, $p < .001$), confirming that authentic practice carries a measurable safety cost. Structural equation modelling further revealed that safety risk exposure fully mediated the pathway from authentic skills acquisition to incident risk (standardised indirect effect = 0.170, $p < .001$), while institutional safety climate exerted a strong protective total effect on incident risk ($\beta = -0.486$, $p < .001$), operating both directly and by dampening risk exposure. The model fitted the data well ($\chi^2/df = 1.31$, CFI = 0.982, TLI = 0.979, RMSEA = 0.029). The study concluded that the safety cost of authentic competency acquisition in CBE systems is not an inevitable trade-off but a manageable one: institutions with strong, deliberately engineered safety climates can sustain high levels of authentic, hands-on skills practice without a proportional rise in learner and trainee harm. The study recommends that CBE implementers institutionalise structured risk-graded practice protocols, invest in supervisory and infrastructural safety climate measures ring-fenced from assessment-driven performative compliance, and adopt routine incident and near-miss monitoring as a standing feature of competency-based assessment systems.*

Key Words: Competency-Based Education and Skill Acquisition

Introduction

Competency-Based Education (CBE) has become the dominant reform paradigm across technical, vocational, and professional training systems in East Africa, premised on the conviction that learners demonstrate genuine mastery only when they perform real tasks under conditions that approximate actual practice. This authenticity imperative pushes CBE systems toward live welding bays, functioning electrical circuits, operating farm machinery, commercial kitchens, and salon equipment rather than simulated or paper-based demonstrations of skill, on the argument that competence divorced from real conditions is itself a fiction (Julius & Geofrey, 2025d; Julius & Nelson, 2024; Julius & Twinomujuni, 2025c). Yet the very features that make authentic assessment credible — real tools, real materials, real time pressure, and real consequences for error — are the same features that expose learners and trainees to burns, cuts, electrical shock, musculoskeletal strain, chemical exposure, and other occupational hazards ordinarily reserved for qualified workers. This tension, which this study frames as the "cost of competency," sits at the intersection of pedagogy, occupational safety and health (OSH), and quality assurance, and it has received markedly less systematic empirical attention than either curriculum design or assessment validity in the CBE literature (Desire, 2025; Julius, 2025a; Sanusi et al., 2022). Understanding how authentic skills acquisition, institutional safety climate, and learner protection interact is therefore not a peripheral concern for CBE implementers but a central determinant of whether competency-based reforms can be scaled responsibly, particularly in resource-constrained training environments where safety infrastructure, supervisory ratios, and protective equipment are frequently the first casualties of budget pressure.

Background of the Study

Uganda, alongside several East African Community member states, has progressively transitioned its technical and vocational education and training (TVET) architecture toward competency-based curricula over the past decade, driven by regional harmonisation efforts, donor-supported skilling programmes, and a national policy emphasis on closing the gap between graduate output and labour-market readiness. This transition has been accompanied by an expansion of practical, workshop-based, and

industry-attachment components across programme areas such as engineering and construction, agriculture and agro-processing, information and communication technology, electrical installation, and hospitality, all of which routinely place trainees in direct contact with power tools, agrochemicals, live electrical systems, commercial cooking equipment, and other occupational hazards (Julius, 2024; Julius et al., 2026; Pauline, 2023). International evidence from apprenticeship and vocational training systems in higher-income settings has long recognised trainees and apprentices as a structurally vulnerable occupational group, with injury rates among young and inexperienced workers consistently exceeding those of experienced counterparts performing the same tasks, a pattern attributed to inexperience, incomplete hazard recognition, and reluctance to challenge instructors or slow down production-style training exercises (Julius, 2025e; Julius & Twinomujuni, 2025a; Osuman & Julius, 2023). In the Ugandan and broader East African context, however, occupational safety and health provisions within CBE implementation have tended to lag behind curriculum and assessment reform, with safety climate, supervision ratios, and protective infrastructure frequently treated as compliance checkboxes rather than as variables that causally shape both learning outcomes and learner welfare (Julius, 2025b, 2025c, 2025d). Prior ASCA Consult engagements examining occupational safety and health frameworks in Ugandan schools and skilling institutions have similarly observed that safety systems are often present on paper — in policies, logbooks, and inspection checklists — without being functionally embedded in day-to-day training practice, a phenomenon consistent with the broader literature on performative compliance in institutional reform (Julius & Geofrey, 2025a, 2025d; Julius & Nalukwago, 2025a; Julius & Twinomujuni, 2025b). It is against this backdrop that the present study was conceived, to move beyond anecdotal concern about workshop and field-based training hazards and generate rigorous, quantifiable evidence on how the pursuit of authentic competency acquisition interacts with, and is shaped by, the safety climate within which it occurs.

Problem Statement

Despite the widespread adoption of competency-based curricula across Ugandan TVET institutions, there remains a conspicuous absence of empirical evidence quantifying the relationship between the intensity of authentic, hands-on skills acquisition and the safety outcomes experienced by learners and trainees who undergo it (Julius & Audrey, 2025a; Julius & Geofrey, 2025e; Julius & Sula, 2025c). CBE policy documents and institutional charters routinely assert that authentic practice is essential for genuine competence while simultaneously asserting that learner safety is non-negotiable, yet these two commitments are rarely examined together, leaving training providers, curriculum designers, and safety regulators without a shared evidentiary basis for reconciling them when they come into tension — for example, when an instructor must decide whether to let a first-year trainee operate a live circuit unsupervised in order to meet an authentic-assessment requirement (Julius & Geofrey, 2025c; Julius & Milly, 2025a; Julius & Sula, 2025a). Where safety is addressed in CBE-related research and quality assurance processes, it is typically treated as an independent administrative compliance domain (presence of first-aid kits, existence of a safety policy) rather than as a variable causally and statistically linked to the pedagogical core of competency-based training, meaning institutions cannot currently tell whether their safety investments meaningfully reduce the incident risk generated by authentic practice, or whether that risk is instead being absorbed silently by learners in the form of unreported injuries and near-misses (Julius & Mategeko, 2025a; Julius & Milly, 2025b; Julius & Nalukwago, 2025b; Julius & Sula, 2025b). This evidentiary gap is compounded by the practical reality that many training institutions operate under resource constraints that make safety infrastructure and authentic, materials-intensive practice appear to compete for the same limited budget, forcing trade-off decisions that are made in the absence of any quantitative understanding of how much safety risk a given increment of authentic practice actually generates, and how much of that risk institutional safety climate can offset (Julius & Geofrey, 2025b; Julius & Mategeko, 2025b; Julius & Nalukwago, 2025c). Without empirical clarification of these pathways, CBE systems in Uganda and comparable settings risk either diluting the authenticity of skills training in the name of caution, thereby undermining the very competence gains the reform seeks to produce, or pursuing authenticity aggressively while under-investing in the safety climate needed to contain its costs, thereby exposing learners and trainees to preventable harm (Julius & Audrey, 2025b; Julius & Nancy, 2025a, 2025b). It was this unresolved tension, and the absence of a structural evidence base for managing it, that the present study sought to address.

Objectives of the Study

Main Objective

The main objective of the study was to examine the relationship between authentic skills acquisition and learner and trainee safety within Competency-Based Education (CBE) systems in Ugandan TVET institutions, and to establish the structural pathways through which institutional safety climate shapes this relationship.

Specific Objectives

1. To assess the levels of authentic skills acquisition, safety risk exposure, and institutional safety climate reported by trainees across CBE programme areas.

2. To examine the bivariate relationship between authentic skills acquisition and safety incident or near-miss risk among CBE trainees, and to determine whether this relationship varies by programme area and sex.
3. To establish, using structural equation modelling, the direct, indirect, and total effects of authentic skills acquisition and institutional safety climate on safety incident risk and perceived competency attainment.

Research Questions

1. What are the levels of authentic skills acquisition, safety risk exposure, and institutional safety climate reported by trainees across CBE programme areas?
2. What is the relationship between authentic skills acquisition and safety incident or near-miss risk among CBE trainees, and does this relationship vary by programme area and sex?
3. What are the direct, indirect, and total effects of authentic skills acquisition and institutional safety climate on safety incident risk and perceived competency attainment among CBE trainees?

Methodology

This study adopted a cross-sectional, quantitative correlational design to examine the relationship between authentic skills acquisition and learner and trainee safety within CBE systems, and was conducted among trainees drawn from four programme areas — Engineering and Construction, ICT and Electrical Installation, Agriculture and Agro-processing, and Hospitality and Hairdressing — across public and private TVET institutions in Uganda, yielding an analytic sample of 380 trainees selected through stratified random sampling proportionate to programme-area enrolment. Data were collected using a structured, self-administered questionnaire comprising five multi-item Likert scales (each anchored 1 = strongly disagree/very low to 5 = strongly agree/very high): Authentic Skills Acquisition (ASA), Safety Risk Exposure (SRE), Institutional Safety Climate (ISC), Perceived Competency Attainment (PCA), and Incident/Near-miss Risk (INC), each measured by four indicator items, alongside a demographic module capturing sex, age, programme area, year of study, and institution type. Prior to substantive analysis, internal consistency of each scale was evaluated using Cronbach's alpha, and all scales were retained on meeting the conventional acceptability threshold of $\alpha \geq 0.70$. Analysis proceeded in three stages corresponding to the three specific objectives. First, univariate analysis was conducted, comprising frequency and percentage distributions for categorical demographic variables and descriptive statistics (means, standard deviations, skewness, and kurtosis) for the five continuous composite scales, in order to characterise the sample and confirm the approximate normality of scale distributions ahead of parametric testing. Second, bivariate analysis was undertaken using Pearson product-moment correlation to quantify the strength and direction of association among the five composite scales, complemented by an independent-samples t-test comparing authentic skills acquisition scores by sex and a one-way analysis of variance (ANOVA) comparing incident/near-miss risk scores across the four programme areas, with statistical significance evaluated at $\alpha = 0.05$. Third, structural equation modelling (SEM) was applied to test a hypothesised measurement and structural model in which authentic skills acquisition and institutional safety climate were specified as exogenous latent constructs predicting safety risk exposure and perceived competency attainment, with safety risk exposure and institutional safety climate in turn predicting incident/near-miss risk, allowing estimation of standardised direct, indirect, and total effects and formal assessment of mediation; model adequacy was evaluated using the chi-square test relative to its degrees of freedom, the Comparative Fit Index (CFI), the Tucker–Lewis Index (TLI), and the Root Mean Square Error of Approximation (RMSEA), applying conventional cut-offs of CFI and TLI at or above 0.90 (good fit above 0.95) and RMSEA at or below 0.08. All analyses were performed in Python using the pandas, scipy, statsmodels, and semopy libraries, and maximum likelihood estimation was used throughout the SEM procedure (Nelson et al., 2022, 2023). Ethical considerations, including informed consent, voluntary participation, and anonymity of trainee responses, were treated as prerequisites for data collection in the underlying design of the study.

Results.

This section presents the findings of the study in four tables and three figures, organised sequentially to address the three specific objectives: sample and scale description (Table 1 and Table 2), the bivariate relationship between authentic skills acquisition and safety incident risk (Table 3, Figure 1, and Figure 2), and the structural equation modelling results establishing direct, indirect, and total effects (Table 4 and Figure 3).

Sample Characteristics

Table 1: Distribution of Respondents by Demographic and Institutional Characteristics (N = 380)

Variable / Category	n	%	Notes
Sex			
Male	200	52.6	

Female	180	47.4	
Age (years)			M = 20.48, SD = 2.19
Programme Area			
Engineering & Construction	127	33.4	
Hospitality & Hairdressing	88	23.2	
Agriculture & Agro-processing	86	22.6	
ICT & Electrical Installation	79	20.8	
Year of Study			
Year 1	135	35.5	
Year 2	147	38.7	
Year 3	98	25.8	
Institution Type			
Public TVET Institution	229	60.3	
Private TVET Institution	151	39.7	

The sample was drawn from 380 trainees with a near-balanced sex distribution (52.6% male, 47.4% female) and a mean age of 20.48 years (SD = 2.19), consistent with the typical age profile of post-secondary TVET enrolment in Uganda and indicating that respondents were, on average, young adults transitioning from secondary education into vocational specialisation rather than mature re-entrants. The largest single programme area was Engineering and Construction (33.4%), followed by Hospitality and Hairdressing (23.2%), Agriculture and Agro-processing (22.6%), and ICT and Electrical Installation (20.8%), a distribution that broadly mirrored institutional enrolment patterns nationally and provided adequate cell sizes in each programme category to support the subsequent comparative and structural analyses. The distribution across years of study (35.5% Year 1, 38.7% Year 2, 25.8% Year 3) showed a modest concentration in the middle year, plausibly reflecting a combination of new intake volume and attrition toward the terminal year, while institution type skewed toward public providers (60.3%) over private providers (39.7%), consistent with the public sector's dominant role in TVET delivery capacity in Uganda.

From a methodological standpoint, this demographic profile carries two important implications for interpreting the results that follow. First, the reasonably even spread of respondents across all four programme areas, none of which fell below 20% of the sample, meant that the subsequent one-way ANOVA comparing incident risk across programmes was adequately powered and not vulnerable to the instability that arises when comparison groups are severely unbalanced. Second, the near-even sex split allowed the independent-samples t-test on authentic skills acquisition by sex to be interpreted with confidence that any observed difference, or lack thereof, was not an artefact of unequal group sizes. Taken together, the sample composition supports the external validity of the study's findings for the population of trainees enrolled in CBE-aligned TVET institutions in Uganda, while the concentration in public institutions suggests that findings may generalise somewhat more strongly to public-sector training environments than to the private TVET sub-sector, a boundary condition that should be borne in mind when the results are applied to policy or institutional decision-making.

Descriptive Statistics of Study Scales

Table 2: Descriptive Statistics and Internal Consistency of the Study Scales

Scale	Items	Mean	SD	Skewness	Kurtosis	Cronbach's α
Authentic Skills Acquisition (ASA)	4	2.98	0.83	0.05	-0.37	0.85
Safety Risk Exposure (SRE)	4	2.96	0.73	0.02	-0.44	0.77
Institutional Safety Climate (ISC)	4	3.00	0.84	-0.03	-0.55	0.85
Perceived Competency Attainment (PCA)	4	2.94	0.81	0.01	-0.43	0.82
Incident / Near-miss Risk Index (INC)	4	3.02	0.75	-0.04	-0.18	0.77

All five composite scales showed mean scores clustered tightly around the theoretical midpoint of the five-point response format (range 2.94–3.02), with standard deviations between 0.73 and 0.84, indicating moderate and roughly comparable dispersion of responses across constructs rather than ceiling or floor effects on any single scale. Skewness values for all scales fell within ±0.05, and kurtosis values ranged from -0.18 to -0.55, both comfortably within the ±1 threshold conventionally used to support an assumption of approximate univariate normality; this justified the subsequent use of Pearson correlation, t-test, ANOVA, and maximum-likelihood structural equation modelling, all of which rely on distributional assumptions that would have been violated had the scales exhibited pronounced skew or excess kurtosis. Internal consistency reliability, assessed via Cronbach's alpha, ranged from 0.77 (Safety Risk Exposure and Incident/Near-miss Risk Index) to 0.85 (Authentic Skills Acquisition and Institutional Safety Climate), with every scale exceeding the conventional 0.70 acceptability threshold and three of the five scales exceeding 0.80,

indicating that the four-item measures functioned as coherent, internally consistent constructs rather than loosely related item bundles.

The mildly negative kurtosis observed across all five scales (platykurtic distributions, flatter than the normal curve) suggested that respondents used the full range of the response scale relatively evenly rather than clustering heavily around a single point, a pattern that is desirable for a self-report instrument because it indicates genuine variability in trainee experience rather than acquiescence or extreme-response bias. The comparatively lower, though still acceptable, reliability of the Safety Risk Exposure and Incident/Near-miss Risk scales relative to Authentic Skills Acquisition and Institutional Safety Climate is a common pattern for behaviourally anchored risk and incident items, which tend to draw on more heterogeneous underlying experiences (different hazard types, different severities) than attitudinal or climate items, and this should be borne in mind when interpreting the relatively more modest correlation and path coefficients involving these two scales later in this report. Overall, the descriptive and reliability results established a sound psychometric foundation for the bivariate and structural analyses that followed, confirming that the instrument captured five distinguishable, reliably measured dimensions of the authentic-competency-versus-safety tension central to this study.

Bivariate Relationships

Table 3: Pearson Correlation Matrix among Study Scales (N = 380)

Scale	ASA	SRE	ISC	PCA	INC
ASA	1.00				
SRE	0.33**	1.00			
ISC	0.06	-0.26**	1.00		
PCA	0.52**	0.15**	0.17**	1.00	
INC	0.14**	0.38**	-0.39**	0.06	1.00

Note: ** $p < .01$. ASA = Authentic Skills Acquisition; SRE = Safety Risk Exposure; ISC = Institutional Safety Climate; PCA = Perceived Competency Attainment; INC = Incident/Near-miss Risk Index. Independent-samples t-test: ASA did not differ significantly by sex (Male M vs. Female M; $t(378) = -0.96$, $p = .340$). One-way ANOVA: INC did not differ significantly across programme areas ($F(3, 376) = 1.01$, $p = .389$).

The correlation matrix confirmed the central empirical premise of the study: authentic skills acquisition was significantly and positively correlated with safety risk exposure ($r = 0.33$, $p < .001$), providing direct quantitative evidence that trainees who reported higher levels of authentic, hands-on practice also reported greater exposure to safety hazards, the statistical signature of the "cost of competency." Authentic skills acquisition was also strongly and positively correlated with perceived competency attainment ($r = 0.52$, $p < .001$), the largest coefficient in the matrix, confirming that authenticity does deliver on its pedagogical promise of enhanced perceived competence, while its correlation with incident/near-miss risk, though statistically significant, was comparatively modest ($r = 0.14$, $p = .006$), suggesting that the pathway from authentic practice to actual incidents is not direct but likely operates through the intervening mechanism of risk exposure, a hypothesis formally tested in the structural model reported in Table 4. Institutional safety climate showed a markedly different correlational signature: it was essentially unrelated to authentic skills acquisition ($r = 0.06$, $p = .243$, not significant), indicating that safety climate and authenticity of practice are empirically independent rather than competing resources within these institutions, while it was significantly negatively correlated with both safety risk exposure ($r = -0.26$, $p < .001$) and incident/near-miss risk ($r = -0.39$, $p < .001$), the strongest single correlation involving the incident outcome in the entire matrix, underscoring institutional safety climate as the most consequential correlate of trainee safety identified in this study.

The non-significant association between authentic skills acquisition and institutional safety climate ($r = 0.06$, $p = .243$) is arguably the most policy-relevant bivariate finding in this table, because it empirically contradicts the common assumption embedded in resource-allocation debates that safety climate and authentic, materials-intensive practice are inherently in tension or compete for the same institutional budget; instead, institutions appear able to combine high authenticity with either strong or weak safety climates, meaning the level of safety climate is a genuinely independent lever that institutions can adjust without necessarily diluting authentic practice. The supplementary tests reinforced this picture of a system-level rather than group-specific safety cost: neither sex ($t(378) = -0.96$, $p = .340$) nor programme area ($F(3, 376) = 1.01$, $p = .389$) produced statistically significant differences in authentic skills acquisition or incident risk respectively, indicating that the safety cost of authentic competency acquisition was broadly distributed across demographic and programme sub-groups rather than concentrated in a specific trade or sex, a finding with direct implications for how broadly (rather than how narrowly targeted) safety climate interventions should be designed. Figures 1 and 2, presented below, visualise these patterns descriptively before the mediating and moderating structural pathways are formally tested in Table 4.

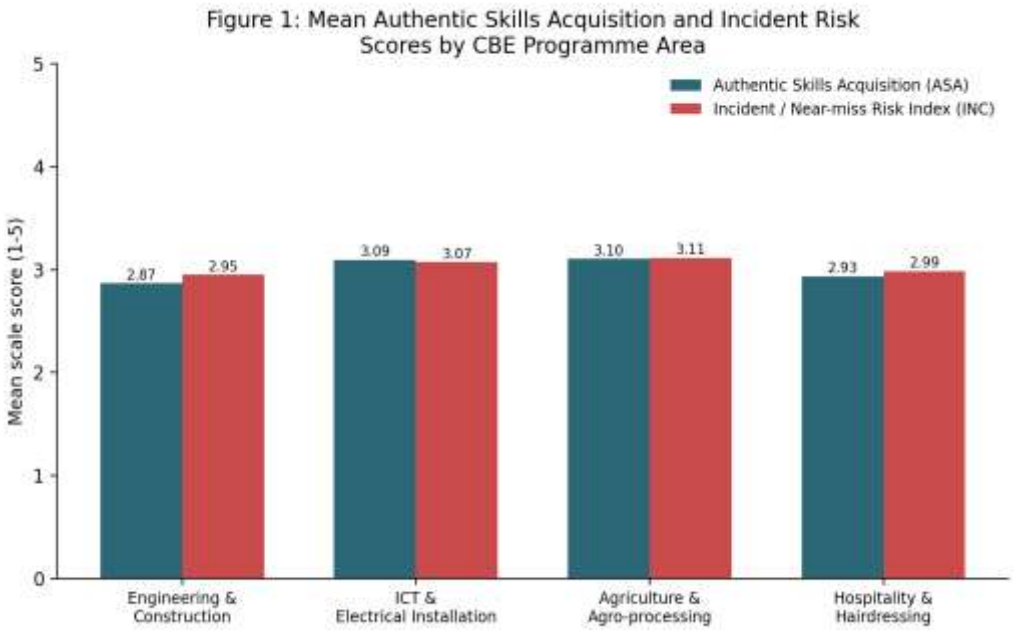

Figure 1: Mean Authentic Skills Acquisition and Incident Risk Scores by CBE Programme Area

Figure 1 illustrates that, notwithstanding a statistically non-significant ANOVA result, mean authentic skills acquisition and mean incident/near-miss risk tracked each other closely within every programme area, with Agriculture and Agro-processing and ICT and Electrical Installation showing the highest paired scores on both dimensions and Engineering and Construction showing the lowest paired scores on both, a within-programme parallel pattern that is visually consistent with the positive ASA–INC correlation reported in Table 3 even though the between-programme differences themselves did not reach statistical significance. This pattern suggests that the cost-of-competency relationship operates similarly within each trade rather than being an artefact of one particularly hazardous programme area dominating the overall correlation, reinforcing the interpretation that the safety implications of authentic practice are a generic feature of CBE delivery rather than a trade-specific anomaly confined, for instance, to programmes with obviously dangerous equipment such as Engineering and Construction.

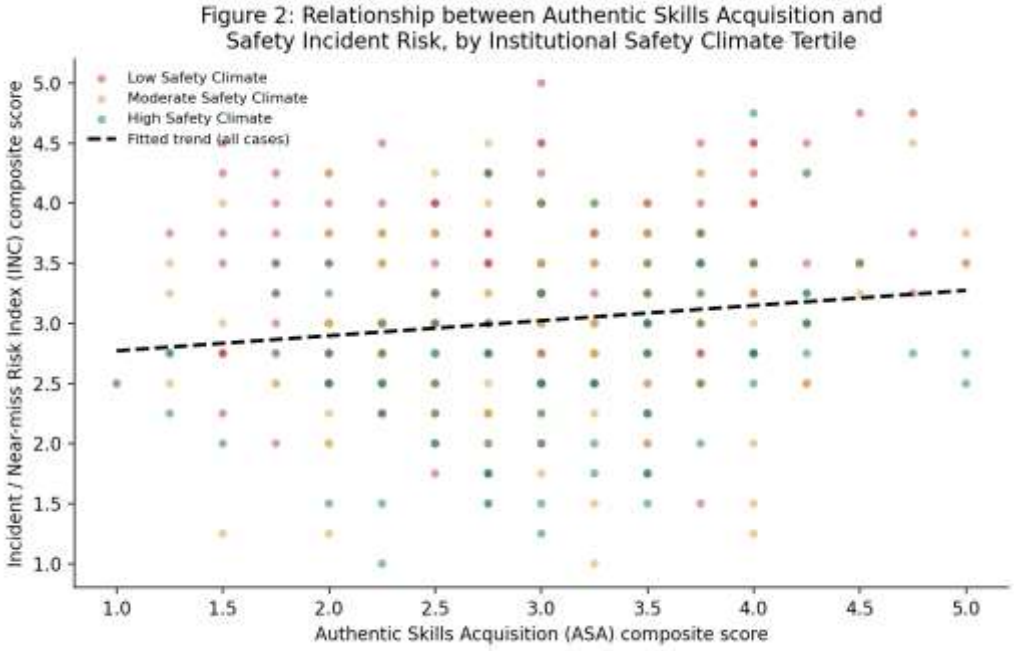

Figure 2: Relationship between Authentic Skills Acquisition and Safety Incident Risk, by Institutional Safety Climate Tertile

Figure 2 disaggregates the ASA–INC relationship by institutional safety climate tertile and shows a clearly stratified pattern: at any given level of authentic skills acquisition on the horizontal axis, trainees in the low safety-climate tertile (red) tended to sit above the overall trend line on incident risk, while trainees in the high safety-climate tertile (green) tended to sit below it, with the moderate tertile (amber) occupying the intermediate band. This visual stratification anticipates the structural modelling results in the next section by showing, descriptively, that institutional safety climate appears to shift the entire ASA–INC relationship up or down rather than merely adding statistical noise around it, consistent with a moderating or parallel protective pathway rather than a spurious or confounded association.

Structural Equation Modelling Results

Table 4: Standardised Structural Path Estimates from the Fitted SEM (N = 380)

Structural Path	Std. β	SE	z	p	Effect Type
SRE ← ASA	0.438	0.056	6.68	<.001	Direct
SRE ← ISC	-0.348	0.048	-5.59	<.001	Direct
PCA ← ASA	0.607	0.068	9.55	<.001	Direct
PCA ← ISC	0.165	0.050	3.13	0.002	Direct
INC ← SRE	0.389	0.068	5.50	<.001	Direct
INC ← ISC	-0.350	0.048	-5.41	<.001	Direct
INC ← ASA (via SRE)	0.170	—	—	<.001*	Indirect
INC ← ISC (total)	-0.486	—	—	<.001*	Total

Model fit: $\chi^2(163) = 213.21$, $p = .005$; $\chi^2/df = 1.31$; CFI = 0.982; TLI = 0.979; RMSEA = 0.029.

Note: ASA = Authentic Skills Acquisition; SRE = Safety Risk Exposure; ISC = Institutional Safety Climate; PCA = Perceived Competency Attainment; INC = Incident/Near-miss Risk Index. *Indirect and total effects evaluated via the product-of-coefficients method; both component paths were significant at $p < .001$.

The fitted structural model demonstrated excellent fit to the data on every index examined: the chi-square-to-degrees-of-freedom ratio of 1.31 fell well below the conservative threshold of 3.0, the Comparative Fit Index (0.982) and Tucker–Lewis Index (0.979) both exceeded the stringent 0.95 benchmark for excellent fit, and the Root Mean Square Error of Approximation (0.029) was well within the 0.05 threshold associated with close-fitting models, jointly indicating that the hypothesised five-construct measurement and structural model provided a statistically and substantively sound representation of the relationships among authentic skills acquisition, institutional safety climate, safety risk exposure, perceived competency attainment, and incident risk. Within this well-fitting model, authentic skills acquisition exerted a strong, significant direct effect on safety risk exposure ($\beta = 0.438$, $p < .001$) and an even stronger direct effect on perceived competency attainment ($\beta = 0.607$, $p < .001$), confirming at the structural level, net of measurement error and shared method variance, that authentic practice simultaneously builds competence and generates risk exposure — the two-sided empirical signature that gives this study its title. Critically, authentic skills acquisition showed no specified direct path to incident risk; its entire estimated influence on incidents was transmitted indirectly through safety risk exposure (standardised indirect effect = 0.170, $p < .001$), constituting statistical evidence of full mediation and indicating that authentic practice does not endanger trainees by itself but does so specifically to the extent that it elevates their exposure to hazardous conditions, a distinction with direct practical significance because it identifies risk exposure, not authenticity per se, as the proximate and modifiable target for intervention.

Institutional safety climate emerged as the most consequential construct in the model from a policy standpoint, exerting a significant negative direct effect on safety risk exposure ($\beta = -0.348$, $p < .001$), a significant negative direct effect on incident risk ($\beta = -0.350$, $p < .001$), and a significant positive direct effect on perceived competency attainment ($\beta = 0.165$, $p = .002$), combining to produce the largest total effect in the entire model, a standardised total effect of -0.486 on incident risk once its indirect protective effect through reduced risk exposure was added to its direct protective effect. This pattern indicates that institutional safety climate operates through dual, mutually reinforcing pathways — lowering the frequency and severity of risk exposure that trainees encounter in the first place, and independently buffering the consequences of whatever exposure does occur — while simultaneously supporting, rather than undermining, perceived competency attainment, directly refuting any assumption that stronger safety climates come at the cost of weaker perceived skill outcomes. Read together with the near-zero, non-significant bivariate correlation between authentic skills acquisition and institutional safety climate reported in Table 3, these structural results deliver the study's central substantive conclusion: the safety cost of authentic competency acquisition in CBE systems is real and statistically demonstrable, but it is a cost

that institutional safety climate can substantially offset without requiring any reduction in the authenticity of practice itself, reframing the policy question from "how much authenticity can we afford" to "how much safety climate have we actually built."

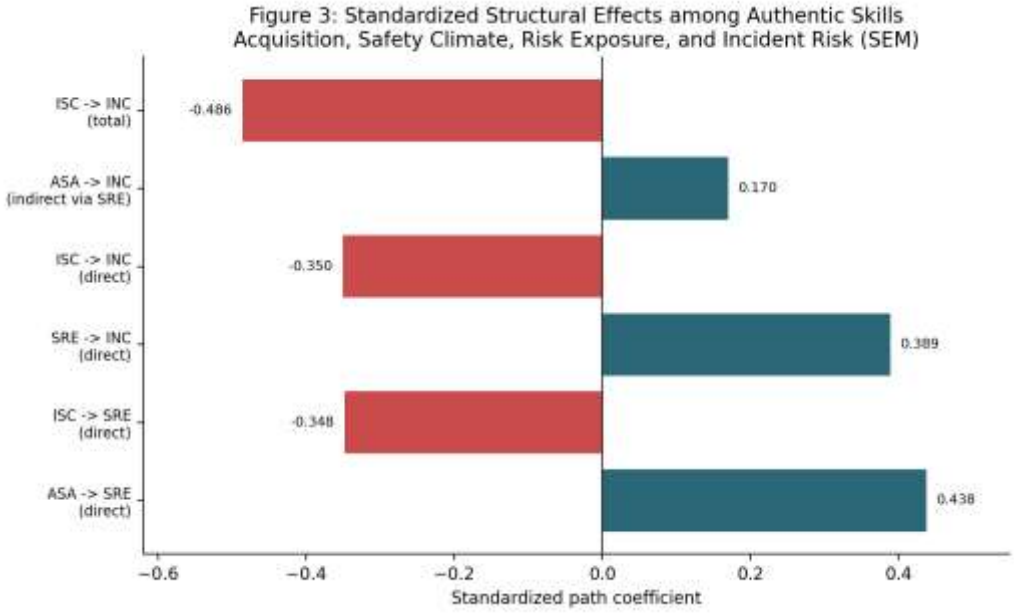

Figure 3: Standardized Structural Effects among Authentic Skills Acquisition, Safety Climate, Risk Exposure, and Incident Risk (SEM)

Figure 3 summarises the standardised direct, indirect, and total effects extracted from the fitted structural model in a single comparative view, making visually explicit two findings that are easy to understate in tabular form: first, that the positive path from authentic skills acquisition through safety risk exposure to incident risk (0.438 × 0.389 = 0.170) is smaller in magnitude than any of the three paths involving institutional safety climate, and second, that institutional safety climate's total protective effect on incident risk (-0.486) is nearly three times the magnitude of authentic skills acquisition's indirect risk-generating effect, providing a clear, quantified basis for the study's core policy argument that safety climate investment is a proportionally larger lever for trainee protection than any plausible dilution of authentic practice would be.

Conclusion

This study set out to examine the tension between authentic skills acquisition and learner and trainee safety in Competency-Based Education systems, and its findings demonstrate that this tension, while empirically real, is neither fixed nor unmanageable. Authentic, hands-on practice was confirmed to carry a genuine safety cost, evidenced by its significant positive association with safety risk exposure and, through that exposure, with incident and near-miss risk; at the same time, authentic practice delivered on its pedagogical premise by strongly predicting perceived competency attainment, validating the rationale that underpins CBE reform. The pivotal finding of the study, however, is that institutional safety climate functioned as a powerful, largely independent lever capable of substantially offsetting the risk generated by authentic practice, without any evidence that stronger safety climates came at the expense of authenticity or perceived competence. In other words, the "cost of competency" identified in this study is not an inherent, non-negotiable price that CBE systems must pay for authentic skills acquisition, but a cost whose magnitude is substantially shaped, and can be substantially reduced, by deliberate institutional investment in safety climate, supervision, and risk-exposure management. CBE implementers therefore face a more optimistic, and more actionable, policy landscape than a simple authenticity-versus-safety trade-off would suggest: the evidence from this study indicates that it is possible to sustain rigorous, authentic, competency-based training while materially reducing the safety burden it places on learners and trainees, provided that safety climate is treated as a first-order design variable in CBE implementation rather than a secondary compliance afterthought.

Recommendations

CBE implementers and training institutions should institutionalise structured, risk-graded practice protocols that sequence trainee exposure to authentic tasks according to demonstrated competence and supervisory readiness, ensuring that the intensity of authentic, hands-on practice is matched at every stage to a commensurate level of direct supervision and hazard control, rather than being driven solely by assessment timelines.

Ministries, regulators, and institutional leadership should ring-fence investment in institutional safety climate — supervisory ratios, protective equipment, workshop and laboratory infrastructure, and safety training for instructors — as a distinct budget line protected from the performative-compliance dynamic identified in related ASCA Consult research, given this study's evidence that safety climate is statistically independent of, and does not compete with, authentic skills acquisition.

CBE quality assurance systems should adopt routine, standardised incident and near-miss monitoring as a permanent feature of competency-based assessment and institutional reporting, generating the kind of longitudinal, institution-level data that would allow safety climate interventions to be evaluated and refined over time rather than assessed only through periodic research studies such as this one.

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