Relationship between Engagement in Online Learning Modules and Injury Prevention Knowledge among Sports Science Students at UiTM Shah Alam

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Abstract
The study investigated the relationship between engagement in online learning modules and injury prevention knowledge among undergraduate Sport Science students at Universiti Teknologi MARA (UiTM) Shah Alam. A cross-sectional survey was administered to 111 Bachelor of Sports Science (Hons) students during the October 2025–February 2026 semester, using an online questionnaire that assessed demographic characteristics, injury prevention knowledge (six-item test), engagement with online injury prevention modules, and perceived effectiveness of these modules. Descriptive statistics, independent-samples t-tests, chi-square tests, and Spearman's rank-order correlation were used to analyse the data. Overall injury prevention knowledge was relatively high (M = 4.95 ± 0.86 out of 6), with 74.8% of students classified as having high knowledge. Students generally reported positive perceptions of online learning modules (M = 3.77 ± 0.49; Cronbach's α = 0.77). However, no significant differences in knowledge scores were found between students who used online learning modules and those who did not (p = .825), and engagement frequency was not significantly correlated with knowledge scores (ρ = 0.05, p = .612). The findings suggest that while online learning modules are well perceived and widely used, engagement alone was not associated with higher injury prevention knowledge in this cohort. These results highlight the importance of integrating online learning strategically within blended curricula and designing modules that promote deeper, application-based learning to enhance educational outcomes in sports injury prevention.
Keywords: Online Learning, Student Engagement, Injury Prevention Knowledge, Sports Science, Higher Education

Introduction
Sports injuries continue to represent a major concern for athletes at all levels of participation, often resulting in reduced performance and long-term health complications that undermine career development and quality of life (Brenner et al., 2024; Watson et al., 2022). Within

sports science education, injury prevention is therefore recognized as a critical competency, equipping future coaches, trainers, and exercise professionals with the ability to identify risk factors, apply evidence-based strategies, and promote athlete safety across training and competitive environments. Evidence indicates that structured injury prevention education can improve safety awareness and foster healthier training behaviours among athletes, underscoring the value of integrating prevention-focused content into academic curricula (Kwon & Jang, 2025a; Mugele et al., 2018; Orton et al., 2016). Nevertheless, knowledge gaps remain, and understanding into applied practice, suggesting the need for more innovative instructional approaches (Spinks et al., 2024).

The expansion of online learning has introduced new opportunities to strengthen educational delivery in higher education. Digital learning modules enable consistent, scalable, and interactive instruction, supporting flexible access to materials while encouraging students to take greater responsibility for their learning. A growing body of literature supports the effectiveness of online and blended learning approaches compared to traditional face-to-face instruction (Alarifi & Song, 2024). Large-scale reviews, such as those by Means et al. (2013), demonstrate that blended learning—combining online and face-to-face elements—produces effect sizes indicating stronger learning outcomes than purely face-to-face methods, with pure online formats also showing equivalence or modest gains. Updated syntheses similarly confirm the non-inferiority of online instruction, attributing advantages to flexible access and repeated exposure to materials across primary and secondary education, higher education, and professional training context. Multimedia tools such as videos and simulations in platforms such as uFuture (an application developed by Universiti Teknologi MARA), Moodle or Canvas can increase motivation by accommodating diverse learning preferences, while formative assessments with immediate feedback (e.g., Wayground, Kahoot or adaptive quizzes) enhance knowledge retention through active recall and spaced practice. Research in health and sport-related disciplines further indicates that well-designed online learning environments can improve knowledge, engagement, and perceived readiness to apply injury prevention principles (Jacobsson et al., 2023; Martín-Rodríguez & Madrigal-Cerezo, 2025). In some cases, digital platforms has even been associated with reductions in injury incidence and improved adherence to safer training behaviours, highlighting their potential to extend learning beyond theoretical knowledge (Ibrahim et al., 2021).

However, the effectiveness of online instruction is not universally guaranteed. Meta-analyses consistently report that blended formats often outperform purely online or purely face-to-face teaching, and learner outcomes are strongly influenced by motivation, engagement, and instructional design quality (Means et al., 2013). Attrition, uneven digital literacy, and limited technological access can further weaken learning outcomes, while increases in knowledge may not always translate into sustained behaviour change without reinforcement or practical application opportunities. These findings emphasize the need to examine how students engage with online modules and whether such engagement results in meaningful gains in injury prevention knowledge.

Blended learning models, in particular, have been associated with higher student satisfaction and lower dropout rates compared with lecture-based formats (Çolakoğlu et al., 2024). . Technology-supported learning environments in physical education and exercise science have demonstrated benefits for understanding injury management and prevention concepts, with

improvements reported in knowledge, skills, and behaviours through the use of online modules, applications, and wearable technologies (Ha et al., 2025; Mishra et al., 2024). These approaches offer interactive and personalized learning experiences that help bridge the gap between theory and practice.

Despite these promising developments, literature reveals significant gaps in empirical research on online learning's specific impact on injury prevention knowledge for undergraduate sports science students, especially in Malaysia. Few studies directly examine online learning's enhancement of injury prevention knowledge among Malaysian undergraduate sports science students, with most research addressing athlete programs or general readiness. A 2021 study on physiotherapy undergraduates (related field) found moderate online learning readiness but no link to injury prevention outcomes, underscoring a knowledge gap in targeted evaluations. Comparative analyses of Malaysian sports science students note perceptions of online learning but lack empirical data on injury-specific knowledge gains (Al Attar et al., 2021; Shaharudin & Ahmad Yusof, 2025).

For example, NDUM students in Malaysia demonstrated low levels of knowledge regarding sports injury management, with most responses reflecting superficial recall rather than application, raising concerns about professional readiness (Amran et al., 2025). Broader surveys similarly indicate inadequate injury-prevention knowledge among university students, often memorized rather than meaningfully applied. This pattern persists despite curricular exposure, suggesting limited transfer to authentic practice. Moreover, Malaysian injury-prevention research has tended to emphasize athlete-focused interventions such as neuromuscular training rather than student education through digital platforms. Studies frequently prioritize general sports safety attitudes or physical activity, overlooking direct connections between online engagement and injury-prevention knowledge within sports science programs. Calls for more individualized, technology-based strategies therefore highlight the absence of online-learning-specific evidence (Amran et al., 2025; Bakar & Shaharudin, 2022; Shaharudin & Ahmad Yusof, 2025).

Despite the widespread adoption of online and blended learning in sports science education, empirical evidence demonstrating whether student engagement with online learning modules translates into meaningful injury-prevention knowledge remains limited. Existing research has predominantly focused on athlete-centred injury-prevention interventions, student perceptions of digital instruction, or general online learning readiness, offering little insight into discipline-specific knowledge outcomes among undergraduate sports science students. This gap is particularly evident in Malaysia, where studies consistently report superficial or recall-based injury-prevention knowledge among sports science students despite formal curricular exposure. Consequently, it remains unclear whether engagement with online learning modules contributes to improved injury-prevention knowledge in this population.

Against this background, the phenomenon of interest in the present study is the role of student engagement with online learning modules in shaping injury-prevention knowledge acquisition. In response to the identified gaps, this study investigates the relationship between engagement in online learning modules and injury-prevention knowledge among undergraduate sports science students at Universiti Teknologi MARA (UiTM) Shah Alam. The

novelty of this research lies in its empirical examination of engagement–knowledge relationships within a Malaysian undergraduate sports science context, extending existing educational research beyond student perceptions and learning readiness. By clarifying how digital engagement relates to knowledge outcomes, this study contributes to the social sciences by informing technology-enhanced pedagogy and supporting the development of more effective, evidence-based curricula for injury-prevention education.

Methodology

Study Design
This study used a cross-sectional quantitative survey design to investigate the relationship between engagement in online learning modules and injury prevention knowledge among undergraduate Sport Science students. The design enabled systematic assessment of students' knowledge, engagement, and perceptions at a single time point during the October 2025 – February 2026 semester.

A cross-sectional approach was deemed appropriate given the exploratory nature of the study and its focus on describing current engagement patterns, perceived effectiveness of online learning modules, and their association with injury prevention knowledge within a defined academic cohort.

Participants and Sampling
Participants were undergraduate students enrolled in the Faculty of Sports Science and Recreation, Universiti Teknologi MARA (UiTM), Shah Alam, Malaysia specifically from the Bachelor of Sports Science (Hons) programme. Students from other faculties, campuses, or postgraduate programmes were excluded to ensure curricular comparability in exposure to injury prevention content At the time of data collection, approximately 614 students were enrolled in the programme. All eligible students were invited to participate through institutional communication channels. A total of 111 students completed the questionnaire and were included in the final analysis.

The final sample comprised 69 males (62.2%) and 41 females (36.9%), with one missing gender response. The majority of participants were aged 21–23 years (n = 70), followed by 24–26 years (n = 25) and 18–20 years (n = 16). In terms of year of study, 17 students were in Year 1, 29 in Year 2, 46 in Year 3, and 17 in Year 4, with two missing responses.

Ethical Considerations
Ethical approval was obtained from the UiTM Ethics Review Committee (Approval No.: ERC/FSR/UG/MR/2025/DEC/278). Participation was voluntary and no incentives were provided; informed consent was obtained electronically prior to accessing the questionnaire. The survey did not collect identifying information, and all responses were handled confidentially in accordance with institutional ethical guidelines. Participants were informed that they could withdraw from the study at any time without academic penalty.

Instrumentation
Data were collected using a self-administered online questionnaire, developed based on previous research on injury prevention education and online learning effectiveness (Kwon & Jang, 2025b). Items were adapted to the academic context of Sports Science students at UiTM

Shah Alam. The questionnaire was reviewed by the research team to ensure content relevance, clarity, and suitability for the target population. Minor wording adjustments were made following informal checks for item comprehension.

The questionnaire consisted of three sections as described below:

Section A: Demographic Information

This section collected information on gender, age, year of study, and prior exposure to injury prevention coursework. These data were used to describe the sample and explore potential variations across subgroups.

Section B: Knowledge of Injury Prevention

Knowledge was assessed using six items reflecting core concepts of sports injury prevention taught in Sport Science curricula:

i.   Importance of warming up before exercise to reduce injury risk,
ii.   Role of poor technique as a cause of sports injuries,
iii.   Common versus non-common risk factors for sports injuries,
iv.   Appropriate immediate response to an ankle sprain,
v.   Importance of recovery and rest in preventing re-injury, and
vi.   The most appropriate strategies for preventing sports injuries.

Each item had one correct answer. Responses were scored dichotomously, with 1 point awarded for each correct response and 0 points for incorrect responses. Scores were summed to produce a total injury prevention knowledge score ranging from 0 to 6, with higher scores indicating greater knowledge.

Section C: Experience and Perceptions of Online Learning Modules

Section C examined students' engagement with online learning modules related to injury prevention and their perceptions of these learning resources. Engagement was assessed using items that asked whether students had previously used online learning modules related to injury prevention (Yes/No), as well as items assessing frequency of use and average duration per session. Perceptions of online learning modules were measured using four Likert-type statements, each rated on a five-point scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The statements assessed perceived usefulness, comparative effectiveness, confidence in application, and willingness to recommend online learning modules for injury prevention education. The four perception items were averaged to create a perceived effectiveness score, with higher values indicating more positive perceptions of online learning modules for injury prevention.

Instrument Scoring and Use in Analysis

Demographic variables were analysed descriptively. The injury prevention knowledge items were treated as a summative knowledge index, while the perception items were treated as a multi-item scale. Engagement indicators (use and frequency) were analysed separately to examine their relationship with injury prevention knowledge.

Data Collection Procedures

Data were collected electronically using Google Forms to ensure ease of access and participation. The survey link was disseminated via institutional communication channels to all eligible SR243 students during the October 2025 – February 2026 semester. Completion of

the questionnaire required approximately 10–15 minutes. Students were informed that participation was voluntary, responses were anonymous, and they could discontinue at any time without academic penalty.

Submitted responses were exported from Google Forms to Microsoft Excel and subsequently imported into statistical software for analysis. Prior to analysis, data were screened for completeness and consistency. All relevant variables were coded numerically to allow computation of composite scores and inferential tests.

Data Analysis
Data analysis was conducted using statistical software following data screening for completeness and consistency. All variables were coded numerically prior to analysis. Descriptive statistics were calculated to summarise participant characteristics and questionnaire responses. Frequencies and percentages were computed for categorical variables, including gender, age group, year of study, prior exposure to injury prevention courses, use of online learning modules, and engagement frequency. For continuous variables, means and standard deviations were calculated.

For injury prevention knowledge, individual items were scored dichotomously (1 = correct, 0 = incorrect) and summed to produce a total knowledge score ranging from 0 to 6. Item-level correct response rates were also calculated to describe performance across knowledge domains. Due to the heterogeneous nature of the knowledge items, the total score was treated as a summative index rather than a unidimensional scale.

For perceptions of online learning modules, responses to the four Likert-type items were averaged to create a perceived effectiveness score. Internal consistency of the perception items was assessed using Cronbach's alpha.

To address the study objectives, a series of inferential analyses were conducted. Independent-samples t-tests were used to compare injury-prevention knowledge scores between students who reported using online learning modules and those who had not, while chi-square tests of independence examined associations between categorical knowledge levels (moderate vs. high) and the use of online learning modules. In addition, Spearman's rank-order correlation was employed to assess the relationship between the frequency of engagement with online learning modules and injury-prevention knowledge, as engagement frequency was measured on an ordinal scale.

Although multiple regression analysis was initially considered, it was not performed due to the limited number of predictors and incomplete data across engagement variables. Consequently, the relationship between engagement with online learning modules and injury prevention knowledge was examined using bivariate analyses only.
All statistical tests were two-tailed, and the level of statistical significance was set at $p < .05$.

Results
Participant Characteristics
Table 1 summarises the demographic characteristics of the respondents. Most participants were male (62.2%), aged 21–23 years (63.1%), and in Year 3 of study (41.4%). The majority (82.0%) reported having previously attended a course or class related to injury prevention.

Table 1
Demographic Characteristics of Participants (n = 111)

Variable	Category	n	%
Gender	Male	69	62.2
	Female	41	36.9
	Missing	1	0.9
Age group (years)	18–20	16	14.4
	21–23	70	63.1
	24–26	25	22.5
Year of study	Year 1	17	15.3
	Year 2	29	26.1
	Year 3	46	41.4
	Year 4	17	15.3
	Missing	2	1.8
Prior injury prevention course	Yes	91	82.0
	No	20	18.0

Injury prevention knowledge
Item-level performance
Six items assessed core concepts of sports injury prevention. Correct response rates ranged from 35.1% to 99.1% (Table 2). Knowledge was highest for basic principles such as warming up, recovery and rest, and the appropriate acute management of injury, while comparatively fewer students correctly identified "adequate rest" as not a common risk factor for sports injuries.

Table 2
Item-level correct response rates for injury prevention knowledge (N = 111)

Item	Correct (%)
Warming up reduces injury risk (True)	99.1
Poor technique causes sports injuries (True)	93.7
Adequate rest as non-risk factor	35.1
Immediate response: R.I.C.E. method	91.0
Recovery and rest prevent re-injury (True)	99.1
Best prevention strategy: all of the above	76.6

Total knowledge score
A summative injury-prevention knowledge score ranging from 0 to 6 was computed by awarding one point for each correct response. Across the sample, scores ranged from 3 to 6, with a mean of 4.95 (SD = 0.86) and a median score of 5. Specifically, 7.2% of students scored 3 out of 6, 18.0% scored 4 out of 6, 47.7% scored 5 out of 6, and 27.0% achieved a perfect score of 6. For categorical analyses, knowledge scores were classified as moderate (0–4; n = 28, 25.2%) or high (5–6; n = 83, 74.8%). Overall, the findings indicate that students demonstrated relatively high levels of injury-prevention knowledge, with the majority of respondents achieving at least five correct responses.

Engagement with Online Learning Modules and Perceived Effectiveness
Use and Engagement Patterns
Most students reported having used online learning modules related to injury prevention, with 89 students (80.2%) indicating prior use and 22 students (19.8%) reporting no use. Among those who provided valid responses to the engagement items (n = 108), engagement frequency was generally low to moderate. Nearly half of the students reported engaging with online modules occasionally, defined as once a month (49.1%), while 28.7% reported rare engagement (once or twice per semester). Fewer students reported frequent use, with 18.5% engaging weekly and only 3.7% engaging more than once a week.

Table 3
Frequency of engagement with online injury prevention modules (valid n = 108)

Category	n	%
Rarely (once or twice a semester)	31	28.7
Occasionally (once a month)	53	49.1
Frequently (weekly)	20	18.5
Very frequently (> once a week)	4	3.7

Among the 107 valid responses, just over half of the participants (56; 52.3%) reported spending 15–30 minutes per session, while 33 respondents (30.8%) spent less than 15 minutes, and a smaller proportion (18; 16.8%) reported session durations of 30–60 minutes.

Table 4
Average duration per session for online injury prevention modules (valid n = 107)

Category	n	%
Less than 15 minutes	33	30.8
15–30 minutes	56	52.3
30–60 minutes	18	16.8

Overall, online modules were used by the majority, but engagement tended to be occasional and brief, with about half of students using them monthly and for 15–30 minutes per session.

Perceived Effectiveness of Online Learning Modules
Perceptions of online learning modules were assessed with four Likert-type items, averaged to produce a perceived effectiveness score (1–5). Internal consistency of the four items was

acceptable, with Cronbach's α = 0.77, indicating that the items reliably capture a single underlying construct of perceived effectiveness.

Among students who reported using online learning modules and provided valid responses (n = 89), the mean engagement score was 3.77 (SD = 0.49) on a 1–5 scale, with scores ranging from 2.00 to 5.00 and an interquartile range of 3.50 to 4.00. These findings indicate that, on average, students moderately to strongly agreed that online learning modules helped them understand the importance of injury prevention, were effective compared with traditional lectures, increased their confidence in applying injury-prevention knowledge, and were worth recommending to other sports science students.

Thus, Objective 1 (to determine the perceived effectiveness of online learning modules) is addressed by showing generally positive perceptions and good internal consistency of the perception scale.

Relationship between Engagement and Injury Prevention Knowledge
The third objective examined whether students' engagement with online learning modules was associated with their level of injury-prevention knowledge. To address this objective, three complementary analyses were conducted: an independent-samples t-test to compare knowledge scores between students who reported using online learning modules and those who did not, a chi-square test of independence to examine the association between categorical knowledge level (moderate vs. high) and module use, and Spearman's rank-order correlation to assess the relationship between frequency of engagement with online modules and injury-prevention knowledge scores.

Knowledge Scores by use of Online Modules
Independent-samples t-tests compared total knowledge scores between students who reported using online learning modules and those who did not (Table 5).

Table 5
Knowledge scores by use of online learning modules

Used online modules	n	Mean knowledge score	SD
Yes	89	4.96	0.86
No	22	4.91	0.87

A Welch's t-test indicated no statistically significant difference in injury-prevention knowledge scores between students who used online learning modules and those who did not, t(32.11) = 0.22, p = 0.825, with a negligible effect size (Cohen's d = 0.05). These results suggest that students in both groups demonstrated very similar levels of injury-prevention knowledge.

Knowledge Level (Moderate vs. High) and Use of Modules
To examine the association between categorical knowledge level and use of online modules, students were classified into moderate (scores 0–4) and high (scores 5–6) knowledge groups and cross-tabulated by module use (Table 6).

Table 6
Knowledge level (moderate vs. high) by use of online injury prevention modules (N = 111)

Knowledge level	No	Yes
High (5–6)	15	68
Moderate (0–4)	7	21

Column percentage analysis indicated that among students who did not use online learning modules (n = 22), 68.2% were classified as having high injury-prevention knowledge and 31.8% as having moderate knowledge. Among students who reported using online modules (n = 89), 76.4% demonstrated high knowledge and 23.6% moderate knowledge. A chi-square test of independence revealed that the difference in knowledge distribution between the two groups was not statistically significant, $\chi^2(1, N = 111) = 0.27$, $p = .602$, with a very small effect size ($\phi = 0.05$). These findings indicate that categorised injury-prevention knowledge levels did not differ meaningfully between students who had used online learning modules and those who had not.

Frequency of Engagement and Knowledge Scores
Finally, Spearman's rank-order correlation was conducted to examine the association between frequency of engagement with online learning modules and injury-prevention knowledge scores among students who reported using online modules (n = 89). Engagement frequency was treated as an ordinal variable ranging from rare use (once or twice per semester) to very frequent use (more than once a week). The analysis revealed a very weak and non-significant positive correlation between engagement frequency and injury-prevention knowledge (Spearman's $\rho = 0.05$, $p = .612$), indicating that higher levels of engagement with online modules were not associated with substantially higher knowledge scores in this sample.

Discussion
The present study examined the relationship between engagement in online learning modules and injury prevention knowledge among undergraduate Sport Science students at Universiti Teknologi MARA (UiTM) Shah Alam, Malaysia. Specifically, the study aimed to (i) determine students' perceived effectiveness of online learning modules for injury prevention education, (ii) assess their current level of injury prevention knowledge, and (iii) examine the relationship between engagement with online modules and injury prevention knowledge. The findings provide several important insights into the role of online learning in sports injury education within a university context.

Perceived Effectiveness of Online Learning Modules
The findings indicate that students generally perceived online learning modules related to injury prevention as effective. The mean perceived effectiveness score (M = 3.77, SD = 0.49) suggests moderate to strong agreement that online modules enhanced understanding, supported confidence in applying injury prevention principles, and were comparable or complementary to traditional lecture-based instruction. The acceptable internal consistency of the perception scale (Cronbach's $\alpha = 0.77$) further supports the reliability of these perceptions as a unified construct.

These findings align with prior research demonstrating positive student attitudes towards online and blended learning approaches in sports science and health-related education (Hergüner et al., 2021; Kwon & Jang, 2025a; Wang et al., 2024). Online modules offer flexibility, self-paced learning, and repeated exposure to content, which may enhance learners' perceived control and engagement (Rasheed et al., 2020; Wang et al., 2025). From a constructivist learning perspective, such features allow students to integrate theoretical knowledge with prior experiences, thereby improving perceived learning effectiveness (Vaughan et al., 2013).

However, while students reported favourable perceptions, perceived effectiveness does not necessarily translate into measurable knowledge gains. This distinction is important, as learners' subjective satisfaction with online tools may reflect usability, accessibility, or convenience rather than actual cognitive outcomes. Consequently, the positive perceptions observed in this study should be interpreted as an enabling factor for learning rather than direct evidence of superior educational impact.

Level of Injury Prevention Knowledge Among Sports Science Students
Overall, students demonstrated relatively high levels of injury prevention knowledge, with a mean score of 4.95 out of 6 and nearly three-quarters of respondents classified as having high knowledge (scores 5–6) which is consistent with prior work indicating at least moderate baseline awareness of sports injury prevention and first-aid principles among university students and athletes (Amran et al., 2025; Hamdan et al., 2022). High correct response rates for fundamental concepts such as warm-up, recovery and rest, recognition of poor technique as a risk factor, and appropriate immediate management of acute injuries are congruent with reports that many students can identify basic R.I.C.E. management and common risk factors (Amran et al., 2025).

These findings are consistent with expectations for undergraduate Sport Science students, the majority of whom reported prior exposure to injury prevention content through formal coursework, and echo evidence that structured education in safe training practices and first aid improves prevention-related knowledge and attitudes (Amran et al., 2025; Soni & Vora, 2025). The results suggest that core injury prevention principles are being effectively conveyed within the existing curriculum at UiTM Shah Alam. This aligns with broader work arguing that injury-prevention principles must be clearly communicated and embedded in real-world practice if they are to impact injury rates (Finch, 2011).

Despite the generally high scores, some important gaps remained. Fewer than half of the students correctly recognised 'adequate rest' as a non-risk factor, suggesting that they may confuse safe recovery with harmful under- or over-training, and conflate training load, fatigue, and rest when thinking about injury risk (Jones et al., 2017; Shamsa et al., 2025). These misconceptions are important, because misinterpreting rest as a risk factor could lead to poor training decisions and injury-management behaviours, reinforcing the need for teaching that stresses how workload, recovery, and injury risk interact rather than focusing only on isolated prevention strategies (Finch, 2011; Jones et al., 2017).

Engagement with Online Learning Modules and Injury Prevention Knowledge
Contrary to expectations, the study found no significant association between engagement with online learning modules and injury prevention knowledge. Knowledge scores did not differ significantly between students who reported using online modules and those who did not, and frequency of engagement was not significantly correlated with knowledge scores. These findings suggest that engagement with online learning modules, as operationalised here, was not a strong predictor of injury prevention knowledge, which is consistent with evidence that single, coarse indicators of online engagement are not always reliable predictors of academic performance (Saqr et al., 2023).

First, a ceiling effect is likely, given the overall high level of knowledge across the sample, meaning that additional resources may produce limited observable gains on a short six-item measure in a cross-sectional design.

Second, the nature of engagement may be more important than frequency alone. Most students reported using online modules only once a month for 15–30 minutes, a pattern that may reinforce existing understanding but may not provide the interactive or constructive engagement needed to shift objective knowledge scores. This interpretation aligns with the ICAP framework, which argues that interactive and constructive activities (e.g. problem-solving, application tasks, reflection) lead to stronger learning outcomes than passive viewing or shallow activity (Chi & Wylie, 2014).

Third, injury prevention knowledge in this cohort is likely shaped primarily by formal coursework, practical classes, and experiential learning, with online modules acting as supplementary resources rather than primary teaching tools, as seen in other blended and physical-education settings (Hrušová et al., 2024; Wang et al., 2024). In such contexts, online learning may enhance confidence and perceived understanding more than it alters scores on brief knowledge tests.

Finally, the cross-sectional design limits the ability to detect causal relationships. It is possible that students with higher baseline knowledge are more inclined to use online learning modules, rather than online engagement leading to increased knowledge (Saqr et al., 2023). Longitudinal or experimental designs would be better suited to disentangling these relationships.

Educational and Practical Implications
Despite the absence of a significant relationship between engagement and knowledge scores, the positive perceptions of online learning modules indicate that such resources are acceptable to students and may support motivation, confidence, and perceived learning support. Educators should therefore consider integrating online modules more strategically into the curriculum, rather than positioning them solely as optional add-ons, in line with recommendations from blended-learning research in physical education and sport (Hrušová et al., 2024; Wang et al., 2024).

To maximise impact, online learning modules could incorporate interactive elements such as quizzes with feedback, case-based scenarios, and application-based tasks aligned with real-world injury prevention contexts, thereby promoting the interactive and constructive

engagement identified as most beneficial by the ICAP framework (Chi & Wylie, 2014). Embedding these modules within assessed coursework may also increase engagement intensity and encourage deeper learning. Additionally, addressing identified misconceptions—such as the role of rest, recovery and training load—could strengthen conceptual understanding of injury risk.

From an institutional perspective, the findings are compatible with a blended learning approach in which online modules complement face-to-face instruction rather than replace it, a model that has shown promise in Sport Science and physical education by supporting both theoretical understanding and practical skill development (Hrušová et al., 2024; Wang et al., 2024).

Limitations and Future Research

Several limitations should be acknowledged. First, the study relied on self-reported engagement measures, which may be subject to recall bias and do not capture the quality or depth of engagement. Second, the injury prevention knowledge scale consisted of only six items, which may limit sensitivity to small differences in knowledge levels. Third, the cross-sectional design precludes causal inference and does not account for changes in knowledge over time.

Future research should employ longitudinal or quasi-experimental designs to examine how structured online learning interventions influence injury prevention knowledge and behaviours. Expanding the knowledge assessment to include scenario-based or application-focused items may provide a more nuanced understanding of learning outcomes. Additionally, exploring behavioural outcomes—such as injury prevention practices during training or competition—would extend the relevance of research beyond cognitive knowledge alone.

Conclusion

In summary, Sport Science students at UiTM Shah Alam demonstrated high levels of injury prevention knowledge and generally positive perceptions of online learning modules. While engagement with online modules was not significantly associated with knowledge levels, the findings suggest that online learning is a valuable supportive tool within a broader educational framework. To enhance its educational impact, online learning should be purposefully integrated with curriculum content and designed to promote active, applied learning. These findings contribute to the growing literature on digital learning in sports education and provide evidence-based guidance for the effective use of online resources in injury prevention education.

Acknowledgement

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