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An examination of nursing students' performance in and Satisfaction with a Patient Safety E-Learning Module

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ABSTRACT

Background: The knowledge nursing students acquire during their undergraduate degree influences the quality of patient care they provide for many years to come. However, previous studies indicate that students may have a limited understanding of core patient safety concepts.

Objectives: The objectives of this study were to (i) examine nursing students' performance in an interactive patient safety e-learning module titled 'One shift, four patients ... a day in the life of a new graduate nurse'; and (ii) explore students' level of satisfaction with the module using the *Satisfaction with the Patient Safety E-Learning Module* scale.

Design: A cross-sectional design was used with students' knowledge and levels of satisfaction examined using descriptive statistics.

Setting and participants: In total, 1038 third-year undergraduate nursing students from 22 Australian universities attempted the module.

Results: The mean correct score was 74%, but there were significant differences in knowledge levels evident across the four activities that comprised the module. Participants achieved the highest mean score in Activity 2 (Predicting, monitoring, and responding to adverse events [79%]) and the lowest in Activity 3 (Clinical reasoning [66%]). The mean score for Activity 1 (Infection control and medication safety) was 74%, and for Activity 4 (Cultural competence), the score was 77%.

The level of student satisfaction with the module was high with responses to each survey item exceeding 4.0 out of 5.0. The Cronbach's alpha for the satisfaction scale was 0.99, and the Content Validity Index was > 0.9.

Conclusions: Universities are responsible for preparing nursing students to become safe clinicians. The results from this study indicate that participants' overall level of knowledge of key patient safety concepts was adequate. However, as knowledge is the foundation for safe practice, these results suggest that further attention to imbedding patient safety in nursing curricula is required.

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Summary of relevance**Problem or Issue**

Little is known about nursing students' level of patient safety knowledge.

What is already known

Most previous studies have examined students' attitudes and self-reported confidence related to patient safety, rather than their knowledge of the factors that impact patient safety.

What this paper adds

This paper provides an overview of more than 1000 nursing students' level of patient safety knowledge related to predicting, monitoring, and responding to adverse events, clinical reasoning, infection control, medication safety, and cultural competence. In addition, the paper reports on the levels of satisfaction with the Patient Safety Module used for data collection.

1. Introduction

Healthcare is not always a safe environment. Globally, adverse events resulting from unsafe care are a leading cause of death and disability. In high-resource countries, it is estimated that more than 10% of patients experience adverse events while in hospital, with unsafe care accounting for more than three million deaths per year (World Health Organization, 2023). Although the reasons for this are multifactorial, more than 50% of adverse events are preventable (Panagioti et al., 2019).

The knowledge and skills nursing students acquire during their undergraduate/pre-licensure studies influence the quality and safety of patient care they provide for years to come (Bressan et al., 2021). As such, higher education providers have a responsibility to ensure that graduates have the requisite knowledge to provide safe patient care.

This paper outlines the findings from a cross-sectional study that examined nursing students' performance in, and satisfaction with, an interactive multimedia Patient Safety Module (PSM) titled '*One shift, four patients ... a day in the life of a new graduate nurse*'.

2. Background

Healthcare has become increasingly complex. Along with inherent human performance limitations, this complexity can result in unintended errors. The personal and fiscal impact of unsafe care is significant. For example, in OECD countries, more than 15% of hospital expenditure is attributable to treating patients who have experienced an adverse event (Organization for Economic Cooperation and Development, 2019). In Australian public hospitals, it is estimated that the costs associated with preventable complications exceed \$4 billion each year (ACSQHC, 2019). Educational approaches that explicitly address patient safety have the potential to result in significant financial savings and, more importantly, better patient outcomes (Vaismoradi, Tella, Logan, Khakurel, & Vizcaya-Moreno, 2020). As such, a focus on the factors that undermine safe care should be part of the educational preparation of nursing students.

Patient safety initiatives aim to prevent and reduce risks, errors, and harm to patients during the provision of healthcare (World Health Organization, 2023). Nurses have a responsibility to both advocate for patient safety and to address issues that have the potential to negatively impact patient outcomes (Vaismoradi et al., 2020). Knowledgeable and skilled nurses also ensure that when errors do occur, they are less likely to become consequential and lead to patient harm.

Preparing nursing students with the skills and knowledge they need to improve patient safety is a critical responsibility for educators (Usher et al., 2017). To practice safely, students must have a

requisite level of clinically relevant knowledge along with the ability to apply their knowledge in clinical settings using critical thinking and clinical reasoning skills (Levett-Jones & Smith, 2022).

Most previous studies have either explored nursing students' patient safety knowledge as a general concept or examined students' attitudes, perceptions, and self-reported confidence related to patient safety knowledge (Lee, Morse, & Kim, 2022; Lee, An, Song, Jang, & Park, 2014; Sullivan, Hirst, & Cronenwett, 2009; Usher et al., 2017). Few studies have directly examined students' understanding of factors that undermine safe patient care. Against this background, the study profiled in this paper specifically focused on nursing students' knowledge of recurring patient safety issues (Levett-Jones et al., 2020) identified in contemporary literature, including infection prevention and control (Haque, Sartelli, McKimm, & Bakar, 2018); medication errors (World Health Organization, 2023); diagnostic errors (Graber, 2017); failure to predict, monitor, and respond to adverse events (O'Connell, Gardner, Coyer, & Wilson, 2015); and a lack of cultural competence (Truong, Paradies, & Priest, 2014).

3. Methods**3.1. Study objective**

The objective of this study was to (i) examine nursing students' performance in an interactive web-based multimedia PSM titled '*One shift, four patients ... a day in the life of a new graduate nurse*'; and (ii) explore students' level of satisfaction with the PSM.

3.2. Research questions

The research questions that we sought to address in this study included:

1. How did nursing students perform in the PSM?
2. What demographic characteristics, if any, impacted students' performance in the PSM?
3. According to the PSM results, what were students' areas of strength and most in need of development?
4. How satisfied were students with the learning design elements of the PSM?
5. How valid and reliable is the Satisfaction with the Patient Safety E-Learning Module (SPSELM) scale?

3.3. The patient safety module

The content of the PSM was informed by the Patient Safety Competency Framework for Nursing Students (Levett-Jones et al., 2017), contemporary patient safety literature, and the results from a previous study that identified specific areas where students' level of patient safety knowledge was low (Levett-Jones et al., 2020). The instructional design principles described by Gagne, Wager, Golas, and Keller (2005) (see Table 1) informed the design and development of the PSM.

The PSM [https://patientsafetyfornursingstudents.org/] includes four clinically relevant activity sets that focus on infection control and

Table 1
Gagne et al.'s (2005) instructional design principles for e-learning.

1. Consider learner capabilities and existing knowledge
2. Consider the programming to be utilised
3. Provide learning guidance
4. Identify learning outcomes and ensure content will deliver
5. Conceptualise and create meaningful and engaging content
6. Present the stimulus material
7. Consider how you will capture and maintain the learner's attention
8. Design objective performance assessments and feedback
9. Incorporate elements to enhance retention, transfer, and behaviour change
10. Incorporate peer review of content and resource evaluation measures

medication safety; predicting, monitoring, and responding to adverse events; clinical reasoning; and cultural competence. Each interactive activity takes approximately 15 min to complete and includes a stimulus video comprised of a simulated patient experience. The videos are followed by a number of question types, for example, multiple choice, hot spot, and click and drag, that require high-level cognitive skills such as analysis, synthesis, application, and evaluation, as well as knowledge recall. The PSM was reviewed by an expert panel consisting of eight academics who provided feedback on the design, structure, relevance, accuracy, and clarity of the activities and the related questions.

Students received immediate and personalised feedback on their performance in each activity and in comparison to other students. They also received a cumulative report indicating their overall areas of strength and those requiring improvement. Extension and reflection resources were provided, and students were able to complete the module as many times as they liked. In this paper, we report students' initial attempt in the PSM. The interactive nature of the PSM, along with the provision of supporting resources and opportunity for multiple attempts, was purposefully considered in the design of the module so as to promote active engagement and meaningful learning, as well as assessment of performance.

3.4. Study design

In order to elicit data from a specific nursing student population at a single point in time, a cross-sectional survey design was considered appropriate for this study.

3.5. Setting and participants

Nursing students enrolled in the final year of pre-registration nursing programs in Australia were eligible to participate.

3.6. Recruitment and ethical considerations

Following ethical approval (HREC ETH18-2352N), Heads of Schools of Nursing from all Australian universities were emailed seeking permission for their students to participate in the study. Those Heads of School who were willing for their students to participate nominated a designated contact person who emailed students or posted an announcement on their learning management system with a link to the study invitation and PSM website.

When students accessed the PSM website, they were provided with a Participant Information Statement that explained that completion of the module was voluntary, results were anonymous, and submission of module answers would be taken as implied consent. Students who completed the module received a certificate of achievement, which included their total score and a score for each of the four activities. The researchers were not provided with any identifying information about the participants.

3.7. Data collection

Data collection was undertaken in late 2020. In addition to PSM performance scores, participants' demographic characteristics (university/college of enrolment, age, gender, previous experience of working in the healthcare industry, and country of origin) were collected.

Students' perceptions of the PSM were evaluated using the 30 item Satisfaction with the Patient Safety E-Learning Module (SPSELM) scale, which was developed for the purpose of this study and informed by Gagne et al.'s (2005) instructional design principles. All items on the SPSELM are rated on a 5-point Likert scale (strongly disagree [1] to strongly agree [5]). No items are reversed scored. There is one open-ended question that asked participants to make general comments about the PSM. To enhance face, content, and construct validity, the SPSELM was reviewed by an expert panel

Table 2
Demographic characteristics.

Variables	(N = 1038) n (%)
Age, mean (SD)	30.48 (10.13)
Age group (years old)	
< 25	407 (39.6%)
25– < 30	185 (18.0%)
30– < 40	240 (23.3%)
40–64	197 (19.1%)
Gender	
Female	873 (84.5%)
Male	160 (15.5%)
Employment	
Currently or previously employed in healthcare	589 (56.7%)
University ^a	
A	388 (37.4%)
B	238 (22.9%)
C	108 (10.4%)
D	92 (8.9%)
E	78 (7.5%)
F	66 (6.4%)
G	13 (1.3%)
H	10 (1.0%)
I (other)	45 (4.3%)
Country of birth	
Australia	595 (57.3%)
Philippines	64 (6.2%)
India	55 (5.3%)
United Kingdom	44 (4.2%)
Nepal	32 (3.1%)
Zimbabwe	29 (2.8%)
China	20 (1.9%)
Vietnam	17 (1.6%)
Singapore	16 (1.5%)
Kenya	15 (1.4%)
Nigeria	11 (1.1%)
New Zealand	10 (1.0%)
South Korea	10 (1.0%)
Other	120 (11.6%)
Duration of living in Australia if CoB is not AU [mean years, SD]	32.25 (18.21)
Language	
English	816 (78.6%)
Other languages	222 (21.4%)

SD: Standard Deviation

^a The name of university was coded as A to H for de-identification; I: Small number of students from 14 other universities.

consisting of eight academics. They were asked to provide feedback on the consistency, clarity, and relevance of the survey items (McGartland Rubio, Berg-Weger, Tebb, Lee, & Rauch, 2003).

3.8. Data analysis

Data analysis was conducted using the Statistical Package for the Social Sciences Statistical Software package version 22.0 for Windows (IBM Corp, 2013). Demographic characteristics, PSM performance scores, and SPSELM scores were determined using descriptive statistics (frequencies, percentages, and measures of central tendency). The validity and reliability of the SPSELM scale were assessed using Cronbach's alpha and Content Validity Index (CVI).

4. Results

4.1. Participant demographic characteristics

In total, 1038 nursing students participated in this study. Students from 22 educational institutions attempted one or more of the activities, and the number of participants by university ranged from 1 to 386. For institutions with less than 10 participants, results were clustered into one group (see Table 2). The majority of the participants were under 25 years of age (mean 30 years) and female. Most participants were born in

Table 3
Performance in the Patient Safety Module by activity and selected demographics.

Variables	Mean % (SD)	Min, Max (%)	p-value
Activity			0.000 ζ
1 (n = 750)	73.73 (14.24)	3.00, 100.00	
2 (n = 467)	79.00 (16.32)	2.00, 100.00	
3 (n = 396)	65.79 (18.04)	4.00, 100.00	
4 (n = 377)	76.56 (15.26)	13.00, 100.00	
Age group (years old) (N = 1029)			0.533 ζ
< 25	74.51 (16.90)	2.00, 100.00	
25–< 30	73.58 (15.91)	17.00, 100.00	
30–< 40	73.67 (15.84)	4.00, 100.00	
40–64	73.67 (16.37)	9.00, 100.00	
Gender (N = 1033)			0.289 λ
Male	74.15 (17.81)	3.00, 100.00	
Female	73.93 (16.07)	2.00, 100.00	
Employment in healthcare			0.438 λ
Currently or previously employed in healthcare	73.57 (16.58)	2.00, 100.00	
Not currently or previously employed in healthcare	74.17 (16.22)	3.00, 100.00	
University (N = 1038) ^a			0.010 ζ
A	68.23 (17.38)	22.00, 96.00	
B	76.45 (14.45)	26.00, 100.00	
C	73.58 (15.44)	13.00, 100.00	
D	72.26 (16.59)	3.00, 100.00	
E	75.78 (20.03)	22.00, 100.00	
F	75.51 (17.90)	4.00, 100.00	
G	75.19 (16.12)	4.00, 100.00	
H	73.70 (17.40)	2.00, 100.00	
I ('other' universities)	74.81 (15.22)	37.00, 100.00	
Language (N = 1038)			0.998 λ
Other languages	73.72 (16.39)	2.00, 100.00	
English	73.97 (16.37)	3.00, 100.00	

Activity 1: Infection control and medication safety.

Activity 2: Predicting, monitoring and responding to adverse events.

Activity 3: Clinical reasoning.

Activity 4: Cultural competence.

ζ : Kruskal–Wallis test for P-value.

λ : Mann-Whitney U test for P-value.

^a The name of university was coded as A to H for de-identification; I: Small number of students from 14 other universities.

Australia followed by the Philippines, India, and the United Kingdom. For those not Australian born, the mean duration of living in Australia was 32 years. Almost a quarter of the sample spoke languages other than English. Over half of the participants indicated that they had been previously or were currently employed in a healthcare setting.

4.2. Performance in the Patient Safety Module

Of the 1038 students who participated, 377 completed all four activities. This included 750 participants who completed Activity 1 (Infection control and medication safety), 467 who completed Activity 2 (Predicting, monitoring and responding to adverse events), 396 who completed Activity 3 (Clinical reasoning), and 377 who completed Activity 4 (Cultural competence) (see Table 3).

The mean correct score percentage for the PSM was 73.77%, and there were significant differences in performance by university ($p = 0.010$) with median correct score percentages ranging from 68 to 76%. There were also significant differences in participant performance across the four activities ($p = 0.000$). The mean correct score percentage for Activity 2 (Predicting, monitoring, and responding to adverse events) was highest at 79%, while for Activity 3 (Clinical reasoning), the mean correct score was lowest at 66%. The mean score for Activity 1 (Infection control and medication safety) was 74%, and for Activity 4 (Cultural competence), the mean score was 77%. It is not possible to determine whether the results for Activities 3 and 4 may be less reliable due to lower participation rates or more reliable due to participant's increased comfort level when interacting with the module. Correct scores were not significantly associated with age, gender, employment in healthcare, or language spoken. There was a significant association between scores for Activities 2 and 4 ($p < 0.001$), potentially related to the cognitive load associated with learning how to engage with the

system requirements in the first two activities (Sweller, Ayres, & Kalyuga, 2011). The overall effect of the university was marginal ($p = 0.078$). Discrimination and difficulty were measured for each question. There was no obvious pattern in the scores for those questions that were accurately or inaccurately answered or the question types.

4.3. Satisfaction with the Patient Safety Module

Using Polit, Beck, and Owen (2007) guidelines for examining CVI, eight content experts assessed the SPSELM scale. The Scale CVI and the Individual CVI were determined to be > 0.9 for both relevance and clarity, with the exception of item 9 ('the interactivity of the module maintained my interest'), which received 0.625 for clarity. Based on these results, the overall scale was considered to be valid (Polit et al., 2007). Internal consistency analysis was performed on the 29-item SPSELM scale revealing a Cronbach's alpha of 0.93–0.97 for the subscales and 0.99 for the overall scale, indicating high internal consistency reliability.

Seventy-five students completed the SPSELM scale. The mean Likert score responses for the SPSELM items exceeded 4.0 with the exception of items 20 and 21, which both related to assessment of performance and were slightly less than 4 (see Table 4).

The responses to the open-ended question illustrated how the participants valued the multimedia inclusions and varied question types, as well as the clinical relevance of the PSM (see Table 5). However, some participants felt that the questions with multiple response options were somewhat confusing.

5. Discussion

The paper presents the results of a cross-sectional study that aimed to examine nursing students' performance in an interactive multimedia

Table 4
Mean and SD of participants' responses to SPSELM scale item.

Variable	N	Mean	SD
<i>Gain attention</i>			
1. The title of the module captured my attention	75	4.013	.923
2. The module's focus on patient safety was of interest to me	75	4.240	.883
3. Knowing that the module could test my readiness to work as a RN was important to me	75	4.413	.887
<i>Clarity of purpose</i>			
4. The objectives of the module were clear	75	4.133	.935
5. I understood the purpose of each of the activities in the module	75	4.173	.950
<i>Stimulate recall of previous knowledge</i>			
6. The module allowed me to use my current knowledge to answer the questions	75	4.187	.865
7. The questions in the module enabled me to recall what I know about patient safety	74	4.189	.886
<i>Present the material to be learned</i>			
8. The storytelling approach used in the module was engaging	75	4.187	.896
9. The interactivity of the module maintained my interest	75	4.213	.905
10. The use of videos and images were beneficial to my learning	74	4.203	.951
<i>Provide guidance for learning</i>			
11. The instructions in the module were easy to understand	75	4.053	1.089
12. The module was easy to navigate	75	4.160	.931
13. The module had a logical structure	75	4.120	.900
<i>Apply to practice</i>			
14. The module presented clinically relevant scenarios	75	4.307	.900
15. I believe that completing the module will make me a safer nurse	74	4.270	.911
16. I will be able to apply what I have learned from the module to my clinical practice	75	4.307	.915
<i>Provide feedback</i>			
17. Timely feedback and results were provided in the module	73	4.301	.908
18. The feedback provided was beneficial to my learning	75	4.267	.875
19. The feedback helped me to understand my strengths and weaknesses in relation to the topics presented	75	4.253	.931
<i>Assess performance</i>			
20. I believe that my results from the module accurately represent my understanding of the content	74	3.986	.972
21. I believe that my overall results are a fair indication of my current level of knowledge about patient safety	75	3.987	.937
<i>Enhance retention and transfer</i>			
22. The module will help me identify environmental factors that could jeopardise patient safety	75	4.200	.854
23. The module will help me to predict and prevent post-operative complications	75	4.200	.870
24. The module will enhance my clinical reasoning skills	75	4.200	.900
25. The module will help me to recognise and respond to patient deterioration	75	4.173	.921
26. The module has enhanced my understanding of cultural competence	75	4.147	.911
<i>Overall perspectives</i>			
27. The technological aspects of the module were easy to use	75	4.187	.940
28. The module was a valuable learning experience	75	4.227	.879
29. I would recommend the module to other nursing students	75	4.293	.927
30. Do you have any other comments about the module?			

SD, standard deviation; SPSELM, Satisfaction with the Patient Safety E-Learning Module.

Table 5
Examples of responses to open-ended questions.

I really enjoyed completing this module. It was not repetitive which kept it interesting and the different forms of questions kept me engaged.
Great module. Great use of pictures and videos.
I really enjoyed doing this module. It was easy to access and I loved how there are videos.
The module makes you realise that you will one day be in the position she is in and it's nice to see what you can do that better.
This module was extremely well delivered and I enjoyed and learned from it.
The module was helpful and interesting however I found some of the questions with multiple answers were confusing.
Well done, it was a helpful assessment and learning experience.
It is a good learning tool, I wished there would be more like this.
Good online module for nursing students who are about to graduate. Great learning opportunity to make sure about patient safety.
The presentation was critical and well designed to test our clinical skills.

PSM titled '*One shift, four patients ... a day in the life of a new graduate nurse*' and to explore their level of satisfaction with the module. The study addresses an important issue, as adverse patient events, many of which are preventable, are a significant cause of death and disability. Nurses play an important role in improving the quality and safety of care through recognition, management, and escalating issues that negatively impact patient outcomes (Vaismoradi et al., 2020). It is therefore essential that before graduation, nursing students possess the knowledge and skills required to address factors that could jeopardise patient safety.

The results from this study indicated that nursing students' mean score in the PSM was 74%. While the scores varied across universities

and between activities within the module, overall, the results are somewhat encouraging. However, the low scores for Activity 3 (Clinical reasoning) may be of concern, given the direct relationship between patient safety and healthcare professionals' clinical reasoning abilities (Levett-Jones & Smith, 2022; Graber, 2017). Similarly, the relatively low scores for Activity 1 (Infection control and medication safety) are also noteworthy when one considers that medication errors and nosocomial infections are the most burdensome of adverse event types (Tella, Smith, Partanen, & Turunen, 2015; Haque et al., 2018).

It is important to note that the PSM is an open access resource designed to both assess and enhance nursing students' patient safety knowledge. While we have reported the results from students' baseline performance (attempt 1) of the PSM, many students completed the extension activities and subsequently reattempted the module, often demonstrating considerable improvement each time.

The SPSELM scale results indicate generally positive student feedback about the PSM with regard to the multimedia approach, varied question types, and provision of immediate feedback, which enhanced engagement and meaningful learning. The validity and reliability of the SPSELM scale indicate potential for its use in evaluating other e-learning initiatives.

While the focus of this study did not extend to examining the impact of various types of educational initiatives for improving nursing students' level of patient safety knowledge, previous studies have found inconsistent results when comparing the outcomes from stand-alone patient safety courses compared to curriculum integration of core patient safety constructs. Similarly, various results

have been demonstrated when examining the impact of different teaching modalities such as lectures, group discussions, simulation, and online activities (Lee et al., 2022).

6. Limitations

Although this study had a relatively large sample size, the participants were not representative of all Australian States and Territories. Also, as the sample was comprised of nursing students enrolled only in Australian universities, generalisability of the results to other countries is not possible. Replicating the study in other regions would strengthen the representativeness and generalisability of the findings. Further, the cross-sectional design provided only a snapshot of students' knowledge levels at one point in time. Future longitudinal studies could address this limitation by exploring the impact of the PSM on students' performance over time. We also acknowledge that it is somewhat difficult to provide a full interpretation of students' performance in the module without a comparable benchmark or standard. We therefore recommend that future studies consider the use of a Modified Angoff approach to establish a pass mark and to determine whether students meet a pre-determined standard, particularly in high-stakes assessments (Ricker, 2006). Lastly, as the study relied on voluntary participation, the results may have been impacted by self-selection bias with those students more confident in their patient safety knowledge being more inclined to participate. It is also possible that these students may have scored higher than the broader cohort, raising some concerns about the overall knowledge levels of graduating students.

7. Conclusion

Evaluating nursing students' knowledge of core patient safety concepts is critical to ensuring that they are equipped to provide safe and effective patient care. This study has demonstrated that the Patient Safety Module 'One shift, four patients ... a day in the life of a new graduate nurse' is an effective strategy for identifying areas of strength and potential knowledge gaps. The results of this study also provide important insights for refocusing nursing curricula with the aim of promoting a culture of safety and preparing future nurses to deliver high-quality care.

Author contributions

Tracy Levett-Jones: Conceptualization, Methodology, Writing and finalising manuscript. **Fiona Bogossian:** Writing, Data analysis, Original draft preparation, Reviewing and editing. **Simon Cooper:** Data analysis, Reviewing and editing manuscript. **Ruben Hopmans:** Software development, Data analysis. **Lisa McKenna:** Writing – review & editing. **Huy Nguyen:** Data analysis. **Jacqui Pich:** Writing – review & editing. **Philippa Seaton:** Writing – review & editing.

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Ethical statement

We confirm that this study received ethical approval (HREC ETH18-2352N) from the University of Technology Sydney Human Research Ethics Committee in October 2020.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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