Evaluation and assessment of the knowledge, attitude and practice of pharmacy students with respect to pharmacovigilance in a Saudi pharmacy school: a cross-sectional study.

CURRENT STATUS: UNDER REVIEW

Ayesha Siddiqua aishaa2804@gmail.com
King Khalid University
Corresponding Author
ORCiD: 0000-0001-9882-7695

Nada Alshahrani
King Khalid University

Javid Mir Iqbal
King Khalid University

Afnan Mohammad Ali
King Khalid University

Raghad Abdulrahman
King Khalid University

Salha ahmad alqarni
King Khalid University

Amjad almanaa
King Khalid University

Waad ahmad asiri
King Khalid University

Mohammed A Al Essa
King Saud bin Abdulaziz University for Health Sciences

Jawaher Abdullah Gramish
King Abdulaziz Medical City

Moteb A Khoabrani
King Khalid University
DOI: 10.21203/rs.2.13367/v2

SUBJECT AREAS
Health Economics & Outcomes Research  Health Policy

KEYWORDS
Pharmacovigilance, Knowledge, Attitude, Practice, Pharmacy students
Abstract

BACKGROUND: Pharmacovigilance is an important part of the health care system as it helps in the detection, assessment, reporting and prevention of Adverse Drug Reactions. Spontaneous reporting of adverse drug reaction plays a vital role in the success of Pharmacovigilance programs and pharmacy students are supposed to acquire sufficient knowledge and necessary skills required for practicing pharmacovigilance under different clinical settings. Hence, this study was carried out in the students of College of Pharmacy of a University in the Southern Province of Saudi Arabia to assess the Knowledge, Attitude and Practice (KAP) of undergraduate Pharmacy students towards Pharmacovigilance.

METHODS: A quantitative, prospective, cross-sectional online survey was carried out using a validated, self-administered questionnaire constituting 4 domains i.e. Demographics, Knowledge, Attitude and Practice of Pharmacovigilance among the pharmacy students of King Khalid University.

RESULTS: The questionnaire was administered to 360 students out of which 329 responded (response rate of 91.3 %). The mean score of Level 7,8,9,10 and intern students for Knowledge was (3.03,5.37, 6.38, 6.19,6.42), Attitude (5.28,4.16, 5.62, 5.01, 5.29), and Practice (2.99, 3.25, 3.04, 3.43, 3.13) respectively. In addition, the findings indicated a significant difference in the mean score among different level of students for knowledge and attitude with a p-value of <0.0001, and 0.0002 respectively. The practice mean score showed there was no much significance among different level of students (p-value = 0.4108)

CONCLUSION: Our research findings revealed that the pharmacy students of the focused university have adequate knowledge and positive attitude towards adverse drug reaction. However, there is a dire need to understand and address concerns regarding real time practice patterns prevalent among Health Care Providers about pharmacovigilance under
different clinical settings.

**Keywords:** Pharmacovigilance, Knowledge, Attitude, Practice, Pharmacy students

**Background**

Pharmacovigilance is an important part of the health care system because it helps in the detection, assessment, understanding and prevention of adverse drug reactions [1]. It involves the evaluation over time of the safety of marketed medicines and primarily focuses on adverse drug reactions and patient care [2]. To fully realize its benefits, pharmacovigilance must also involve building healthy collaborations at national and international levels. At the international level, the Uppsala Monitoring Centre (UMC) was the first World Health Organization (WHO) collaborating center to be established for pharmacovigilance, which is the scientific and technical responsibility of the WHO Programme for International Drug Monitoring [1]. In Saudi Arabia, The National Pharmacovigilance and Drug Safety Center has been established under the Saudi Food and Drug Authority and is responsible for promoting pharmacovigilance [3]. Adverse event reporting is a responsibility of clinical researchers as well as health care professionals (such as physicians, pharmacists, and nurses) and consumers (such as patients, family members, and lawyers), even if the side effects are only suspected. Such reporting supports the determination of which side effects are worth the risk to patients considering how effectively the reaction-causing drug treats a disease. Spontaneous reporting of adverse drug reactions plays a prominent role in the success of the pharmacovigilance program[4,5]. One initiative of the Saudi 2030 vision plan is to advance patient care through a more robust, safety/quality-centered culture together with a more collegial relationship between local and international drug manufacturers and Saudi regulatory authorities[6]. As pharmacovigilance is a subject of broad and current interest, significant studies have been carried out on this topic globally by Suyagh et al, Alsaleh et al, and
Gupta et al, but limited studies have been carried out in this important domain in Saudi Arabia[7,8,9]. Therefore, our aim was to expand the research and conduct a survey among pharmacy students, who are future health care providers and are tasked with acquiring the knowledge and skills required for practicing pharmacovigilance in different clinical settings. This study may enhance adverse drug reaction reporting in the future, which might reduce the health care expenditures and costs associated with adverse drug reactions and their treatment, which may be extensive.

Methods

Aim of the study

This study was carried out in a sample of students attending the College of Pharmacy at a university in a southern province in Saudi Arabia to assess the knowledge, attitude and practice (KAP) of undergraduate pharmacy students with respect to pharmacovigilance. 

Study design and setting: This prospective, cross-sectional descriptive online study was designed to assess the level of knowledge, attitudes and practices of pharmacovigilance among undergraduate students attending the College of Pharmacy, King Khalid University, Abha, Saudi Arabia.

Target population, Sampling Criteria and Sample size: The College of Pharmacy of King Khalid University has a large group of students, both male and female, distributed across ten levels, from Level–1 to Level–10. Each academic year comprises 2 levels, for a total of 5 years. Each level refers to a single semester of study. After completing the ten levels, students are subjected to a training period of one year in primary health care centers and pharmacies, which is known as an internship. The web-based survey was administered to a sample of study participants comprising both male and female fourth- and fifth-year students (Level–7, 8, 9, and 10) and those involved in their internship during the study period (October 2018–November 2018). We excluded students below Level–7 and students
not enrolled in the College of Pharmacy. We used a simple random sampling technique, and our estimated sample size was 359, as calculated via Raosoft with a confidence interval of 99% [10]. The online questionnaire link was given to the class representative of each level, and the representatives forwarded the link to the students through their WhatsApp groups.

Survey instrument development and Data collection: A self-administered structured pre-validated questionnaire based on instruments used in previous similar studies was adapted [9]. Then, by conducting an extensive literature review and holding focus group discussions, a final questionnaire was prepared that could fulfil the objective of this study. The questionnaire was then subjected to a face and content validation process involving experts from the research team to ensure that the survey was sufficiently comprehensive. A pilot study was carried out to determine the validity, reliability and clarity of the questionnaire. The results of the pilot study were not included in the final results. The feedback was analyzed, the double-barreled, confusing and leading questions were modified, and a finalized questionnaire was created accordingly. The internal consistency of the questionnaire was also evaluated, and a Cronbach’s alpha value of 0.844 was obtained (by SPSS), which indicates that the questionnaire is reliable. The questionnaire comprised 4 domains. The first section included the independent variables of the study, i.e., information such as participants’ sex and level of education. The second section consisted of 11 closed-ended questions presented in a multiple choice format that assessed the students’ knowledge of pharmacovigilance. The third section consisted of 7 questions presented in a yes/no format that assessed students’ attitude towards pharmacovigilance, whereas the last section, i.e., the fourth section, comprised 6 questions pertaining to the practice of pharmacovigilance presented in a yes/no format. The dependent variables in this study were knowledge, attitude, and practice. The
questionnaire was converted into a web-based format and was then delivered to the study participants; the data were collected from October to November 2018. Eligible participants were approached.

Statistical Analysis: The results were downloaded and stored in Microsoft Excel spreadsheets. The data were analyzed using SPSS version 21.0 statistical software (IBM Inc., Chicago, USA). Descriptive statistics (mean and standard deviation) were used to describe the categorical study and outcome variables. Unpaired Student's t tests, one-way analysis of variance and Bonferroni multiple comparisons were used to compare the mean scores of the domains, i.e., knowledge, attitude and practice, between the sexes and across the academic levels. A p value of ≤ 0.05 and 95% confidence intervals were used to report the statistical significance and precision of the results in the tables.

Results

The online questionnaire measuring 3 dependent variables, knowledge, attitude, and practice, which had total possible scores of 11, 7, and 6, respectively, was self-administered to 359 participants. Three hundred twenty-nine responded, giving a response rate of 91.3%. Seventy-seven percent (n = 254) of the students were based on the female campus, while the remaining 23% (n = 75) were based on the male campus.

Table 1: Sex-based comparison of the mean scores for the Knowledge, Attitude and Practice subscales:
The mean knowledge scores were calculated and are shown in Table-1. An unpaired Student’s t-test was carried out to compare the knowledge of male and female participants, and it was estimated that the mean score for female participants was $6.2 + 2.1$, whereas for males, it was $5.79 + 2.25$. The estimated two-tailed $p$ value was $0.1374 (<0.05)$, indicating that the means were not significantly different. Furthermore, Table-1 shows the mean attitude scores of the male and female participants. An unpaired Student’s t-test was carried out to compare the attitudes of the male and female students, and it was estimated that the mean score for female participants was $5.22 + 1.78$, whereas for males, it was $4.64 + 1.8$. The estimated two-tailed $p$ value was $0.0131 (<0.05)$, indicating a significant difference. The students were also asked some basic questions that assessed their practice with respect to pharmacovigilance; the results are also summarized in Table-1. An unpaired t-test was carried out to compare the practice of the male and female participants, and it was estimated that the mean score for female participants was $3.21 + 1.47$, whereas for males, it was $3.03 + 1.47$. The estimated two-tailed $p$ value was $0.3459 (<0.05)$, indicating no significant difference.

Table 2: Comparison of mean knowledge scores across different levels of students:
The mean knowledge score of the participants was estimated and compared across the academic levels for both sexes. The mean scores for the Level–7, –8, –9, and –10 students and the intern students were found to be 3.03+1.47, 5.37+2.14, 6.38+2.21, 6.19+2.03, and 6.42+2.31, respectively. A one-way analysis of variance was carried out, and the estimated p value was <0.0001 (<0.05), indicating a significant difference. Bartlett’s test for homogeneity of variances was also carried out and yielded a p value of 0.0026 (<0.05), indicating a significant difference between the groups. Bonferroni’s multiple comparisons test was also carried out to compare the academic levels and determine significant differences among the groups, and the results are clearly displayed in Table–2. [Table–2]

Table 3: Comparison of mean attitude scores across different levels of students

The mean attitude scores of the participants were estimated and compared across the academic levels for both sexes. The mean scores for Level–7, –8, –9, and –10 students and the intern students were 5.28+1.82, 4.16+1.93, 5.62+1.56, 5.01+1.62, and 5.29+1.76, respectively. A one-way analysis of variance was carried out, and the estimated p value was 0.0002 (<0.05), indicating a significant difference. Bartlett’s test for homogeneity of variances was also carried out, yielding a p value of 0.4716 (<0.05), suggesting no significant differences between the groups. Bonferroni’s multiple comparisons test was also carried out to compare the groups, and the details are summarized in Table 3. [Table–3]

Table 4: Comparison of mean practice scores across different levels of students

The mean practice score of the participants was estimated and compared across the
academic levels for both sexes. The mean scores for Level–7, –8, –9, and –10 students and the intern students were 2.99±1.53, 3.25±1.54, 3.04±1.56, 3.43±1.29, and 3.13±1.42, respectively. A one-way analysis of variance was carried out, and the estimated p value was 0.4108 (<0.05), indicating no significant difference. Bartlett’s test for homogeneity of variances was also carried out, yielding a p value of 0.5233 (<0.05), suggesting no significant difference between the groups. Bonferroni’s multiple comparisons test was also carried out to compare the groups, and the details are summarized in Table–4. [Table–4]

Discussion
The findings of this study clearly indicated that the students attending King Khalid University have adequate knowledge and positive attitudes towards pharmacovigilance (p value < 0.05), which corroborates the findings of Abdel-Latif. In the study of Abdel-Latif, the respondents were unable to correctly define the term pharmacovigilance, but they were aware of adverse drug reactions, whereas in our study, many students were able to define the term pharmacovigilance correctly, and they were very much aware of adverse drug reactions and the systems for reporting them. However, most of them were not aware of the system used in Saudi Arabia for reporting adverse drug reactions, and most of them had not seen the form used in Saudi Arabia [11]. In a previous study conducted by Othman and colleagues among pharmacy students, most of the respondents had poor knowledge of this concept, which differs from the results at our university [12]. In another study conducted in Dammam, Saudi Arabia, by Ali and his colleagues, respondents also had inadequate knowledge and poor attitudes, in contrast to our results [13]. This difference in the findings regarding knowledge and attitude across studies may be due to differences in the teaching curriculum as well as the level of training received. Regarding the practice of pharmacovigilance, our findings showed that students required adequate training to improve their skills. Many studies conducted previously on student samples or
samples of health care professionals, such as those of Suyagh Alsaleh et al. and Gupta et al., found that participants also had poor practice, which is in accordance with our findings [7,9]. Vora et al. (2012) suggested that the initiation of organized training programs for pharmacovigilance in undergraduate medical curricula is mandatory if we wish to see better results in the future, as pharmacy students are society's future prescribers. They also suggested providing online and telephone line access to facilitate adverse drug reaction reporting [14]. In another study carried out by Khan S, the participants were deficient in knowledge and attitude, and the author suggested that urgent attention was required not only to improve the rate of spontaneous reporting but also to improve safety for patients and society at large [15]. Shanko H also recommended the development of specific strategies to improve awareness, knowledge and practice in his study population, because he found gaps in the knowledge, awareness and practice of healthcare professionals with respect to adverse drug reaction (ADR) reporting [16]. There was even a study carried out by Aljadhey H in Saudi Arabia to explore the challenges of pharmacovigilance from the perspective of healthcare professionals in Saudi Arabia. The author recommended that healthcare professionals be trained continuously on the importance of pharmacovigilance and that the regulatory authority should make serious efforts to increase the awareness of patients and the public regarding ADR reporting. Health sciences colleges were also recommended to incorporate pharmacovigilance courses into their curriculum to increase future healthcare providers’ awareness at an early stage of their career [17]. Some studies also recommended that educational interventions in pharmacovigilance and strategies for promoting ADR reporting by healthcare professionals that have proven effective in other countries should also be adopted in Saudi Arabia [17–19]. Such recommendations are applicable to the students in our study because pharmacy students are also future health care providers. Thus,
conducting workshops in the future to create awareness among them could be beneficial. However, this study has several limitations. Data collection was limited to a single point of time, so changes over time were not assessed. The participants might have easily answered the questions with help from their classmates or by searching online because we used a self-administered web-based questionnaire. This could have affected the accuracy of our findings, particularly for the knowledge section, because this method does not allow us to examine the behavior of the participant while completing the survey. The survey was carried out in a single pharmacy school; therefore, these findings could not be generalized to other schools in Saudi Arabia. Thus, a future study in other schools in Saudi Arabia might help in creating a clear picture.

Conclusion

Our research findings revealed that the pharmacy students at King Khalid University have adequate knowledge and positive attitudes towards adverse drug reaction reporting; however, there is a dire need to understand and address concerns regarding real-time pharmacovigilance practice patterns among health care providers in different clinical settings. Educational interventions, such as the incorporation of this concept in undergraduate practical training, continuous medical education (CME), and workshops on pharmacovigilance, may help improve adverse drug reaction monitoring and reporting skills.

List Of Abbreviations

World Health Organization (WHO)
Knowledge, attitude and practice (KAP)
Continuous medical education (CME)
Adverse drug reaction (ADR)
Declarations

ETHICS APPROVAL AND CONSENT TO PARTICIPATE:
The study was approved by the Ethics Committee of College of Pharmacy, King Khalid University and all the respondents were asked for their verbal consent before participation in the study. Assessment of the responses was done blindly.

CONSENT FOR PUBLICATION:
Not applicable

AVAILABILITY OF DATA AND MATERIALS:
The data used to support the findings of this study are available from the corresponding author upon request.

COMPETING INTERESTS:
The authors declare that there are no competing interests regarding the publication of this paper.

FUNDING:
The authors declare that they have not received any funding from any organization.

AUTHOR’S CONTRIBUTION:
AS, NA, MJ, were major contributors in writing the manuscript and they were involved in the analysis and interpretation of the data. AM, RA, SA, AA, WA performed the data collection and were involved in writing the manuscript as well. ME, JG, MK were major contributors in writing the manuscript. All authors read and approved the final manuscript.

ACKNOWLEDGEMENTS:
The authors would like to thank the students of this University to participate in this survey and the members of the research committee to guide us throughout our study.
AUTHOR’S INFORMATION:

a Department of Clinical Pharmacy, College of Pharmacy, King Khalid University, Abha, Kingdom of Saudi Arabia.

b College of Pharmacy, King Saud bin Abdulaziz University for Health Sciences, P. O. BOX 3660, Riyadh 11426, Kingdom of Saudi Arabia.

c Pharmaceutical Care Services, King Abdulaziz Medical City, Riyadh, MC 1445, Kingdom of Saudi Arabia.

References

1. Pharmacovigilance [Internet]. World Health Organization. 2019 [cited 24 October 2019]. Available from:https://www.who.int/medicines/areas/quality_safety/safety_efficacy/pharmvigi/en/

2. Lu Z. Information technology in pharmacovigilance: Benefits, challenges, and future directions from industry perspectives. Drug, Healthcare and Patient Safety. 2009;1:35-45.

3. Alshammari T, Alshakka M, Aljadhey H. Pharmacovigilance system in Saudi Arabia. Saudi Pharm J. 2017; 25(3): 299-305.

4. Muraraiah S, Rajarathna K, Sreedhar D, Basavalingu D, C R J. A questionnaire study to assess the knowledge, attitude and practice of Pharmacovigilance in a paediatric tertiary care centre. J Chem Pharm Res. 2011, 3(6):416-422

5. Alshammari T, Alamri K, Ghawa Y, Alohal N, Abualkol S, Aljadhey H. Knowledge and attitude of health-care professionals in hospitals towards pharmacovigilance in Saudi Arabia. International Journal of Clinical Pharmacy. 2015;37(6):1104-1110.

6. Alhawassi T, Abuelizz H, Almetwazi M, Mahmoud M, Alghamdi A, Alruthia Y et al. Advancing pharmaceuticals and patient safety in Saudi Arabia: A 2030 vision
7. Suyagh M, Farah D, Abu Farha R. Pharmacist’s knowledge, practice and attitudes toward pharmacovigilance and adverse drug reactions reporting process. Saudi Pharm J. 2015; 23(2): 147-153.

8. Alsaleh F, Alzaid S, Abahussain E, Bayoud T, Lemay J. Knowledge, attitude and practices of pharmacovigilance and adverse drug reaction reporting among pharmacists working in secondary and tertiary governmental hospitals in Kuwait. Saudi Pharm J. 2017; 25(6): 830-837.

9. Gupta R, Sharma D, Malhotra P. Assessment of knowledge, attitude and practice of pharmacovigilance among the undergraduate medical students in a northern Indian tertiary care teaching hospital—an observational study. Int J Pharm Sci Res. 2017; 8(6): 2654-59.

10. Sample Size Calculator by Raosoft, Inc. [Internet]. Raosoft.com. 2019 [cited 25 October 2019]. Available from: http://www.raosoft.com/samplesize.html

11. Abdel-Latif M, Abdel-Wahab B. Knowledge and awareness of adverse drug reactions and pharmacovigilance practices among healthcare professionals in Al-Madinah Al-Munawwarah, Kingdom of Saudi Arabia. Saudi Pharm J. 2015;23(2):154-61.

12. Othman G, Ibrahim M, Alshakka M, Ansari M, Al-Qadasi F, Halboup A. Knowledge and Perception about Pharmacovigilance among Pharmacy Students of Universities in Sana’a Yemen. J Clin Diagn Res. 2017; 11(6): FC09-FC13

13. Ali M, Hassan Y, Ahmed A, Alaqel O, Al-Harbi H, Al-Suhaimi N. Knowledge, Practice and Attitudes Toward Pharmacovigilance and Adverse Drug Reactions Reporting Process Among Health Care Providers in Dammam, Saudi Arabia. Curr Drug Saf. 2018;13(1):21-25.

14. Vora M, Paliwal N, Doshi V, Barvaliya M, Tripathi C, 2012. Knowledge of adverse drug
reactions and pharmacovigilance activity among the undergraduate medical students of gujarat. Int J Pharm Sci Res. 2012; 3(5): 1511-1515

15. Khan S, Goyal C, Chandel N, Rafi M. Knowledge, attitudes, and practice of doctors to adverse drug reaction reporting in a teaching hospital in India: An observational study. J Nat Sci Biol Med. 2013 Jan;4(1):191-6.

16. Shanko H, Abdela J. Knowledge, Attitudes, and Practices of Health Care Professionals Toward Adverse Drug Reaction Reporting in Hiwot Fana Specialized University Hospital, Harar, Eastern Ethiopia: A Cross-sectional Study. Hosp Pharm. 2018;53(3):177-187

17. Aljadhey H, Mahmoud M, Alshammari T, Al-Dhaeefi M, Le Louet H, Perez-Gutthann S et al. A qualitative exploration of the major challenges facing pharmacovigilance in Saudi Arabia. Saudi Medical Journal. 2015;36(9):1097-1102.

18. Lopez-Gonzalez E, Herdeiro M, Piñeiro-Lamas M, Figueiras A. Effect of An Educational Intervention to Improve Adverse Drug Reaction Reporting in Physicians: A Cluster Randomized Controlled Trial. Drug Safety. 2014;38(2):189-196.

19. Ribeiro-Vaz I, Santos C, da Costa-Pereira A, Cruz-Correia R. Promoting Spontaneous Adverse Drug Reaction Reporting in Hospitals Using a Hyperlink to the Online Reporting Form. Drug Safety. 2012;35(5):387-394.

Tables
| Table-2- Comparison of mean knowledge scores across different levels of students |
|---------------------------------|---------------------------------|---------------------------------|
| One-way analysis of variance   |                                |                                |
| P value                         | < 0.0001                        |                                |
| P value summary                 | ***                             |                                |
| Are means signif. different? (P < 0.05) | Yes                        |                                |
| Number of groups                | 5                               |                                |
| F                               | 36                              |                                |
| R squared                       | 0.305                           |                                |
| Bartlett's test for equal variances |                    |                                |
| Bartlett's statistic (corrected) | 16.3                           |                                |
| P value                         | 0.0026                          |                                |
| P value summary                 | **                              |                                |
| Do the variances differ signif. (P < 0.05) | Yes                        |                                |
| ANOVA Table                     |                                |                                |
| Treatment (between columns)     | 598                            | 4                              | 149                      |
| Residual (within columns)       | 1360                           | 328                            | 4.16                     |
| Total                           | 1960                           | 332                            |                          |
| Bonferroni's Multiple Comparison Test |                        |                                |
| Mean Diff.                      | t                               | Significant? P < 0.05?          | Summary                  | 95% CI   |
| Level 7 vs Level 8              | -2.34                           | 6.54                           | Yes                      | ***       | -3.351 |
| Level 7 vs Level 9              | -3.36                           | 9.27                           | Yes                      | ***       | -4.381 |
| Level 7 vs Level 10             | -3.16                           | 9.32                           | Yes                      | ***       | -4.121 |
| Level 7 vs In Training          | -3.39                           | 10.2                           | Yes                      | ***       | -4.331 |
| Level 8 vs Level 9              | -1.01                           | 2.63                           | No                       | ns        | -2.101 |
| Level 8 vs Level 10             | -0.817                          | 2.25                           | No                       | ns        | -1.851 |
| Level 8 vs In Training          | -1.05                           | 2.95                           | Yes                      | *         | -2.061 |
| Level 9 vs Level 10             | 0.196                           | 0.534                          | No                       | ns        | -0.842 |
| Level 9 vs In Training          | -0.0392                         | 0.109                          | No                       | ns        | -1.061 |
| Level 10 vs In Training         | -0.235                          | 0.697                          | No                       | ns        | -1.191 |

ANOVA-Analysis of Variance, ns-not significant, vs-versus, df-degrees of freedom, ss-sum of squares, MS- Mean square, Mean difference
Table-3- Comparison of mean attitude scores across different levels of students

| One-way analysis of variance |
|-------------------------------|
| P value                       | 0.0002 |
| P value summary               | ***    |
| Are means signif. different? (P < 0.05) | Yes |
| Number of groups              | 5      |
| F                             | 5.82   |
| R squared                     | 0.0668 |

Bartlett’s test for equal variances
Bartlett’s statistic (corrected) 3.54
P value 0.4716
P value summary ns
Do the variances differ signif. (P < 0.05) No

ANOVA Table
| SS    | df | MS    |
|-------|----|-------|
| Treatment (between columns) | 70.8 | 4 | 17.7 |
| Residual (within columns)   | 990  | 325 | 3.04 |
| Total                        | 1060 | 329  |

Bonferroni’s Multiple Comparison Test
| Mean Diff. | t     | Significant? P < 0.05? | Summary | 95% CI of Diff |
|------------|-------|------------------------|---------|----------------|
| Level 7 vs Level 8 | 1.12  | 3.62 | Yes | ** | 0.24 to 1.99 |
| Level 7 vs Level 9 | -0.34 | 1.09 | No | ns | -1.2 to 0.54 |
| Level 7 vs Level 10 | 0.263 | 0.9  | No | ns | -0.51 to 1.09 |
| Level 7 vs In Training | -0.0117 | 0.0408 | No | ns | -0.8 to 0.54 |
| Level 8 vs Level 9 | -1.46  | 4.43 | Yes | *** | -2.39 to -0.52 |
| Level 8 vs Level 10 | -0.856 | 2.75 | No | ns | -1.7 to 0.04 |
| Level 8 vs In Training | -1.13  | 3.7  | Yes | ** | -2.01 to 0.26 |
| Level 9 vs Level 10 | 0.604  | 1.92 | No | ns | -0.21 to 1.02 |
| Level 9 vs In Training | 0.329 | 1.06 | No | ns | -0.54 to 1.29 |
| Level 10 vs In Training | -0.275 | 0.952 | No | ns | -1.0 to 0.47 |

ANOVA-Analysis of Variance, ns-not significant, vs-versus, df-degrees of freedom, ss-sum of squares, MS-Mean square, t-difference
Table-4- Comparison of mean practice scores across different levels of students

| One-way analysis of variance | | | |
|---|---|---|---|
| P value | 0.4108 | | |
| P value summary | ns | | |
| Are means signif. different? (P < 0.05) | No | | |
| Number of groups | 5 | | |
| **F** | 0.994 | | |
| **R squared** | 0.0121 | | |

| Bartlett's test for equal variances | | | |
| Bartlett's statistic (corrected) | 3.21 | | |
| P value | 0.5233 | | |
| P value summary | ns | | |
| Do the variances differ signif. (P < 0.05) | No | | |

| ANOVA Table | SS | df | MS |
|---|---|---|---|
| Treatment (between columns) | 8.53 | 4 | 2.13 |
| Residual (within columns) | 697 | 325 | 2.15 |
| Total | 706 | 329 | | |

| Bonferroni's Multiple Comparison Test | Mean Diff. | t | Significant? P < 0.05? | Summary | 95% CI of Diff. |
|---|---|---|---|---|---|
| Level 7 vs Level 8 | -0.26 | 0.999 | No | ns | -0.993 to 0.474 |
| Level 7 vs Level 9 | -0.0503 | 0.192 | No | ns | -0.792 to 0.691 |
| Level 7 vs Level 10 | -0.442 | 1.8 | No | ns | -1.14 to 0.252 |
| Level 7 vs In Training | -0.145 | 0.604 | No | ns | -0.826 to 0.535 |
| Level 8 vs Level 9 | 0.209 | 0.756 | No | ns | -0.573 to 0.992 |
| Level 8 vs Level 10 | -0.183 | 0.7 | No | ns | -0.922 to 0.556 |
| Level 8 vs In Training | 0.114 | 0.444 | No | ns | -0.392 to 0.782 |
| Level 9 vs Level 10 | -0.392 | 1.49 | No | ns | -1.14 to 0.354 |
| Level 9 vs In Training | -0.0952 | 0.367 | No | ns | -0.792 to 0.691 |
| Level 10 vs In Training | 0.297 | 1.22 | No | ns | -0.145 to 0.739 |

ANOVA-Analysis of Variance, ns-not significant, vs-versus, df-degrees of freedom, ss-sum of squares, MS- Mean square, M difference
Supplementary Files

This is a list of supplementary files associated with the primary manuscript. Click to download.

Supplementary file-References-IJCP.docx
Supplementary file-Appendix-Ayesha-IJCP.docx