


Research Article

A Principal Component Analysis of Nursing Students' Satisfaction with Blended E-learning following the Covid-19 Pandemic

N Tayyib, F Alsolami, HI Asfour, PR Ramaiah, EE Ahmed, I Nomani, GM Lindsay*

Abstract

Background: Covid-19 restrictions following the outbreak of the Covid-19 pandemic forced the educational sector to quickly introduce blended e-learning.

Objective: To assess student satisfaction with this rapid change to e-blended learning within an existing nursing programme.

Participants: A 35 item questionnaire, subdivided into the educational domains of Interaction, Instruction, Instructor, Management and Technology, was circulated to 478 nursing students. In total, n=283 (59.2%) responses were received from 84 (n=32+37+15) male and 199 (n=58+66+75) female students in their 2nd, 3rd and 4th years of study respectively.

Methods: Principal component analysis, summary and comparative statistics were used to rate and compare domain satisfaction for the whole group, between genders and across different years of study, and to explore sub-themes underlying student satisfaction.

Results: 58.8% of responses registered positive satisfaction with 17.7% registering dissatisfaction. Principal Component Analysis (PCA) revealed domain satisfaction ranging from 74.9% to 80.6% with similar male/female ratings except for Year-2 management (p=0.002). Year-3/Year-4 satisfaction was also similar across domains and significantly higher than Year-2 for Instruction (p=0.027) and Instructor (p≤001). PCA suggested that

- Approximately 55% of nursing students felt uninhibited when participating within a mixed gender environment;
- Approximately 30% of nursing students preferred blended e-learning over face-to-face learning;
- Approximately 60% of students registered satisfaction with the management of out-of-classroom issues including accessibility of learning materials and evaluation of course work etc.
- Approximately 70% of students believe satisfactory course management relied primarily on Instructors maintaining class discipline.

Conclusion: Nursing students reported good satisfaction with the immediate transition to an unfamiliar e-learning blended curriculum. More mature students (Year-3 and Year-4) demonstrated better technological skill, resilience and fortitude than Year-2 students when presented with this rapidly changing environment.

Affiliation:

¹College of Nursing, Umm Al-Qura University, Saudi Arabia

*Corresponding Author

Grace M Lindsay, College of Nursing, Umm Al-Qura University, Saudi Arabia.

Citation: N Tayyib, F Alsolami, HI Asfour, PR Ramaiah, EE Ahmed, I Nomani, GM Lindsay. A Principal Component Analysis of Nursing Students' Satisfaction with Blended E-learning following the Covid-19 Pandemic. *Journal of Women's Health and Development* 6 (2023): 45-55.

Received: February 10, 2023

Accepted: February 21, 2023

Published: April 13, 2023

Keywords: Blended Learning; Principal Component Analysis; Nursing Student Satisfaction; Transition to E-Learning

Introduction

The rapid development of information and computer technology and the increased percentage of college students with advanced prior knowledge of computers and the internet has facilitated enriched teaching and learning experiences, creating for many a better quality of education [1]. Consequently, educational providers worldwide are actively investigating computer-based teaching and assessment due to its potential and proven benefits including savings in cost and time, and the automated delivery and accurate scoring of grades including the immediacy of feedback to faculty of individual student progress and performance [2]. Educational curricula in nursing and higher education are delivered using mixed teaching approaches including traditional classroom lectures, laboratory and practical sessions, small group teaching and tutorials all of which increasingly use electronic tools for promoting learning. This progression has led to another dimension of learning, frequently described in the literature as 'blended learning' and defined by the statement that "Blended learning integrates face-to-face instruction with computer-mediated instruction [3]". Although blended learning typically refers to the practice of using both online and face-to-face learning experiences when teaching students, how and in what ratio these constituents are combined has received less attention and is addressed by Tayyib et al.[4]. This research into satisfaction with blended learning arose following the rapid introduction of e-learning into a B.ScN (Hons) nursing programme, the content of which included theoretical lectures, clinical practice sessions, case presentations and critical discussions. The purpose of this study was to understand and obtain feedback on the student experience through the assessment of their satisfaction with the rapid change to a blended e-learning curriculum enforced by the urgent requirement for social distancing due to the Covid-19 pandemic. A complementary survey of staff experiences is reported in Ramaiah et al. [5]. Online learning was facilitated using BlackBoard© (<https://www.blackboard.com/teaching-learning>) with support in project/group work and communication via WhatsApp (<https://www.whatsapp.com>) according to methods described previously [6]. Blackboard allows the delivery of lecture material and facilitates student interactions via discussion tutorials, chat lines and access to educational resources via links provided by the instructor. Instructors select the learning processes and appropriate subject material for the students, thereby allowing key components of learning to be delivered online.

Methods

Design

This is a descriptive study.

Questionnaire

This survey used a validated questionnaire developed previously at the College of Information Technology (CIT), UAE, for assessing student satisfaction with a blended learning course which was structurally similar to that introduced in the Faculty of Nursing following the immediate implementation of an e-learning format in response to the Covid-19 pandemic [7]. The questionnaire comprised 28 positively and 7 negatively framed statements each requiring a response on a 5-point Likert scale ranging from strongly agree (5), agree (4), neutral (3), disagree (2) to strongly disagree (1). The 35 statements were subdivided into the domains of Interaction (n=9), Instruction (n=12), Instructor (n=5), Management (n=3) and Technology (n=6) each measuring various aspects of student satisfaction with blended learning. The survey was developed using Google Forms (<https://drive.google.com>).

Participants

The questionnaire was circulated to all male and female undergraduate nursing students enrolled in the 2nd, 3rd and 4th years of the B.ScN (Hons) programme (n=478 students). Students were advised that the survey was open to undergraduates 18 years of age and older. Fully completed responses were received from 199 female (58+66+75) and 84 male (32+37+15) from years 2-4 respectively giving a response rate of 59.2%.

Data Collection

Data were collected online via a self-completed validated satisfaction questionnaire [7]. An information sheet was circulated to all undergraduate nursing students using WhatsApp describing the purpose of the study, what participation entailed and assuring them that data would be collected anonymously. An electronic link to the satisfaction questionnaire was included with the information sheet.

Statistical Methods

Student responses to the questionnaire were investigated separately for each domain of educational enquiry. A principal component analysis (PCA) was used to deconstruct correlations between responses in any domain. The outcome is a family of uncorrelated components, or factors, the values of which are determined from raw domain scores in a formulaic way. The importance of any factor is measured by the percentage of total domain information (variance) explained by that factor.

Ethical Considerations

The study was conducted in accordance with the methods and procedures for human research [8]. Ethical approval was

granted by the Research Ethics Committee of the Faculty of Nursing. Students were informed that participation was voluntary, anonymous and separate from their academic studies. Online submission of a completed questionnaire was considered to be consent to participate in the research study.

Results

Section 1: Descriptive and Comparative Analysis

Table 1 lists the domains of enquiry, the frequency of responses and the number of questions allocated to each domain together with the mean group response, the mean values of the male and female responses and the result of chi-squared and t-test comparisons of the frequencies and mean values of these responses. Importantly, mean responses significantly exceed 3.0 (neutral response) in all domains of educational enquiry ($p < 0.001$). Overall $n = 9905$ responses were received in which 5.9% ($n = 589$) reported strong dissatisfaction, 11.8% ($n = 1167$) reported dissatisfied, 23.5% ($n = 2331$) were neutral, 37.0% ($n = 3661$) reported satisfaction and 21.8% ($n = 2157$) reported strong satisfaction. Thus 58.8% of responses registered positive satisfaction and 82.3% of responses were not dissatisfied with the blended learning programme. Tayyib et al. [9] give a full discussion of the descriptive and comparative properties of the data

presented in Table 1. The ensuing analysis will present a principal component analysis of this data, and in particular, will investigate sub-themes that are not transparent using descriptive and comparative statistical tools.

Section 2: Principal Component Analysis

Principal Component Analysis (PCA) is a statistical technique which aims to reduce domain dimensionality while simultaneously maintaining variability and limiting information loss in large datasets [10]. The procedure used here constructs a family of uncorrelated variables, or “factors”, from the covariance matrix of the raw data. The value of each factor is constructed in a formulaic way from that of the raw data. Two complementary strategies are developed, the first of which determines what questions in a domain are strongly correlated with a given factor, and the second of which assesses student agreement with the subtheme underlying that factor. Strong correlation in this context means positive or negative correlations exceeding 0.5. The theme/subtheme under investigation is identified by interpreting the content of the questions to which that factor is strongly correlated [11]. Student agreement with this subtheme is then assessed by counting the percentage of students with factor score on or above that of a hypothetical student who always responds 3

Table 1: The domains of educational enquiry, the frequencies and mean values of group, male and female responses and the results of chi-squared and t-test comparisons of the male and female responses in each domain of enquiry are described.

Domains	Group	Numbers and Frequency of scores					Mean (SD)	Chi-squared and t-test (p-values)
		1	2	3	4	5		
Interaction (9 items)	M+F	150 (5.9%)	291 (11.4%)	631 (24.8%)	990 (38.9%)	485 (19.0%)	3.54 (1.01)	M vs. F $X^2 = 23.399$ ($p < 0.001$) t = -1.6941 ($p = 0.009$)
	F	95 (5.3%)	233 (13.0%)	438 (24.5%)	708 (39.5%)	317 (17.7%)	3.51 (1.09)	
	M	55 (7.3%)	58 (7.7%)	193 (25.5%)	282 (37.3%)	168 (22.2%)	3.60 (1.13)	
Instruction (12 items)	M+F	261 (7.7%)	423 (12.5%)	816 (24.0%)	1179 (34.7%)	717 (21.1%)	3.49 (1.18)	M vs. F $X^2 = 29.455$ ($p < 0.001$) t = -2.500 ($p = 0.012$)
	F	180 (7.5%)	310 (13.0%)	583 (24.4%)	867 (36.3%)	448 (18.8%)	3.46 (1.16)	
	M	81 (8.0%)	113 (11.2%)	233 (23.1%)	312 (31.0%)	269 (26.7%)	3.57 (1.22)	
Instructor (5 items)	M+F	75 (5.3%)	192 (13.6%)	330 (23.3%)	523 (37.0%)	295 (20.8%)	3.55 (1.12)	M vs. F $X^2 = 10.483$ ($p = 0.007$) t = -1.2261 ($p = 0.220$)
	F	46 (4.6%)	147 (14.8%)	238 (23.9%)	371 (37.3%)	193 (19.4%)	3.52 (1.10)	
	M	29 (6.9%)	45 (10.7%)	92 (21.9%)	152 (36.2%)	102 (24.3%)	3.60 (1.17)	
Management (3 items)	M+F	38 (4.5%)	103 (12.1%)	187 (22.0%)	312 (36.7%)	209 (24.9%)	3.65 (1.11)	M vs. F $X^2 = 4.036$ ($p = 0.802$) t = 0.6283 ($p = 0.530$)
	F	22 (3.6%)	75 (12.6%)	129 (21.6%)	226 (37.9%)	145 (24.3%)	3.67 (1.09)	
	M	16 (6.3%)	28 (11.1%)	58 (23.0%)	86 (34.1%)	64 (25.4%)	3.61 (1.16)	
Technology (6 items)	M+F	65 (3.8%)	158 (9.3%)	367 (21.6%)	657 (38.7%)	451 (26.6%)	3.75 (1.07)	M vs. F $X^2 = 27.483$ ($p < 0.001$) t = -5.4964 ($p < 0.001$)
	F	54 (4.5%)	127 (10.6%)	274 (22.9%)	454 (38.0%)	285 (23.9%)	3.66 (1.09)	
	M	11 (2.2%)	31 (6.2%)	93 (18.5%)	203 (40.3%)	166 (32.9%)	3.96 (0.98)	

(neutral) to every question of that domain. Table 2 shows that the primary and secondary factors in each domain capture at least 52.1% of the domain information. Primary factors in a domain measure student satisfaction with the implementation of blended learning as it pertains to that domain, while the secondary factor assess student agreement with the leading subtheme underlying the domain responses. The subthemes described by the primary and secondary factors for each domain of enquiry are listed in Table 3 together with the percentage of student agreement with each subtheme. Student satisfaction rated at 75% or better. For example, the primary factor in the domain of Interaction calculates individual student domain satisfaction scores using the expression

$$0.1774 \times Q1 + 0.1710 \times Q2 + 0.0264 \times Q3 - 0.0538 \times Q4 + 0.0926 \times Q5 + 0.1426 \times Q6 + 0.1483 \times Q7 + 0.1489 \times Q8 + 0.1465 \times Q9,$$

where Q1- Q9 are to be replaced by their raw responses to questions Q1 to Q9 respectively after first reverse scoring negatively worded questions. It is easily verified that the hypothetical students who respond 3 (neutral) to every question will generate a satisfaction score of 3. The percentages stated in Table 3 are constructed from the fraction of students generating a score of 3 or better. Table 4 presents an analysis of how domain satisfaction and the subthemes described in Table 3 depend on gender and the year of study. The percentage values quoted in Table 4 are based on the number

of students who generate a better than average score for the themes expressed in Table 3 for each gender and each level of study. Thereafter, a chi-squared test is used to investigate the NULL hypothesis that the distributions of responses with gender are not different at the 5% level of significance for each year of study. The results of Table 4 indicate that by-and-large gender differences in student satisfaction are not statistically significant across the domains of educational enquiry. The exception is the management domain for Year-2 students, where the data indicates that female nursing students are significantly more satisfied than their male counterparts. Likewise the data indicates that secondary factors are by-and-large not significantly different for male and female students with the exception of the domain of Interaction at Year-4, where the principal component analysis suggests that female students' willingness to interact in the classroom environment is significantly inhibited by the presence of male students. However, the reliability of this finding should be qualified by the large gender imbalance in this year-group: it was the first occasion men were allowed to enroll in the university nursing program. Overall the results reported in Table 4 suggest that male and female responses per year of study are similar. Thus male and female responses are pooled for the purpose of comparing levels of domain satisfaction and levels of agreement with domain subthemes between years of study as reported in Table 5. The important observation from Table 5 is that Year-2 students rate their satisfaction (primary

Table 2: The correlations between raw domain scores and the primary and secondary factors are shown for each educational domain, where primary and secondary factors denote respectively those capturing the largest and second largest domain variance.

Topic of enquiry	Factor	Importance	Correlation between factor and domain responses											
			Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9			
Interaction	Questions													
	Primary	35.20%	0.79	0.81	0.10	-0.24	-0.38	0.69	0.62	0.72	0.74			
	Secondary	17.50%	-0.26	-0.19	0.75	-0.33	0.66	-0.02	0.20	-0.25	-0.18			
	Total	52.70%												
Instruction	Questions		Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21
	Primary	42.50%	0.6	0.78	0.72	0.72	0.67	0.60	0.74	0.22	0.70	0.82	0.46	0.54
	Secondary	9.60%	-0.15	0.01	-0.13	-0.16	0.32	-0.28	-0.18	0.30	-0.11	-0.05	0.79	-0.19
	Total	52.10%												
Instructor	Questions		Q22	Q23	Q24	Q25	Q26							
	Primary	47.60%	0.69	0.67	0.64	0.75	0.69							
	Secondary	18.60%	-0.29	-0.56	-0.19	0.24	0.59							
	Total	66.20%												
Management	Question		Q27	Q28	Q29									
	Primary	54.60%	0.53	0.65	0.89									
	Secondary	25.80%	0.70	0.36	-0.44									
	Total	76.00%												
Technology	Question		Q30	Q31	Q32	Q33	Q34	Q35						
	Primary	51.50%	0.74	0.31	0.85	0.57	0.83	0.64						
	Secondary	15.70%	-0.09	-0.7	-0.08	-0.45	0.48	-0.28						
	Total	67.20%												

Table 3: Primary factors measure of domain satisfaction. Secondary factors characterize the most important subtheme underlying domain responses. The right hand column quantifies the percentage agreement with themes/subthemes characterized by the primary and secondary factors. The raw responses significantly correlated with primary and secondary factors are shown in the Factor column.

Domain	Factor	Satisfaction (primary) and subtheme (secondary) factors	Level of agreement
Interaction	Primary:- Q1,Q2, Qs 6-9	Assesses student satisfaction with their participation in or interaction with the learning process in the classroom setting.	80.6%
	Secondary:- Q3, Q4, Q5	Assesses the level of student agreement that a mixed gender classroom environment does not modify or inhibit their willingness to participate or interact.	55.5%
Instruction	Primary:- Qs 10-16, Q18, Q19, Q21	Assesses student satisfaction with the instruction received and the positive benefits of the blended learning environment.	74.9%
	Secondary:- Q20	Assesses students' preference for blended learning as opposed to face-to-face learning.	30.7%
Instructor	Primary:- Qs 22- 26	Assesses positive student satisfaction with the performance and quality of the instructor within the classroom environment.	76.7%
	Secondary:- Q23, Q26	Assesses student satisfaction with how instructors dealt with out-of-classroom issues connected with the accessibility of learning material and the evaluation of submitted work.	59.7%
Management	Primary:- Qs 27-29	Assesses student satisfaction with course management.	77.4%
	Secondary:- Q27	Assesses student belief that class discipline is the foremost management issue and assesses how well instructors maintain class discipline.	69.6%
Technology	Primary:- Q30, Qs 32-35	Assesses student satisfaction with the effectiveness of the technological tools used to present a blended learning sessions.	79.5%
	Secondary:- Q31	Assesses student satisfaction with the effectiveness of out-of-classroom technology.	91.2%

Table 4: Table shows the results of a PCA analysis of domain responses by gender for each year of study.

Domain	Factor	Sex	Year-2 responses n=90 (M=32, F=58)		Year-3 responses n=103 (M=37, F=66)		Year-4 responses n=90 (M=15, F=75)	
Interaction	Primary	F	81.0%	$\chi^2 = 0.109$	77.2%	$\chi^2 = 1.286$	81.3%	$\chi^2 = 0.015$
		M	78.1%	$p = 0.741$	86.4%	$p = 0.257$	80.0%	$p = 0.904$
	Secondary	F	51.7%	$\chi^2 = 0.194$	59.1%	$\chi^2 = 1.985$	45.3%	$\chi^2 = 6.012$
		M	46.9%	$p = 0.660$	73.0%	$p = 0.159$	80.0%	$p = 0.014$
Instruction	Primary	F	63.8%	$\chi^2 = 0.606$	75.6%	$\chi^2 = 0.091$	84.0%	$\chi^2 = 2.451$
		M	71.9%	$p = 0.436$	78.4%	$p = 0.763$	66.7%	$p = 0.117$
	Secondary	F	24.1%	$\chi^2 = 0.533$	48.6%	$\chi^2 = 1.884$	25.3%	$\chi^2 = 0.193$
		M	31.3%	$p = 0.465$	34.8%	$p = 0.170$	20.0%	$p = 0.661$
Instructor	Primary	F	62.1%	$\chi^2 = 0.112$	77.3%	$\chi^2 = 2.238$	86.7%	$\chi^2 = 1.692$
		M	65.6%	$p = 0.738$	89.2%	$p = 0.135$	73.3%	$p = 0.193$
	Secondary	F	75.9%	$\chi^2 = 1.792$	56.1%	$\chi^2 = 1.559$	57.3%	$\chi^2 = 0.036$
		M	62.5%	$p = 0.181$	43.2%	$p = 0.212$	60.0%	$p = 0.849$
Management	Primary	F	89.7%	$\chi^2 = 9.504$	74.2%	$\chi^2 = 1.244$	73.3%	$\chi^2 = 0.292$
		M	62.5%	$p = 0.002$	83.8%	$p = 0.265$	80.0%	$p = 0.589$
	Secondary	F	65.5%	$\chi^2 < 0.001$	66.7%	$\chi^2 = 1.575$	73.3%	$\chi^2 = 0.277$
		M	65.6%	$p = 0.992$	78.4%	$p = 0.209$	66.7%	$p = 0.599$
Technology	Primary	F	75.9%	$\chi^2 = 0.897$	74.2%	$\chi^2 = 2.116$	57.3%	$\chi^2 = 1.755$
		M	84.4%	$p = 0.343$	86.5%	$p = 0.146$	93.3%	$p = 0.185$
	Secondary	F	93.1%	$\chi^2 = 1.746$	89.4%	$\chi^2 = 0.001$	93.3%	$\chi^2 = 1.059$
		M	84.4%	$p = 0.186$	89.2%	$p = 0.974$	100%	$p = 0.303$

factor) lower than that of Year-3 and Year-4 students in the Instruction and Instructor domains, the difference being particularly significant in the Instructor domain. Otherwise, no significant differences are found in student satisfaction (as measured by the primary factor) between different years of study and educational domain. The main observation in the results reported in Table 5 is the diversity of sentiments expressed by the different year groups with the exception of the Technology domain. Arguably the sentiments of Year-3 and Year-4 students are better aligned and different from the sentiments of Year-2 students. The rather low importance placed by Year-4 students on the maintenance of class discipline may reflect the atypical nature of this year-group as mentioned previously. Table 6 shows the result of using PCA to examine the relative contribution of each domain to overall student satisfaction with blended learning, where the raw data are now taken to be the average student response in each domain thereby allowing a fair domain-by-domain comparison. Overall satisfaction is calculated from the expression

$0.1667 \times (\text{Mean Interaction Score}) + 0.2194 \times (\text{Mean Instruction Score}) + 0.2230 \times (\text{Mean Instructor Score}) + 0.2290 \times (\text{Mean Management Score}) + 0.1619 \times (\text{Mean Technology Score})$, in which the contribution from each domain to overall satisfaction is quantified by its loading factor with larger values corresponding to those domains which make greater contributions to student satisfaction. Specifically, if each domain was equally important then all loading factors would have value 0.2. However, the values of the loadings in this expression suggest that the "Instruction", "Instructor" and "Management" domains contribute most to student satisfaction with blended learning. Participants who respond 5 to positively worded and 1 to negatively worded questions will generate an overall satisfaction score of 5 whereas those who do the reverse will generate an overall satisfaction score of 1. Others will generate a satisfaction score between 1 and 5.

Discussion

This study has reported nursing student satisfaction in five domains of educational enquiry following a new and

Table 5: The Table shows the levels of student domain satisfaction (primary factor) and levels of student agreement (secondary factor) with the themes listed in Table 3.

Comparison of primary factor (domain satisfaction) between years of study						
Domain	Year of Study			Comparison between years		
	Y2	Y3	Y4	Y2 vs. Y3	Y2 vs. Y4	Y3 vs. Y4
Interaction	80.0%	80.6%	81.1%	$\chi^2 = 0.010$ $p = 0.919$	$\chi^2 = 0.035$ $p = 0.851$	$\chi^2 = 0.009$ $p = 0.926$
Instruction	66.7%	76.7%	81.1%	$\chi^2 = 2.399$ $p = 0.121$	$\chi^2 = 4.866$ $p = 0.027$	$\chi^2 = 0.559$ $p = 0.455$
Instructor	63.3%	81.6%	84.4%	$\chi^2 = 8.101$ $p = 0.004$	$\chi^2 = 10.40$ $p = 0.001$	$\chi^2 = 0.283$ $p = 0.595$
Management	80.0%	77.7%	74.4%	$\chi^2 = 0.156$ $p = 0.693$	$\chi^2 = 0.790$ $p = 0.374$	$\chi^2 = 0.275$ $p = 0.600$
Technology	78.9%	78.6%	81.1%	$\chi^2 = 0.002$ $p = 0.966$	$\chi^2 = 0.139$ $p = 0.709$	$\chi^2 = 0.182$ $p = 0.670$
Comparison of secondary factor (domain sub-theme) between years of study						
Domain	Year of Study			Comparison between years		
	Y2	Y3	Y4	Y2 vs. Y3	Y2 vs. Y4	Y3 vs. Y4
Interaction	50.0%	64.1%	51.1%	$\chi^2 = 3.895$ $p = 0.048$	$\chi^2 = 0.022$ $p = 0.881$	$\chi^2 = 3.316$ $p = 0.069$
Instruction	26.7%	39.8%	24.4%	$\chi^2 = 3.712$ $p = 0.054$	$\chi^2 = 0.117$ $p = 0.733$	$\chi^2 = 5.155$ $p = 0.456$
Instructor	71.1%	51.5%	57.8%	$\chi^2 = 7.773$ $p = 0.005$	$\chi^2 = 3.491$ $p = 0.062$	$\chi^2 = 0.774$ $p = 0.379$
Management	65.6%	58.3%	40.0%	$\chi^2 = 0.008$ $p = 0.929$	$\chi^2 = 6.423$ $p = 0.011$	$\chi^2 = 6.401$ $p = 0.011$
Technology	90.0%	89.3%	94.4%	$\chi^2 = 0.024$ $p = 0.877$	$\chi^2 = 1.239$ $p = 0.266$	$\chi^2 = 1.659$ $p = 0.198$

Chi-squared comparisons of these levels between different years of study are reported.

Table 6: The Table shows how mean satisfaction ratings in the domains of educational enquiry contribute to overall student satisfaction with blended learning.

Number of Questions	Educational domain	Loading
9	Interaction	0.1667
12	Instruction	0.2194
5	Instructor	0.2230
3	Management	0.2290
6	Technology	0.1619

immediate transition from traditional classroom education into a blended e-learning curriculum for nurse training consequent on the protective measures introduced for Covid-19. Student satisfaction provides an important measure of the effectiveness of curriculum changes and was assessed here using a previously validated student e-learning questionnaire [7]. Significantly above average student satisfaction occurred in all educational domains (Table 3) with satisfaction nowhere falling below 74.9% (Instruction). Year-4 students registered the highest satisfaction in four of the five domains (Table 5) potentially attributable to the increased diversity of the blended-learning experience combined with their increased maturity allowing them to adapt better to change. Otherwise no significant gender differences in satisfaction arose in the domains of Interaction, Instruction, Instructor and Technology, the exception being Management where Year-2 female satisfaction at 89.7% significantly exceeded that of male students at 62.5% (Table 4). Male and female nursing students both reported significantly above average satisfaction in respect of interactions with other students and lecturers (Table 1). Interestingly, the majority (Table 3, 55.5%) of students believed that a mixed gender teaching environment did not modify/inhibit their participation/interaction within the classroom, with Year-3 students being least sensitive to a mixed gender teaching environment (Table 5). The increasing acceptance of mixed gender teaching on progression from Year-2 to Year-3 is explicable in terms of societal norms and the increased familiarity with the mixed gender teaching environment. The Year-4 sentiment seems at odds with this progression being almost identical to Year-2 sentiment, but as mentioned previously, Year-4 was potentially atypical. Mahmood et al. [12] argued that teaching presence is a critical factor determining student satisfaction with online learning programs. Similarly Kuo et al. [13] argued that effective face-to-face and online learning correlates strongly with good student-student and student-teacher interactions. Within the instruction and instructor domains, Year-2 students were less satisfied than Year-3 or Year-4 students, and statistically less satisfied in the Instructor domain (Table 5). Otherwise, Year-4 students recorded the best satisfaction in four of the five domains of enquiry, and Year-3 students were for practical purposes at least as well satisfied as Year-2 students in four of the five domains of enquiry although

differences were not statistically significant except in some comparisons with Year-2. Interestingly, approximately one third (30.7%) of nursing student preferred blended learning over face-to face learning (Table 3), and approximately 60% of students were satisfied with how instructors managed out-of-classroom issues such as the accessibility of class teaching materials, information and the evaluation of submitted work. Approximately 70% of students agreed that an Instructor's ability to maintain classroom discipline was the foremost management issue in determining their satisfaction with Course Management (Table 3). Educationalist recognize that adherence to class discipline is essential for good student satisfaction [14]. Finally, satisfaction within the Technology domain of the blended learning environment was highly rated across all year-groups with male students being consistently better satisfied than female students although not significantly so (Table 4). Technological skills acquired by nursing students through familiarity with applications such as social media facilitated the rapid change to an unfamiliar e-blended learning environment without the need for formal training. History has reported that men are more proficient than women with computers and the internet, and are more likely to use online media [14]. While this survey revealed evidence of a gender gap (Table 5), further inspection reveals that these gaps relate largely to societal and not technology issues [15,16]. Arguably the growth in communication and social tools has promoted female engagement with the internet, thereby reducing the importance of technological knowhow in navigating the e-learning environment [17,18]. Ke & Kwak [17] identified learner relevance, active and authentic learning, learner autonomy and technological competence as important ingredients of learner satisfaction. Kuo et al. [13] identified a strong correlation between positive student satisfaction and effective technology facilitating the engagement of students with instructors and course content. Battalio [19] argued that positive course satisfaction requires effective learner-instructor interaction while Dziuban et al. [20] associated course satisfaction with an effective learning environment in which the learner understands the value of the course and, together with the instructor, shares a commitment for its success. Students reported significantly above average satisfaction with the operation of Blackboard, WhatsApp, digital devices and e-learning support. These findings were supported by other investigators who commented that satisfaction with e-learning hinges on the effectiveness and convenience of technology tools [21]. The findings of this study indicate that nursing students have endorsed the rapid change to a blended e-learning environment, and recognize the importance of attending and participating in the blended learning process with the same diligence as would happen with face-to-face learning.

Limitations

Although the questionnaire used here was developed

for students of information technology, nevertheless the educational domains of the questionnaire are generic and relevant for assessing nursing students' satisfaction with blended e-learning. Arguably the domain of Management has too few items to fully explore the construct while the domain of Instruction may have too many items potentially introducing information duplication. However, the need to achieve thoughtful responses and minimize responder fatigue always limits the total number of items in a questionnaire. Also it cannot be assumed that negatively worded questions have been correctly interpreted by all students.

Conclusions

Nursing students reported statistically significantly above average satisfaction across all domains of educational enquiry following their immediate transition to remote blended e-learning while dealing simultaneously with the impact of the ongoing pandemic. Students in advanced years of study better managed the new unfamiliar environment. Principal component analysis revealed and quantified student sentiment on issues motivating their assessment of overall programme satisfaction. Formal satisfaction feedback on course changes provides important insights relating to components of the educational experience not available from end-of-course surveys.

Recommendations

Education providers should be confident about implementing agile practices when meeting student and staff needs resulting from unexpected disruption to practice. Multi-system action and intervention have been traced to the end-user and shown to be collectively powerful endorsements for the re-design of their learning and assessment processes and context.

References

1. Albanna N, Abu-Safe H. Investigating students' attitudes towards computer-based and traditional paper-pencil testing: Are there gender differences in e-learning use and assessment? Proceedings of ICERI2019 Conference 11th-13th November 2019, Seville, Spain (2019).
2. Hewson C. Can online course-based assessment methods be fair and equitable? Relationships between students' preferences and performance within online and offline assessments. *Journal of Computer Assisted Learning* 5 (2012): 488-498.
3. Graham CR. Blended learning systems: Definition, current trends and future directions. In C. J. Bonk & C. R. Graham (Eds.), *The handbook of blended learning: Global perspectives, local designs* (pp. 3-21). San Francisco: Pfeiffer (2006): 3-21.
4. Tayyib N, Alsolami F, Asfour HI, et al. Growth of Blended E-learning Paradigms in Nursing and Health Sciences and the Student Experience: Insights from the Literature. *CPQ Medicine* 11 (2021): 2.
5. Ramaiah P, Tayyib NA, Alsolami FJ, et al. Health Professionals Dynamic Role Amid COVID-19: Nursing Perspectives 32 (2020): 93-100.
6. Tayyib NA, Khedr S, Fawzi N, et al. A Systematic Review of the Use of Smart Phones with WhatsApp Messaging and Practice Recommendations Within Curriculum Learning Activities in Undergraduate Nursing Programmes. *CPQ Medicine* 6 (2019): 6.
7. Naaj MA, Nachouki M, Ankit A. Evaluating student satisfaction with blended learning in a Gender-segregated Environment. *Journal of Information Technology Education: Research* 11 (2012): 185-200.
8. WHO. Ethical standards and procedures for research with human (2020).
9. Tayyib N, Alsolami F, Asfour H, et al. Undergraduate Nursing Students Endorse Education Standards in Blended e-Learning Theory Teaching during COVID-19 Pandemic. *The Open Nursing Journal* 15 (2021).
10. Ke F, Kwak D. Constructs of student-centered online learning on learning satisfaction of adverse online student body: A structural equation modeling approach. *Journal of Educational Computing Research* 48 (2013): 97-122.
11. Applied Multivariate Statistical Analysis (2002).
12. Mahmood A, Mahmood ST, Malik AB. A comparative study of student satisfaction level in distance learning and live classroom at higher education level. *Turkish Online Journal of Distance Education (TOJDE)* 13 (2012): 128-136.
13. Kuo YC, Walker AE, Belland BR, et al. A predictive study of student satisfaction in online education programs. *The International Review of Research in Open and Distance Learning* 14 (2013): 16-39.
14. Cuadrado-García M, Ruiz-Molina ME, Montoro-Pons JD. Are there gender differences in e-learning use and assessment? Evidence from an interuniversity online project in Europe. *Procedia Social and Behavioral Sciences* 2 (2010): 367-371.
15. McCoy LP, Heafner TL. Effect of gender on computer use and attitudes of college seniors. *Journal of Women and Minorities in Science and Engineering* 10 (2004): 55-66.
16. Shaw LH, Gant LM. Users divided? Exploring the gender gap in internet use. *Cyberpsychology & Behavior* 5 (2002): 517-527.
17. Bruestle P, Haubner D, Schinzel B, et al. Doing E-Learning/Doing Gender? Examining the Relationship between Students' Gender Concepts and E-learning Technology. 5th European Symposium on Gender &

- ICT Digital Cultures: Participation - Empowerment – Diversity, March 5 - 7, 2009 - University of Bremen (2009).
18. Adamus T, Kerres M, Getto B, et al. Gender and E-Tutoring – A Concept for Gender Sensitive E-Tutor Training Programs. 5th European Symposium on Gender & ICT Digital Cultures: Participation - Empowerment – Diversity, March 5-7, 2009 – University of Bremen (2009).
19. Battalio J. Interaction online: A re-evaluation. *Quarterly Review of Distance Education* 8 (2007): 339-352.
20. Dziuban CD, Moskal PD, Brophy-Ellison J, et al. Student satisfaction with asynchronous learning. *Journal of Asynchronous Learning Networks* 11 (2007): 87-95.
21. Keengwe J, Diteeyont W, Lawson-Body A. Student and instructor satisfaction with e-learning tools in online learning environments. *International Journal of Information and Communication Technology Education (IJICTE)* 8 (2012): 76-86.

Questionnaire

	Statement	Strongly agree	Agree	neutral	Disagree	Strongly disagree
	Interaction					
1	A blended learning session keeps me always alert and focused.					
2	Interaction is adequately maintained with the lecturer when he/she is on the other side of the blended learning classroom					
3	Having students from the opposite gender on the other side of the blended learning classroom listening to what I say might restrict my participation					
4	A blended learning course makes it more important for students to visit the lecturer during office-hours.					
5	I cannot interrupt the lecturer to ask a question when he/she is on the other side of the blended learning classroom.					
6	I am satisfied with the quality of interaction between all involved parties					
7	I am dissatisfied with the process of collaboration activities during the course.					
8	I am satisfied with the way I interact with other students					
9	I am satisfied with my participation in the class.					
	Instruction					
10	The use of blended learning technology in this course encourages me to learn independently.					
11	My understanding is improved compared to similar courses I studied before					
12	My performance in exams is improved compared to similar courses I studied before					
13	I am satisfied with the level of effort this course required.					
14	I am dissatisfied with my performance in this course.					
15	I believe I will be satisfied with my final grade in the course.					
16	I am satisfied with how I am able to apply what I have learned in this course.					
17	If I had known this was going to be a blended learning class, I would not have taken it.					
18	I am willing to take another course using the blended learning delivery mode					
19	I am satisfied enough with this course to recommend it to others.					
20	Compared to face-to-face course settings, I am less satisfied with this learning experience.					
21	I enjoy working on assignments by myself.					
	Instructor					
22	The instructor makes me feel that I am a true member of the class					

	Statement	Strongly agree	Agree	neutral	Disagree	Strongly disagree
23	I am dissatisfied with the accessibility and availability of the instructor					
24	The instructor uses blended learning technology appropriately.					
25	Class assignments were clearly communicated to me.					
26	Feedback on evaluation of tests and other assignments was given in a timely manner					
	Course Management					
27	Discipline is highly observed when the lecturer is on the other side of the blended learning					
28	The lecturer/supervisor always takes attendance.					
29	I attend discussion board classes the same way I attend face-to-face classes					
	Technology					
30	The instructor's voice is audible.					
31	Course content shown or displayed on the smart board is clear.					
32	The microphone is in good working condition.					
33	The image is clear and comprehensive when the lecturer is on the other side of the blended learning classroom.					
34	Technical problems are not frequent and they do not adversely affect my understanding of the course.					
35	The technology used for blended teaching is reliable					