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Course design aspects of blended learning in undergraduate education

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ABSTRACT

Blended learning is a popular teaching mode in today's higher education system. Course design for blended education presents a challenge for educational specialists. This research aims to identify the essential aspects of course design in undergraduate blended learning. Course content, course structure and delivery, collaborative engagement, learner facilitation, and assessment and evaluation were discovered as aspects of blended learning course design. Based on the identified aspects, a survey questionnaire was designed and pilot tested to check the reliability and validity of the measurement tool. The analysis revealed that the questionnaire was acceptable in terms of psychometric characteristics after removing four items. Therefore, 23 items remained in the final questionnaire, which was considered reliable and valid for the context. The information was gathered using an online questionnaire from academic staff at Sri Lankan state universities attached to the departments conducting degree programs in the computing discipline. There were 97 participants included in the final dataset. The results were analyzed using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). The results revealed that 'assessment and evaluation' was highly considered when designing undergraduate blended learning courses, while other aspects which are also imperative, have been paid less attention by the university academicians.

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1. INTRODUCTION

Blended learning is a trending educational delivery mode in today's educational environment. When considering higher education, most adult learners are motivated by self-learning. Unlike in primary and secondary education, various techniques can be utilized in higher education to improve the educational situation of the students. The university education system in Sri Lanka is primarily focused on teacher-centered methods. However, the university education system is now encouraged to shift towards a student-centered learning (SCL) paradigm. SCL is an educational approach in which students construct knowledge through active and collaborative participation in the learning process [1]. The students can learn independently in an online or blended learning environment. By combining the best features of face-to-face and online education, the blended environment allows for convergence [2], [3].

Although blended learning is widely used in undergraduate education, it is challenging for teachers to design courses in a blended environment when teaching undergraduate courses. As a result, the primary focus of this study is on analyzing aspects of course design for undergraduate learners in a blended environment.

Five aspects were identified in the literature: course content, course structure and delivery, collaborative engagement, learner facilitation, and assessment and evaluation. A questionnaire was developed with the course design aspects of blended learning, and responses were collected from academic staff attached to departments conducting degree programs in the computing discipline. After analyzing the questionnaire results, the most important aspects of the blended learning course design for the Sri Lankan context were identified. The key significance of this study is that the course designers can more focus on the least significant aspects when designing undergraduate courses to be conducted in a blended environment since those are the less affected aspects of blended course design. The study findings can be used to provide effective course designs for undergraduate blended learning.

Undergraduates, as a category of adult learners in higher education, often encounter initial challenges within traditional, teacher-centered classrooms. These challenges include issues such as the teaching workload and the printing costs of learning materials [4]. Currently, most universities are practicing online learning. Although online learning has many advantages, it also has some disadvantages. As a result, educational experts are encouraged to introduce new learning modes. According to the literature, some significant issues in online education include less interaction among peers, less teacher facilitation, cultural barriers, and fewer technological resources [5]. Therefore, by reducing the workload of fully teacher-based classrooms, blended learning was identified as the most appropriate mode in higher education [4]. Blended learning is the combination of the best features of online and face-to-face learning [6].

In contrast to teacher-centered classrooms, learners in blended classrooms are active and collaborative participants, with the teacher serving as a facilitator. The online learning component is used for self-learning and collaborative participation with peers and teachers. The course design considerations must be thoroughly discussed when designing courses in a blended environment. When designing courses in a blended environment, aspects such as course content, course structure and delivery, learner facilitation, collaborative engagement, and assessment and evaluation must be considered. However, some of these issues have already been resolved, while others remain unresolved. Since the focus of this study is on designing effective courses, the subsequent paragraphs will address the issues connected to these identified aspects.

According to Berkeley University [7], course content is any material with information consisting of text, video, audio recordings, and assignments that have been designed for learning. When designing courses in the blended environment, appropriateness and availability issues may arise related to the course content. When providing learning materials by the teachers, sometimes the content may be inappropriate [8], or the learning materials may not be available to be referred to by the learners [9], [10]. Those issues must be minimized when preparing the course content.

The course structure assists the learners in planning, organizing and managing their activities in learning. According to Carnegie Mellon University [11], the course structure can be defined as selecting the relevant topics, organizing and ordering the course content adhering to the learning objectives. Delivering the lessons according to the course structure is another challenge for the teacher. When delivering the lessons, the incompatibility of the teacher's teaching and the learner's learning styles is prominent in the present higher educational context [12].

Collaborative activities and peer interaction are two main items in blended education [13]. Unlike in traditional teacher-centered classrooms, the learners actively participate in collaborative activities as small groups and share their knowledge with peers [14]–[16]. In a collaborative environment, the teacher acts as a facilitator to assist and motivate the learners [14]–[16]. Further, the learners should engage actively with the learning content in a blended environment [17]. However, most learners are not enthusiastically participating in peer-to-peer activities, and learner-content collaboration is not satisfactory in the present context.

In the blended environment, the face-to-face portion has more teacher interaction than the online portion. In online lessons, the learners learn through online mediums, minimizing teacher interaction. However, the teacher must facilitate and guide the learners in their learning tasks. They need to respond to the learners' queries immediately [18]; so that the learners feel that they are not isolated.

Assessment and evaluation are another course design aspect of blended learning. Assessment is an integrated part of the teaching and learning process to check whether the learners achieve the required learning outcomes [19], [20]. In evaluation, the teacher checks whether the learner has achieved the defined learning criteria [21]. In higher education, providing constructive feedback on time is a driving factor in the learning process. The facilitator is responsible for providing feedback on the learners' activities [22]. When designing successful courses in the blended environment, issues related to assessment and evaluation must be minimized.

This research analyses the significant aspects of blended learning course design in the Sri Lankan context by considering the identified issues related to blended learning course design. According to the accessed literature, there were several kinds of research done for online courses [23], [24]. But there were no pre-defined surveys to identify the significance of the aspects of course design in a blended environment. To analyze how the aspects affect the blended course design, this research tool is a reliable and valid measurement tool for the context. By referring to the analysis of the research, the course designers can pay more attention to the course design aspects according to the significance when designing undergraduate blended courses.

2. RESEARCH METHOD

This section provides a comprehensive explanation of the research methodology. It begins by detailing the development of the conceptual model of the study, which was formed by the existing literature. The developed conceptual model, research design, research participants, and implementation of the research is explained with the tools and techniques used.

2.1. Conceptual model of the research

The conceptual representation of the research is shown in Figure 1. According to the model, 'course content', 'course structure and delivery', 'collaborative engagement', 'learner facilitation' and 'assessment and evaluation' were identified as the aspects of course design. The aspect 'collaborative engagement' was subdivided into 'learner-peer collaboration' and 'learner-content collaboration'. The aspect 'assessment and evaluation' was subdivided into 'assessment instructions', 'evaluation criteria' and 'feedback'.

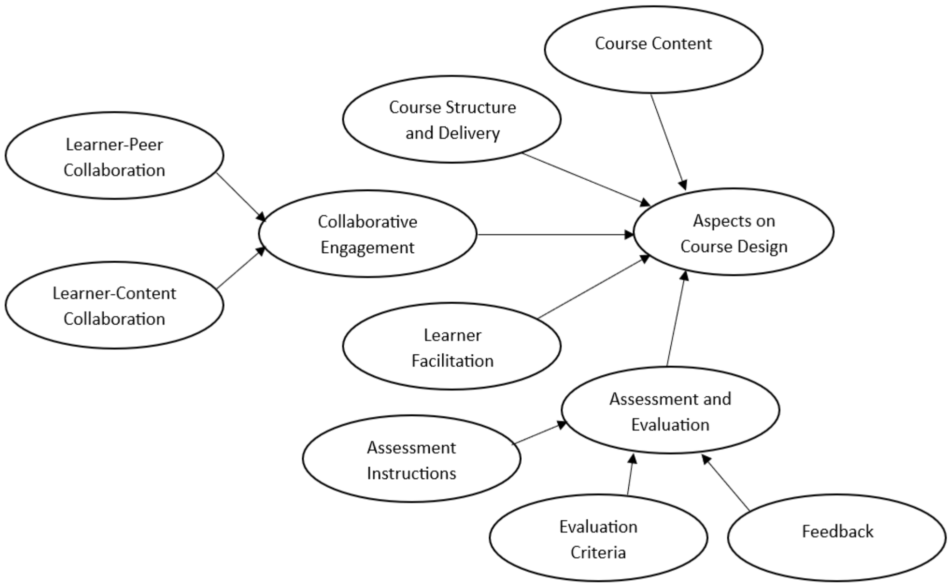

Figure 1. Conceptual model of the research

2.2. Research design

This study was carried out using the case-study method and a quantitative approach. The university academic staff members were used as the cases and closely evaluated their experiences for course designing in the blended environment. Questionnaires were used as the primary research instrument in the study, and they were distributed online as Google Forms, with responses collected in comma-separated values (.csv) format.

At the beginning of the questionnaire, the necessary information was given about the survey. Since it was an anonymous questionnaire, confidential information such as names, email addresses and phone numbers were not captured, and the participants were informed that it was a voluntary participation. The total population sampling technique was used under purposive sampling for sample selection. Follow-up actions were taken to increase the response rate by sending email reminders. Before the analysis, the dataset was checked for sampling adequacy using the Kaiser-Meyer-Olkin (KMO) measure and for normality using skewness and kurtosis values. Based on the literature, the course design considerations in a blended learning environment were operationalized. In the operationalization table, the constructs and dimensions were measured through indicators. Based on the operationalization table, the research instrument was developed as a survey questionnaire with scaling and multiple-choice questions (MCQs). The questionnaire was face-validated and distributed as the pilot survey.

Statistical analysis was performed to analyze the questionnaire responses. SPSS and SmartPLS statistical software tools were used as the data analysis software. The reliability of the questionnaire was assured by checking the internal consistency performed with Cronbach's alpha (CA) method [25], [26].

Dimension reduction was performed to check the validity of the questionnaire. Finally, exploratory factor analysis (EFA) was performed to find the emerging factors related to Sri Lankan undergraduate teaching and learning in a blended environment. The validated questionnaire was used for the final data collection. The confirmatory factor analysis (CFA) method was used to analyze the final dataset. In CFA, the reliability of the final questionnaire was checked using CA and composite reliability (CR). The convergent validity was checked using the average variance extracted (AVE) value. The discriminant validity was checked using the Fornell-Larcker criterion, Cross loading and Heterotrait-Monotrait ratio [27].

2.3. Participants of the study

This survey focused on collecting responses from the academic staff in Sri Lankan state universities attached to the departments conducting undergraduate degrees in the computing discipline. The final questionnaire was distributed among 486 university academic staff members and received 114 responses. The response rate was 23.46%. Among the responses, 17 were not following blended learning practices; therefore, the final dataset contained 97 responses. In the survey, the academic staff members represented all the Sri Lankan state universities. Table 1 shows further information on the participants' demographic details.

Table 1. Demographic details of the participants

		Frequency	Percentage (%)
Age range (years)	Below 30	35	36
	31–40	36	37
	41–50	18	19
	51–60	7	7
	Above 60	1	1
Designation	Professor	5	5
	Senior lecturer	28	29
	Lecturer	3	3
	Lecturer (probationary)	61	63
Teaching experience	Less than 1 year	5	5
	1–3 years	29	30
	4–6 years	24	25
	7–10 years	17	18
	11–15 years	8	8
	More than 15 years	14	14
Types of learners	Only undergraduates	71	73
	Undergraduates, postgraduates and others	26	27

2.4. Research implementation

The questionnaire was divided into two sections. Section I contained demographic information, and Section II contained course design-related questions. There were 27 questions related to course design were divided into five categories as course content (4 items), course structure and delivery (4 items), collaborative engagement (6 items), learner facilitation (4 items) and assessment and evaluation (9 items). In the questionnaire, the primary question type was scaling questions as it captures the psychometric measures to obtain the attitudes and opinions of the respondents. Within the categories, several questions related to open educational resources (OER) and assessment and evaluation were in MCQ format. In the scale-type questions, a 5-point Likert scale was used with values ranging from strongly disagree=1 to strongly agree=5. The questionnaire was shared as a Google Form, and the responses were recorded in an Excel spreadsheet linked to the Google Form. The final Excel sheet was downloaded as a .csv file.

After extracting the pilot survey data from the Google Form, the responses in the .csv file were preprocessed. The dataset was checked for missing values and outliers. After that, the Likert scale responses in the .csv file were encoded. The Likert scale item '5–strongly agree' was replaced as number 5; '4–agree' was replaced as number 4; '3–neutral' was replaced as number 3. The Likert scale item '2–disagree' was replaced as number 2, and '1–strongly disagree' was replaced as number 1. Also, the table headings were labelled as A1Q1, A1Q2, A1Q3, A1Q4, and A2Q1, up to A5Q9. Table 2 gives the items listed under each construct in the pilot survey questionnaire. After preparing the dataset, the .csv file was fed into SPSS software to perform the statistical analysis. By performing the reliability and validity analysis, the questionnaire was refined for the final data collection. CFA was performed on the final dataset.

Table 2. Items appear under each construct

Constructs		Items	Number of items
A1: course content	-	A1Q1, A1Q2, A1Q3, A1Q4	4
A2: course structure and delivery	-	A2Q1, A2Q2, A2Q3, A2Q4	4
A3: collaborative engagement	Learner-peer collaboration	A3Q1, A3Q2, A3Q3	3
	Learner-content collaboration	A3Q4, A3Q5, A3Q6	3
A4: learner facilitation	-	A4Q1, A4Q2, A4Q3, A4Q4	4
A5: assessment and evaluation	Assessment instructions	A5Q1, A5Q2, A5Q3, A5Q4	4
	Evaluation criteria	A5Q5, A5Q6, A5Q7	3
	Feedback	A5Q8, A5Q9	2

3. RESULTS AND DISCUSSION

The final dataset was collected using the refined questionnaire, and CFA was performed on 97 responses. The dataset was first checked for missing values and outliers. According to the SPSS statistics, there were no missing values and outliers within the 97 records.

3.1. Sample adequacy

KMO measure of sampling adequacy and Bartlett's test of sphericity (KMO and Bartlett's test) were used to check the adequacy of the sample for analysis. According to the statistics, the KMO measure was 0.734, and the significant value of Bartlett's test was 0.000. To achieve sampling adequacy, the KMO value should be greater than 0.5, and Bartlett's test significant value should be less than 0.05 [28]–[30]. Therefore, the result indicated a sufficient sample size for analysis.

3.2. Normality of the dataset

The dataset was then checked for normality using skewness and kurtosis values. According to the literature, for a normal distribution, the skewness values should be in the range of +3 to -3. The kurtosis value should be within +10 to -10 [31]. All the skewness and kurtosis values for this dataset were in the acceptable range. Therefore, the dataset was considered a normal distribution.

3.3. Descriptive statistics of the demographic information

The survey participants were from the Sri Lankan state universities attached to the departments conducting degree programs in the computing discipline. According to the statistics, most participants were in the 31–40 age range, which was 37%. Next, the highest age range was 'below 30', with 36%. 19% of participants were in the 41–50 age range, and 7% were in the 51–60 age range. The age categories 'above 60' had the lowest percentage of 1%. The bar chart in Figure 2 shows the details.

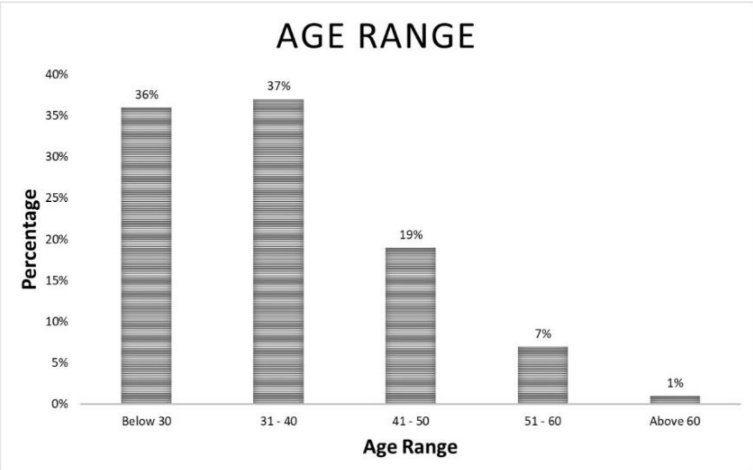

Figure 2. The age range of the participants

When considering the years of teaching experience, most participants had 1–3 years of teaching experience, which was 30%. 25% of the participants had 4–6 years, and 18% had 7–10 years of experience in teaching. 14% of the participants had more than 15 years of experience. The next highest was 11–15 years, with a percentage of 8%, and 5% of participants had less than one year of experience in teaching, which was the lowest. Figure 3 represents the teaching experience of the participants in a bar chart.

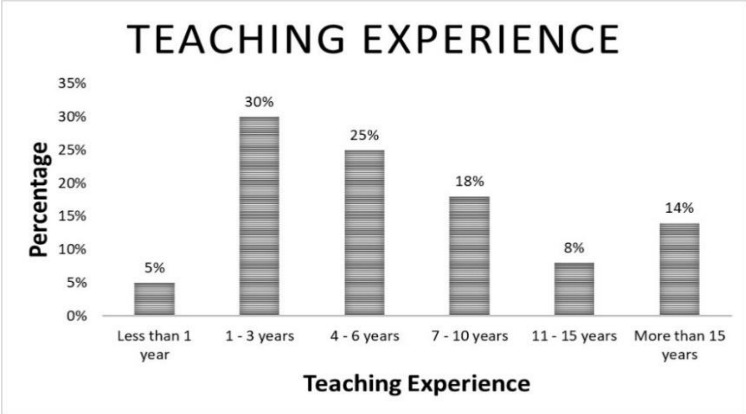

Figure 3. Teaching experience of the participants

According to the descriptive statistics, most participants were probationary lecturers, and the percentage was 63%. Among the participants, 29% were senior lecturers, and 5% were professors. The lowest was lecturers, and the percentage was 3%. Figure 4 shows the pie chart representing the percentages in each designation.

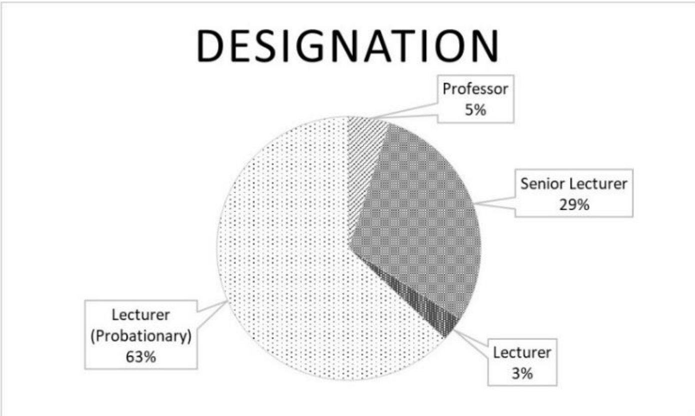

Figure 4. Designations of the participants

3.4. Descriptive statistics of the Likert-scale items

The Likert-scale items were the primary type of questions in the questionnaire. The item values were transformed into the mean of the items in each category. The mean, median, mode, minimum, maximum, standard deviation, skewness and kurtosis of each category were obtained. Table 3 shows the values of each category related to the dataset.

Table 3. Descriptive statistics of the transformed Likert-scale items

Construct	Mean	Median	Mode	Standard deviation	Skewness	Kurtosis	Minimum	Maximum
Course content	4.52	4.67	5.00	0.44	-0.46	-0.74	3.33	5.00
Course structure and delivery	4.02	4.00	4.00	0.52	-0.15	0.78	2.25	5.00
Collaborative engagement	3.68	3.80	4.00	0.58	-0.25	0.28	2.00	5.00
Learner facilitation	4.01	4.00	4.00	0.41	0.41	-0.18	3.25	5.00
Assessment and evaluation	4.01	4.00	4.14	0.50	0.08	-0.67	2.86	5.00

3.5. Analysis of the assessment categories and modes

When considering the assessments, most staff members (89%) preferred a mix of individual and group assessments and 9% preferred individual assessments. The percentage of the staff members who preferred to give group assessments was 1%. Also, the same percentage of staff members preferred to give individual and project-based assessments. Figure 5 shows the preferable assessment categories of the participants. Among the assessment modes, 86% of the participants used both online and offline modes, 9% were using only online, and 5% were using only offline. Figure 6 represents the preferable assessment modes of the participants.

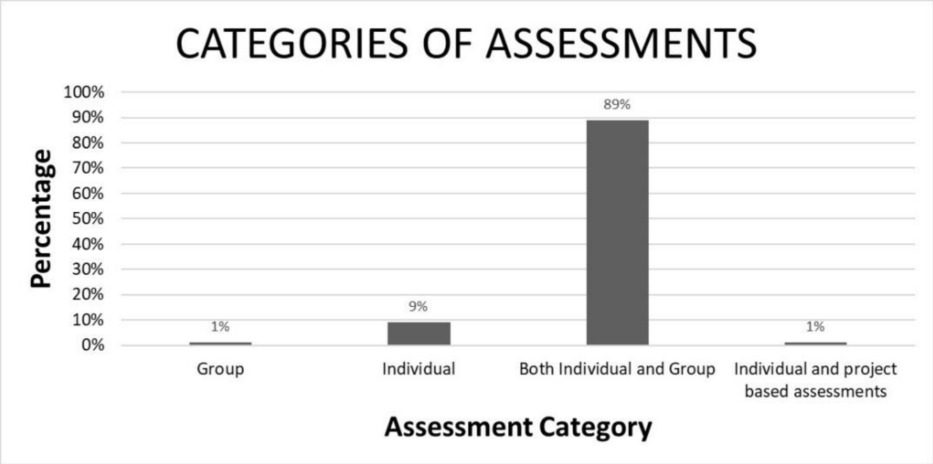

Figure 5. Preference for assessment categories

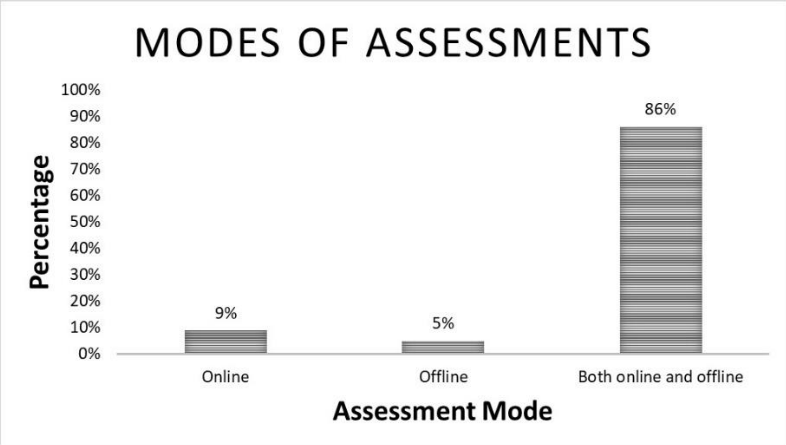

Figure 6. Preference for assessment modes

3.6. Reliability analysis of the questionnaire

Reliability analysis was performed to check the internal consistency of the questionnaire. For this research, the internal consistency of the questionnaire was measured using CA coefficient. For a reliable questionnaire, CA coefficient should be greater than 0.7. When CA coefficient lies between 0.6 to 0.7, the internal consistency of the questionnaire is also acceptable [27], [32], [33]. According to this analysis, CA coefficient for the overall questionnaire was 0.926, which shows a highly reliable result for all 27 items. Not only for the whole questionnaire but also the reliability was checked for each construct and dimension separately. Among the five constructs, one was subdivided into two dimensions, and the other was subdivided into three. Initially, CA coefficient for the first construct, 'course content', was 0.674, giving an acceptable result for four items. According to the reliability statistics, when item A1Q4 is deleted, CA coefficient could be increased to 0.760 for three items. To get a more reliable result, the analysis was performed again by removing A1Q4. Since CA value was greater than 0.7, it gave a reliable result [34].

Then, the reliability analysis was performed for the second construct, 'course structure and delivery'. The CA coefficient for 'course structure and delivery' was 0.752 for four items which showed a reliable result. 'Collaborative engagement' contained two dimensions; 'learner-peer collaboration' and 'learner-content collaboration'. The CA coefficient for 'learner-peer collaboration' was 0.824 (for three items) and showed a reliable result. Initially, CA coefficient for 'learner-content collaboration' was 0.619 (for three items), which showed an acceptable level of reliability. However, CA could be increased to 0.746 by removing A3Q6. Therefore, that item was removed from the construct.

Then CA coefficient was checked for the construct 'learner facilitation', and it was 0.609 for the four items, which was acceptable. However, increasing CA further was impossible by deleting any item. Therefore, 'learner facilitation' was kept with CA coefficient of 0.609 with the justification of 0.6 CA is acceptable [27], [33]. The last construct was 'assessment and evaluation' with three sub-dimensions; 'assessment instructions', 'evaluation criteria' and 'feedback'. The CA coefficient for 'assessment instructions' was 0.671, which gave an acceptable level of reliability. However, the reliability could be increased up to 0.744 by removing item A5Q2. Therefore, A5Q2 was removed and not considered for further analysis. For 'evaluation criteria', CA was 0.719, and for 'feedback', it was 0.703, which shows reliable results for all. The summary of the findings is represented in Table 4.

Table 4. Summary of the reliability analysis

Construct	Dimension	CA	Reliability level	Remaining items	Remarks
Course content	-	0.760	Reliable	A1Q1, A1Q2, A1Q3	Removed A1Q4 to increase reliability
Course structure and delivery	-	0.752	Reliable	A2Q1, A2Q2, A2Q3, A2Q4	-
Collaborative engagement	Learner-peer collaboration	0.824	Reliable	A3Q1, A3Q2, A3Q3	-
	Learner-content collaboration	0.746	Reliable	A3Q4, A3Q5	Removed A3Q6 to increase reliability
Learner facilitation	-	0.609	Acceptable	A4Q1, A4Q2, A4Q3, A4Q3	-
Assessment and evaluation	Assessment instructions	0.744	Reliable	A5Q1, A5Q3, A5Q4	Removed A5Q2 to increase reliability
	Evaluation criteria	0.719	Reliable	A5Q5, A5Q6, A5Q7	-
	feedback	0.703	Reliable	A5Q8, A5Q9	-

In this research instrument, for every construct, CA coefficient values were higher than 0.7, except for 'learner facilitation'. It had a CA coefficient value of 0.609, which lies between 0.6 and 0.7 and gives an acceptable reliability level. Therefore, the internal consistency of the questionnaire is acceptable, and the reliability is acceptable. Additionally, by looking at the results, it was possible to say that the research tool would give credible results in further analysis. In summary, by considering the reliability analysis, items A1Q4, A3Q6 and A5Q2 were removed from the survey instrument, and only 24 were considered for further analysis.

3.7. Testing for validity of the questionnaire

The face validity of the questionnaire was done at the beginning. The questionnaire was face-validated by three subject-related experts. The expert comments were addressed before distributing the questionnaire to the academic staff. The construct validity of the questionnaire was tested using the factor analysis method. Under factor analysis, the dimension reduction method was performed with principal component analysis (PCA) and Varimax rotation. In the dimension reduction, the factor loadings of each item were checked in the component matrix generated by the statistical software tool. The factor reduction was performed by considering the factor loading of the items. When checking for factor loadings, to accept a particular factor for the newly developed items, the factor loading value needed to be greater than 0.5 [35]–[37].

When considering the construct 'course content', dimension reduction was performed for three items as item A1Q4 was removed in the reliability analysis. The factor loadings of all the items in 'course content' were greater than 0.5. Therefore, all three factors were taken into consideration for further analysis. Then, the same function was performed on the items in the second construct, 'course structure and delivery,' with four items. Since all the factors had factor loading values greater than 0.5, no items/factors were removed from the construct. The next set of items was in 'learner-peer collaboration' under 'collaborative engagement', and three were there to apply dimension reduction. The items had factor loading values greater than 0.5. The other two items under 'collaborative engagement' in the 'leaner-content collaboration' category also had a factor loading greater than 0.5.

The next construct was 'learner facilitation', and the factor loading values of all four items were greater than 0.5. Therefore, all the items in 'learner facilitation' was taken for further analysis. The last construct was 'assessment and evaluation', which contained three categories; 'assessment instructions' (3 items), 'evaluation criteria' (3 items) and 'feedback' (2 items). After performing dimension reduction for the three categories, all the items had factor loading values greater than 0.5. Since all the items had factor loading values greater than 0.5 when performing dimension reduction, the research tool was considered a 'valid tool' for further analysis. The summary of the dimension reduction is shown in Table 5.

Table 5. Summary of the dimension reduction process

Construct	Dimension	Items	Factor loading
Course content	-	A1Q1	0.891
		A1Q2	0.788
		A1Q3	0.783
Course structure and delivery	-	A2Q1	0.864
		A2Q2	0.686
		A2Q3	0.810
		A2Q4	0.696
Collaborative engagement	Learner-peer collaboration	A3Q1	0.931
		A3Q2	0.837
		A3Q3	0.819
	Learner-content collaboration	A3Q4	0.893
		A3Q5	0.893
Learner facilitation	-	A4Q1	0.637
		A4Q2	0.661
		A4Q3	0.759
		A4Q4	0.703
Assessment and evaluation	Assessment instructions	A5Q1	0.844
		A5Q3	0.769
		A5Q4	0.828
	Evaluation criteria	A5Q5	0.874
		A5Q6	0.766
		A5Q7	0.780
	Feedback	A5Q8	0.879
		A5Q9	0.879

3.8. Exploratory factor analysis

In the questionnaire, since the factors were identified from the literature in different contexts, EFA was performed to determine whether the identified factors existed in the Sri Lankan context. When considering the constructs, course content, course structure and delivery, collaborative engagement and learner facilitation, no emerging factors could be identified by EFA. However, emerging factors related to the Sri Lankan higher educational context could be identified when performing EFA for the construct, assessment and evaluation.

Eight items remained in the construct ‘assessment and evaluation’, and EFA was performed on those eight items. The components were allowed to evolve with eigenvalues. The analysis was performed using Varimax rotation with Kaiser normalization and PCA extraction. Two components were extracted according to the ‘total variance explained’ matrix when the components were allowed to evolve with eigenvalues. The eigenvalues of the two components were greater than 1. Therefore, the construct was able to be subdivided into two components. According to the rotated component matrix, A5Q1, A5Q3, A5Q4, and A5Q5 were formed into one component and A5Q7, A5Q8, and A5Q9 were formed into another component. All had factor loading values greater than 0.5 within their component.

Item A5Q6 had a factor loading greater than 0.5 within both components. However, it was identified as a cross-loaded item as the difference between the factor loadings is less than 0.1 [38], [39], and the difference was 0.034. Therefore, A5Q6 was removed from the research tool. The rotated component matrix of the construct assessment and evaluation is shown in Table 6. According to the literature, the two components were named ‘assessment guidance’ and ‘assessment evaluation’. The items A5Q1, A5Q3, A5Q4 and A5Q5 were highly discussed when providing assessment guidance. The items A5Q7, A5Q8 and A5Q9 were highly discussed and related when evaluating the assessments.

Table 6. The rotated component matrix in EFA-assessment and evaluation

Item	Component 1	Component 2
A5Q4	0.850	
A5Q3	0.764	
A5Q5	0.619	
A5Q1	0.603	
A5Q6	0.570	0.536
A5Q9		0.904
A5Q7		0.701
A5Q8		0.658

3.9. Confirmatory factor analysis

After performing EFA, the emerging model contained five constructs, and one was subdivided into two dimensions. Table 7 shows the emerging factors included in the final dataset. The model was analyzed as a reflective-formative higher-order model. The constructs ‘course content’, ‘course structure and delivery’, 'collaborative engagement', 'learner facilitation', 'assessment guidance' and 'assessment evaluation' were considered lower-order. The constructs 'assessment and evaluation' and 'aspects on course design' were considered higher-order constructs. All the indicators were reflective, and the constructs were formative. Figure 7 shows the emerging model after performing EFA. The repeated indicators approach was used to model the constructs and indicators. In the repeated indicators approach, the factors of all the associated first-order constructs are repeated in the particular second-order construct [40]. The measurement model, or the outer model, was analyzed to assess the quality of the constructs. When assessing the outer model, it measures the contribution of each indicator with its associated construct [40].

Table 7. Emerging factors in the final dataset

Construct	Dimension	Items	Number of items
Course content	-	A1Q1, A1Q2, A1Q3	3
Course structure and delivery	-	A2Q1, A2Q2, A2Q3, A2Q4	4
Collaborative engagement	-	A3Q1, A3Q2, A3Q3, A3Q4, A3Q5	5
Learner facilitation	-	A4Q1, A4Q2, A4Q3, A4Q4	4
Assessment and evaluation	Assessment guidance	A5Q1, A5Q3, A5Q4, A5Q5	4
	Assessment evaluation	A5Q7, A5Q8, A5Q9	3

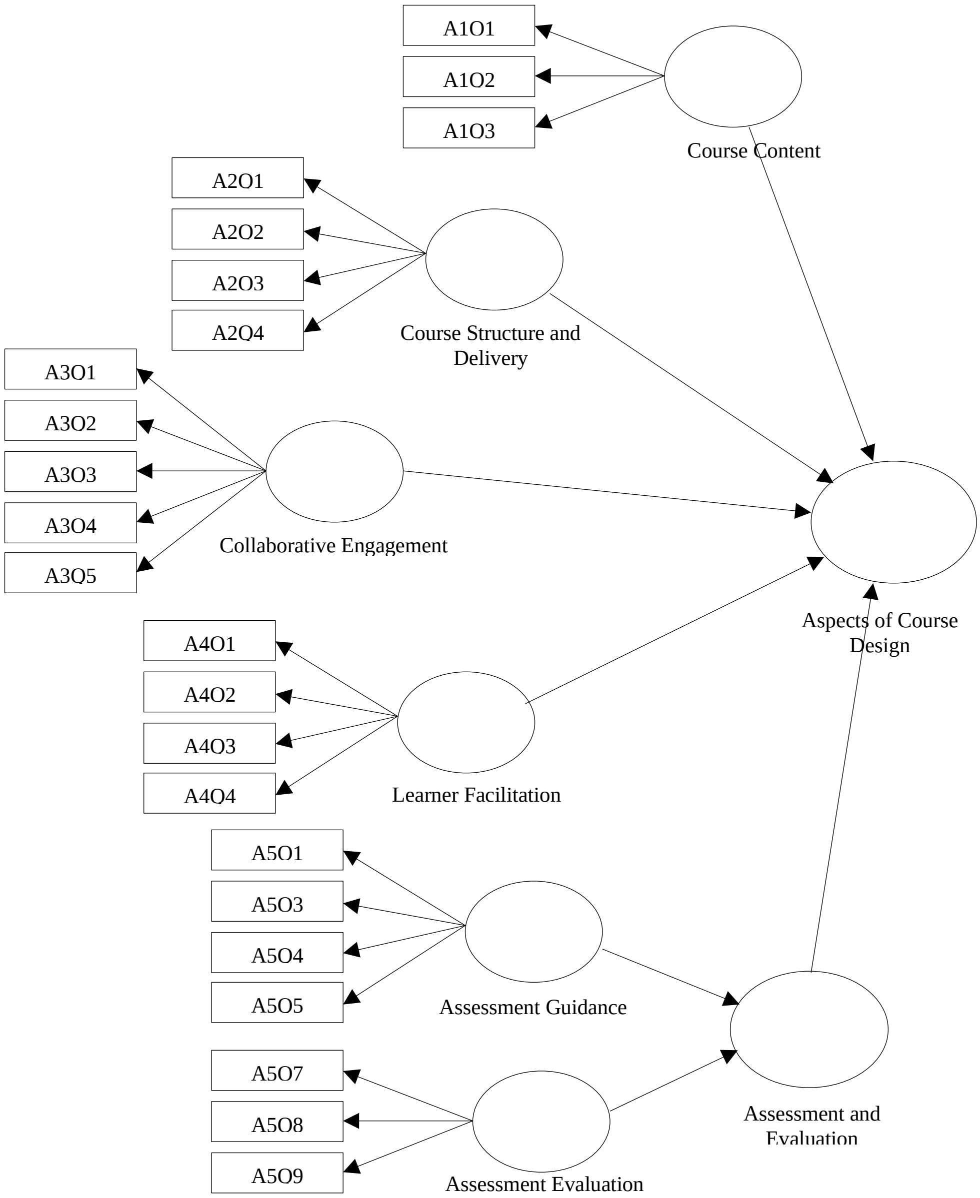

Figure 7. Emerging model after performing EFA

In the outer model assessment, first, the factor loadings of the items were checked to assess the indicator reliability. The threshold value was taken as 0.5. As the first step, the indicators were removed with low factor loading values one by one. In each step, the reliability and validity of the tool were checked. According to the statistics, the factor loadings of all the items were greater than 0.5 except for item A2Q1. It has a factor loading value of 0.442, less than the threshold value. However, when considering all the other criteria in the optimum situation, all were acceptable. Therefore, it was decided to keep item A2Q1 without deleting it. The factor loadings of the items in the optimum model are listed in Table 8.

In CFA, the constructs were evaluated for internal consistency/reliability, convergent validity and divergent validity, as the model was a reflective outer model [40]. The reliability analysis was done to check the internal consistency using CA coefficient and CR. For a reliable instrument, both values should be greater than 0.7 [27], [41], [42]. According to the statistics, all the constructs' CA values were greater than 0.7 except for the construct course structure and delivery. However, CA value of 'course structure and delivery' was 0.663 and considered acceptable. Therefore, the research instrument was considered a reliable survey tool. The reliability statistics in the optimum model are represented in Table 9.

The convergent validity was checked using the AVE value. To achieve convergent validity of the instrument, the AVE value is required to be greater than 0.5. Further, the literature explains that if the CR of a particular construct is greater than 0.6, the AVE greater than 0.4 is also acceptable [43] to achieve the required convergent validity. According to this dataset, the convergent validity was acceptable only for 'collaborative engagement' and 'learner facilitation'. For other constructs, the convergent validity was adequate. Table 10 shows the convergent validity statistics in the optimum model.

The divergent validity was checked using Fornell and Larcker criterion, Cross-loadings and Heterotrait-Monotrait ratio. To satisfy the Fornell and Larcker criterion, the diagonal values (the square root of AVE of the particular construct) in the matrix should be greater than the values listed below in the same column (correlation with the other dimensions). For a valid questionnaire, cross-loadings should not have appeared. The loading of a particular item on the parent construct should be higher than the other constructs, and the difference should be greater than 0.1 between the item's factor loadings [38], [39]. To satisfy the Heterotrait-Monotrait ratio in the matrix, the correlation values should be less than 0.9 [27]. Table 11 shows the divergent validity results of the optimum model. According to the Fornell and Larcker criterion, all the diagonal values in the matrix were greater than the values listed below. Also, there were no Cross-loadings among the items. The correlation values were less than 0.9 in the matrix, which was at the acceptable level of the Heterotrait-Monotrait ratio. Therefore, it is possible to conclude that the divergent validity is also acceptable in the optimum outer model.

Table 8. Factor loading of the items in the lower-order constructs in the optimum outer model

Lower-order constructs	Items	Factor loading
Course content	A1Q1	0.802
	A1Q2	0.669
	A1Q3	0.615
Course structure and delivery	A2Q1	0.442
	A2Q2	0.578
	A2Q3	0.511
	A2Q4	0.706
Collaborative engagement	A3Q1	0.554
	A3Q2	0.639
	A3Q3	0.704
	A3Q4	0.855
	A3Q5	0.772
Learner facilitation	A4Q2	1.000
Assessment guidance	A5Q1	0.682
	A5Q3	0.547
	A5Q4	0.596
	A5Q5	0.716
Assessment evaluation	A5Q7	0.628
	A5Q8	0.812
	A5Q9	0.583

Table 9. Reliability statistics in the optimum outer model

Constructs	-	CA	CR	Reliability level
Course content	-	0.727	0.740	Reliable
Course structure and delivery	-	0.663	0.649	Acceptable
Collaborative engagement	-	0.839	0.835	Reliable
Learner facilitation	-	1.000	1.000	Reliable
Assessment and evaluation	Assessment guidance	0.737	0.732	Reliable
	Assessment evaluation	0.708	0.718	Reliable

Table 10. Convergent validity statistics of the optimum outer model

Constructs		AVE	Remarks
Course content	-	0.489	Convergent validity is adequate since the relevant CR value is greater than 0.6.
Course structure and delivery	-	0.322	Convergent validity is adequate since the relevant CR value is greater than 0.6.
Collaborative engagement	-	0.508	Convergent validity is acceptable.
Learner facilitation	-	1.000	Convergent validity is acceptable.
Assessment and evaluation	Assessment guidance	0.408	Convergent validity is adequate since the relevant CR value is greater than 0.6.
	Assessment evaluation	0.464	Convergent validity is adequate since the relevant CR value is greater than 0.6.

Table 11. Divergent validity results of the optimum outer model

Constructs		Fornell and Larcker criterion	Cross loading	Heterotrait-Monotrait ratio	Remarks
Course content Course structure and delivery Collaborative engagement Learner facilitation Assessment and evaluation	- - - - Assessment guidance Assessment evaluation	The diagonal values in the matrix are greater than the values listed below in the same column	No cross-loadings	The correlation values are less than 0.9 in the matrix	Divergent validity is acceptable

3.10. Testing for multicollinearity issues

The model was then tested for multicollinearity issues using the variance inflation factor (VIF). If the VIF value is greater than 5, multicollinearity issues can occur within the constructs [40]. According to the statistics, the outer VIF values of the indicators ranged from 1.000 to 2.584. The inner VIF values of the constructs ranged from 1.513 to 2.514. Therefore, it is possible to say that there are no multicollinearity issues in the model.

3.11. Significance of the aspects of course design

The model was then tested to identify the significance of the aspects of course design. Consistent PLS bootstrapping was used with 5,000 sub-samples to generate the final output. According to the statistics, all the indicators were significant. The most significant aspect of the course design was ‘assessment and evaluation’. The path coefficient of ‘assessment and evaluation’ was 0.636 with a significance value of 0.03, less than the threshold p-value of 0.05 [43], [44]. The T-value of the construct was 2.172, which was greater than the threshold T-value of 1.96 [44]. The other constructs have not achieved the required significant level based on the P-values and T-values. Table 12 shows the corresponding path coefficients, P-Values and T-values of the constructs of aspects of course design.

Table 12. Path coefficients, p-values and T-values of the constructs of aspects on course design

Constructs	Path coefficient	T-value	P-value
Course content	0.111	0.263	0.793
Course structure and delivery	0.288	0.246	0.806
Collaborative engagement	0.322	0.403	0.687
Learner facilitation	0.008	0.032	0.974
Assessment and evaluation	0.636	2.172	0.030

4. CONCLUSION

This research was carried out to identify the most significant aspects of course design in a blended environment. According to the literature, the aspects of course design were identified as course content, course structure and delivery, collaborative engagement, learner facilitation and assessment and evaluation. Further, collaborative engagement was subdivided into learner-peer collaboration and learner-content collaboration. The aspect, assessment and evaluation, was subdivided into assessment instructions, evaluation criteria and feedback. A survey questionnaire was developed using the operationalization table to be distributed among the academic staff in the departments conducting degree programs in the computing discipline. A pilot survey was conducted, and the responses were used to assess the reliability and validity of the questionnaire. The EFA was carried out to determine whether there are any emerging factors in the Sri Lankan undergraduate context. The emerging model was created using the final dataset. CFA was used further to assess the reliability and validity of the questionnaire. The significance of the course design elements was then assessed using path coefficients and the significant level of the constructs. According to the path coefficients of the construct, assessment and evaluation was the most crucial aspect of course design in the Sri Lankan undergraduate context. However, since literature has revealed that the other aspects are also imperative in blended course designing, educational specialists must consider them also when designing courses for undergraduates. Further, the research findings provide valuable insights for guiding course designers to design undergraduate blended courses by identifying the significance of the course design aspects.

There are several limitations of this research. This was conducted with the academic staff in the computing discipline. In addition, the data were collected only from Sri Lankan state universities for the survey. Therefore, as future work, this research can be expanded for other disciplines beyond the computing discipline to produce more generalizable results. Further, many private universities currently offer undergraduate degree programs in the computing discipline. Therefore, this study can also be expanded to analyze data from other universities also.

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