CHAPTER IV

ANALYSIS OF THE DATA

This study was conducted according to the following research objectives: 1) To identify and analyze factors related to the virtual classroom environment design for project-based learning in higher education, 2) To design the virtual classroom environment for project-based learning, and 3) To propose a virtual classroom model for project-based learning in higher education.

In this chapter, the findings are divided into three phases:

Phase 1: Analysis of factors related to virtual classroom environment design for project-based learning in higher education. The factors finding from the experts were presented.

Phase 2: Designing of an online project-based learning for virtual classroom environment by adopting the identified factors from phase 1. In this phase, the findings are organized around six categories:

1) Personal information about the subjects,

2) Description of subjects' opinions about factors affecting learning achievement in virtual classrooms,

3) Comparisons of the effects of virtual classroom environments on learning achievement and team learning skills,

4) Factor analysis of the design of virtual classroom environments,

5) Comparisons of the effects of group size on learning achievement and team learning skills by using one-way analysis of variance, and

6) Analysis of the relationship between learning achievement and team learning skills and the factors affecting the design of virtual classroom environments.

Phase 3: Proposing of a model of virtual classroom environment design for project-based learning in higher education.

PHASE 1: ANALYSIS OF FACTORS RELATED TO VIRTUAL CLASSROOM ENVIRONMENT DESIGN FOR PROJECT-BASED LEARNING IN HIGHER EDUCATION.

The factors affecting virtual classroom environment design were surveyed and evaluated by five experts. The results from the first round are shown in Table 8.

Table 8 Expert review results

List of factors	Frequency (Total no.= 5)
Learner factors	
1. Cognitive styles	2
2. Learning style	3
3. Self-directed learning	3
4. Internet ability	1
5. Intrinsic control	1
6. Online experience	2
7. Previous knowledge	0
8. Psychosocial Traits	1
9. Gender, age , and racial group	1
10. Identification with course goals (new item)	1
Pedagogy and instructional design factors	
1. Interactive design	2
2. Interface design	2
3. Content design	3
4. Usability design	2
5. Accessibility and responsiveness	2
6. Feedback quality	2
7. Instructor experience	3
8. Assessment	2
9. Activity design (new item)	2
Environment and community of learners factors	
1. Community tools	2

Table 8 (Continue)

List of factors	Frequency (Total no.= 5)
2. Online student support	3
3. Learning resource	2
4. Availability of instructors	4
5. Quality technology	2
6. Orientation to course	2
7. Accessibility to hardware and software	2
8. Clearly defined written instructions	1
9. Flexible synchronous / asynchronous communication	1
10. Positive interaction between instructor and learner	4
11. Maintain online website/resources	2
12. Formal and informal social activities and interaction	1
13. scaffolding	4
Group dynamic and peer impact	
1. Team interaction	3
2. Team leadership	3
3. Task clarity	3
4. Strength of peer cooperation	3
5. Group size	4

Following the expert review, the number of factors to be included in the second online questionnaire was reduced from 37 to 29. Factors not checked by two of more experts were removed from the list while all new factors recommended by experts were added. In the second round online questionnaire, experts were asked to rate the factors. The results are as follows:

Table 9 Rating factors from expert review results

List of factors	$\bar{x}$	S.D.
Learner factors		
1. Cognitive Style	2.00	0.000
2. Learning style	3.00	0.816
3. Self-directed learning	3.75	1.258
4. Online experience	3.00	1.155
5. Identification with course goals	3.25	0.957
Pedagogy and instructional design factors		
6. Interactive design	4.50	0.577
7. Interface design	4.00	0.000
8. Content design	4.00	0.000
9. Usability design	4.00	0.000
10. Accessibility and responsiveness	4.00	0.577
11. Feedback quality	4.25	0.500
12. Instructor experience	3.75	1.258
13. Assessment	4.25	0.500
14. Activity design	4.25	0.500
Environment and Community of learners Factors		
15. Community tools	3.50	1.291
16. Online student support	3.75	0.957
17. Learning resource	3.75	0.957
18. Availability of instructors	3.50	1.291
19. Quality technology	3.50	1.000

Table 9 (Continue)

List of factors	$\bar{x}$	S.D.
20. Orientation to course	4.00	0.816
21. Accessibility to hardware and software	4.00	1.155
22. Positive interaction between instructor and learner	3.75	1.258
23. Maintain online website/resource	3.00	0.816
24. scaffolding	4.00	0.816
Group dynamic and Peer Impact		
25. Team interaction	3.00	0.000
26. Team leadership	3.50	0.577
27. Task clarity	4.25	0.500
28. Strengths of the peer cooperation	4.00	0.000
29. Group size	4.50	0.577

The expert rating in the second questionnaire helped cut down the number of factors remaining in the pool from 29 to 23. If a factor's mean was less than 3.49, it was removed from the list. Finally, the factors in this study were following.

1. Learner factors

1. Self-directed learning was the only one learner that was approved by the expert

2. Pedagogy and instructional design factors

There were nine sub-factor included in pedagogy and instructional design. The factors were following: 1) Interactive design, 2) Interface design, 3) Content design, 4) Usability design, 5) Accessibility and responsiveness, 6) Feedback quality, 7) Instructor experience, 8) Assessment, 9) Activity design.

3. Environment and community of learner factors

There were nine sub-factors in environment and community of learner. The sub-factors were following: 1) Community tools, 2) Online student support, 3) Learning resource, 4) Availability of instructors, 5) Quality technology, 6) Orientation

to course, 7) Accessibility to hardware and software, 8) Positive interaction between instructor and learner, and 9) scaffolding.

4. Group dynamic and peer impact

There were five sub-factor in group dynamic and peer impact factor: 1) Team leadership, 2) Task clarity, 3) Strengths of the peer cooperation, and 4) Group size.

PHASE 2: TO DESIGN BY IMPLEMENTING FACTORS IN ONLINE PROJECT-BASED LEARNING IN HIGHER EDUCATION

In this phase, the findings were conduct from 349 subjects. The details are as follows.

2.1 Personal information of the subjects

Table 10 Percentage of Internet competency of subjects

Items	Frequency	Percentage
Excellent	32	9.2
Good	177	50.7
Moderate	140	40.1
Total	349	100.0

Half of the subjects had internet competency rated good (50.7%) while only nine point two percent of the subjects ranked excellent in Internet competency. See table 10 for details.

Table 11 Percentage of experiences in project-based learning of subjects

Project-based learning experience	Frequency	Percentage
Yes	189	54.2
Little (taken 1-2 courses)	117	61.9
Moderate (taken 3-5 courses)	52	27.5
Much (taken more than 5 courses)	20	10.6
No	160	45.8
Total	349	100.0

There were fifty-four point two percent of the subjects had some experienced in project-based learning prior to this study. Of those, there were sixty-one point nine percent of the subjects had less experienced one or two courses and ten point six percent of subject reported they had experienced more than five courses. Those with no experience in project-based learning composed forty five point eight percent of the subjects. See table 11 for details.

Table 12 Percentage on preference and reasons to have team learning activities in virtual classroom

Team learning on the web	Frequency	Percentage
Yes	293	83.9
Sharing vision, knowledge, and skills to make quality projects.	159	54.3
Team learning practice	30	10.2
Making new friends	21	7.2
Sharing responsibilities	70	23.9
Working faster	5	1.7
Learning from team members	7	2.4
Monitoring progress of team members	1	0.3

Table 12 (Continue)

Team learning on web	Frequency	Percentage
No	56	16.1
Prefer not to work as a team because it is more difficulties than individual learning	16	28.5
Does not like to work with a team	15	26.8
Team members have different schedules	9	16.0
A lack of trust between team members	7	12.5
More responsibility	2	3.6
A lack of internet ability	2	3.6
They have limited access to a computer	2	3.6
Prefer to work with team face-to-face	1	1.8
A risk of failure to finish project because team members do not complete their work	1	1.8
Can not motivate themselves to learn or work on the web	1	1.8
Total	349	100.0

There were eighty-three point nine percent of subjects reported that they prefer to do team learning activities in virtual classroom over individual learning on the web. The main reason given (54.3%) is because the students can share vision, knowledge, and skills to make quality projects. Only one person likes Web-based team learning because his can monitor his teammates' progress.

The subjects who said they do not prefer team learning on the web totaled sixteen point one percent. Team learning creates more difficulties than individual learning was the number one reason given (28.5%). A surprising finding was that sixteen point four percent of the subjects who did not appreciate team learning in virtual classroom felt that it was difficult to maintain contact with other members. In fact, virtual classroom were designed to solve this problem. See table 12 for further details about the reasons for liking and not liking team learning in the virtual classroom.

details about the reasons for liking and not liking team learning in the virtual classroom.

2.2 Descriptions of subject's opinions about factors affecting learning achievement in virtual classroom

Table 13 Mean and standard deviation of subjects' opinions about how characteristics of self-directed learning affect learning achievement in virtual classrooms.

Items	$\bar{x}$	S.D.	Meaning
Learning need assessments ability for myself	3.96	.568	Agree
Ability to select the way to learn for supported learning outcome	3.99	.582	Agree
Ability to control myself to join with learning activity.	3.90	.664	Agree
Ability to choose or plan to learn by myself	3.98	.674	Agree
Total	3.96	.466	Agree

Of all the learner factors found in the survey of the previous research, the experts, only approved self-directed learning. The subjects reported that self-directed learning was the most influential factor in learning achievement and team learning ($\bar{x} = 3.96$). See table 13 for details.

Table 14 Mean and standard deviation of subject in pedagogy and instructional design variables affecting in learning achievement in virtual classroom

Items	$\bar{x}$	S.D.	Meaning
Interactive design	*3.97*	*.543*	*Agree*
Interactive lesson to encourage learning outcome	4.00	.764	agree
Having a pool of quizzes for learning outcome evaluation	4.12	.741	Agree
Excellent virtual classroom that can chose the best lesson level for learners after a pre-test	4.07	.657	Agree
Synchronous communication, such as instant messaging, with instructors or peers	3.88	.863	Agree
Asynchronous communication, such as Web-board or E-mail, with instructors or peers	3.84	.893	Agree
Able to download needed programs, lessons and so on from the virtual classroom	3.93	.797	Agree
Interface design	*4.05*	*.529*	*Agree*
Fantastic screen design	3.94	.759	Agree
Suitability of text attributes such as color, size, or type	4.18	.691	Agree
Consistency of color in virtual classroom	3.98	.748	Agree
Hyperlinks clearly show what information they connect to	4.11	.708	Agree
The buttons in the virtual classroom clearly show what function they perform (e.g. 🖫 means save)	4.10	.778	Agree
Consistency of navigator, both of format and position	4.02	.719	Agree
Content design	*4.10*	*.524*	*Agree*
Suitable amount of content per page	4.13	.712	Agree
High-quality content such as interactive content and quizzes that support learning path	4.04	.710	Agree
Suitable color, illustrations, sound, and graphics for content design	4.09	.768	Agree
Uses a variety of media (text, graphics, audio, and video)	4.14	.735	Agree
Adequate Number of Well-constructed and varied assignments.	4.08	.736	Agree
Uses simple, clear language	4.13	.741	Agree
Content is designed for supporting different learning styles	4.10	.688	Agree

Table 14 (Continue)

Items	$\bar{x}$	S.D.	Meaning
Usability design	*4.01*	*.571*	*Agree*
Has link validity	4.09	.741	Agree
Able to connect to virtual classroom anytime and anywhere, unlimited by choice of Web browser, computer competency, or Internet speed	4.03	.780	Agree
Quality of virtual classroom tools	4.01	.771	Agree
Virtual classroom allows smooth running of learning activities.	4.04	.748	Agree
The functions in the virtual classroom are well organized	3.93	.777	Agree
Virtual classroom is interesting enough to encourage frequent connections	3.95	.768	Agree
Accessibility and responsiveness	*3.97*	*.657*	*Agree*
Accessible to people with special needs, such as someone who is deaf	3.96	.787	Agree
Has rapid respond time	3.99	.717	Agree
Feedback quality	*4.14*	*.605*	*Agree*
Given immediate and adequate feedback from instructors	4.12	.760	Agree
Prefers to get better quality of feedback than just true or false	4.21	.767	Agree
Prompt feedback	4.24	.726	Agree
Prefers to get negative feedback by e-mail, not Web-board or instant messenger	4.02	.844	Agree
Instructor experience	*4.15*	*.601*	*Agree*
Instructors have more experience in online learning	4.19	.723	Agree
Instructors have experience in online learning activities	4.06	.761	Agree
Instructors have a excellent computer skills to manage virtual classroom	4.19	.709	Agree
Assessment	*4.18*	*.588*	*Agree*
Assessment methods are valid, reliable, flexible, and fair	4.21	.728	Agree
Authentic assessments were adopt to measure learning outcome	4.20	.731	Agree
A variety of assessment methods	4.15	.691	Agree

Table 14 (Continue)

Items	$\bar{x}$	S.D.	Meaning
Activity design	*4.12*	*.565*	*Agree*
Team learning activities made me and team members work together very well	4.04	.781	Agree
Learning activities encouraged self-study	4.13	.721	Agree
Team activities with team members encourage better understanding of content.	4.14	.707	Agree
Learning activities that emphasize team learning lead to broader knowledge.	4.20	.703	Agree
Total	4.06	.454	Agree

Among a number of pedagogical and instructional design factors, assessment factors were viewed as the most influential to learning achievement and good team learning skills ($\bar{x}$ = 4.18). Instructor experience ($\bar{x}$ = 4.15) and feedback quality ($\bar{x}$ = 4.14) were the next most influential factors for learning achievement and good team learning skills. Interactive design and accessibility and responsiveness factors were the least factor influential to learning achievement and team learning skills ($\bar{x}$ = 3.97). The result of research showed that asynchronous and synchronous communication with instructors or peer were the least influential sub-factors to success in virtual classrooms ($\bar{x}$ = 3.84, $\bar{x}$ = 3.88). This result is a surprising finding. See table 14 for details.

Table 15 Mean and standard deviation on subjects' opinions about environment and community of learner variables learning achievement in virtual classrooms

Items	$\bar{x}$	S.D.	Meaning
Community tools	*4.18*	*.657*	*Agree*
Multiple contact methods (mail, phone, etc.)	4.20	.778	Agree
Ease of use of communication tools	4.17	.715	Agree
Online student support	*4.01*	*.650*	*Agree*
Instructors or tutors offer support when problems are encountered	4.12	.775	Agree
FAQ function helps solve problems	3.91	.746	Agree
Learning resources	*4.19*	*.584*	*Agree*
A lot of information sources available	4.16	.795	Agree
Variety of information sources available	4.21	.738	Agree
Easier to access information sources in virtual classroom than traditional classroom	4.23	.735	Agree
Unlimited access to information sources	4.17	.741	Agree
Availability of instructors	*4.13*	*.651*	*Agee*
Reassurance and encouragement of instructor anytime, anywhere	4.12	.767	Agree
Clearly time schedule or study time timetables of instructors	4.15	.743	Agree
Quality technology	*4.09*	*.665*	*Agree*
High-speed Internet	4.07	.845	Agree
Good quality hardware	4.17	.749	Agree
Able to download programs and lessons is quickly	4.05	.795	Agree
Orientation to course	*4.12*	*.577*	*Agree*
I knew the learning objectives and how to function in virtual classrooms before the class started	4.13	.712	Agree
Learning guidance and support allow me success in virtual classroom	4.12	.728	Agree
Possesses minimum degree of computer competency and prerequisite skills and knowledge before the class started	4.17	.706	Agree
In case of difficulties, help is available	4.08	.735	Agree

Table 15 (Continue)

Items	$\bar{x}$	S.D.	Meaning
Accessibility to hardware and software	*4.02*	*.637*	*Agree*
Adequate hardware for learner	4.01	.846	Agree
Reliability of software	4.02	.756	Agree
Needed accessory programs, such as Adobe Reader, can be downloaded directly from virtual classroom	4.05	.753	Agree
Positive interaction between instructor and learner	*4.20*	*.637*	*Agree*
I prefer to have positive interactions with instructor	4.24	.707	Agree
I prefer to talk with instructors in informal manner	4.17	.716	Agree
Scaffolding	*4.13*	*.673*	*Agree*
Adequate navigator to identify the current position in a course	4.11	.753	Agree
Clear menu structure to guide learner if they lose the way	4.16	.734	Agree
Total	4.12	.488	Agree

Out of all number the environment and community of learner factors, positive interaction between instructor and learner ($\bar{x}$ = 4.20) had the greatest influenced toward success in learning achievement and team learning. Learning resources ($\bar{x}$ = 4.19) and community tools ($\bar{x}$ = 4.18) were the next most influential sub-factor, while the results showed that accessibility to hardware and software ($\bar{x}$ = 4.02) was the least factor influential sub-factor learning achievement and team learning skills. See table 15 for details.

Table 16 Mean and standard deviation on subject's opinions about team dynamics and peer impact variables affecting learning achievement in virtual classrooms

Items	$\bar{x}$	S.D.	Meaning
Team leadership	*4.16*	*.571*	*Agree*
Team leader needs to be able to guide team member to work together	4.20	.716	Agree
Team leader needs to be able to resolve internal conflicts	4.14	.730	Agree
Team leader needs to be able to manage team members' time schedules.	4.15	.694	Agree
Team members can trust each other; especially the team leader	4.19	.717	Agree
Task clarity	*4.21*	*.626*	*Agree*
Team members understand the goals and feeling committed to them	4.21	.741	Agree
Team members take responsibility for their tasks	4.20	.766	Agree
Teams with members having varied skills are more efficient at projects	4.20	.716	Agree
Strengths of peer cooperation	*4.15*	*.675*	*Agree*
Team members have strong shared responsibility	4.17	.738	Agree
Team members transfer or share knowledge to one another	4.12	.761	Agree
Total	4.17	.552	Agree

Of the group dynamics and peer impact factors, task clarity ($\bar{x}$ = 4.21) was the sub-factor subjects' viewed most strongly as leading to success in learning achievement and team learning skills. Strength of peer cooperation ($\bar{x}$ = 4.15) and team leadership ($\bar{x}$ = 4.16) were the next most influential factors. See table 16 for details.

Table 17 Mean and standard deviation on subject's opinions about the principal factors affecting learning achievement in virtual classrooms

Items	$\bar{x}$	S.D.	Meaning
Learner factors	3.95	.466	Agree
Pedagogy and instructional design factors	4.06	.454	Agree
Environment and community of learner factors	4.12	.488	Agree
Group dynamics and peer impact factors	4.17	.552	Agree

Group dynamics and peer impact factors ($\bar{x}$ = 4.17) were viewed as the most influential to success in learning achievement and team learning followed by environment and community of learner factors ($\bar{x}$ = 4.15), Pedagogy and instructional design variables ($\bar{x}$ = 4.06), and learner variable ($\bar{x}$ = 3.95) were the next factor influenced subjects to success in learning achievement and team learning. See table 17 for details.

2.3 Comparison of the effects of virtual classroom environments on learning achievement and team learning skills

In this section, the data analyses show how the virtual classroom environment changed subjects' learning achievement and team learning skills.

Table 18 Comparison of the effect of virtual classroom environments upon the learning achievement by using t-test

Learning achievement	Pre-test		Post-test		t-test	P
	Mean	S.D.	Mean	S.D.		
Pre-test – Post-test	7.31	2.670	11.99	3.175	-24.201	.000

P<.05

The results of this study show that there are significant differences on the learning achievement before and after using the virtual classroom environment. See table 18 for details.

Table 19 Comparison of the effect of virtual classroom environments upon the learning achievement by using t-test

	Pre-test		Post-test		t-test	P
	Mean	S.D.	Mean	S.D.		
Pre-test – Post-test	2.39	.225	2.53	.233	-9.478	.000

P<.05

The results of this study showed that there are significant differences oin team learning skills before and after using the virtual classroom environment. See table 19 for details.

2.4 Factor analysis of the design of virtual classroom environments.

To identify the factor structure, an analysis was conducted on the rating of the factors. The results helped categorize the factors affecting virtual classroom environment design.

Prior to the factor analysis, Kaiser-Meyer-Olkin was used to examine the data. The results are shown in table 20.

Table 20 Measurement of sampling adequacy for factor analysis by using the Kaiser-Meyer-Olkin (KMO)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.957
Bartlett's Test of Sphericity	Approx. Chi-Square	5412.414
	df	276
	Sig.	.000

The KMO index of 0.957 indicates that the correlation matrix is suitable for factor analysis.

Table 21 Factor loadings of the virtual classroom environment factors (factor loading = 0.4)

	LF*	PID*	ECL*	GPI*	Factor			
					1	2	3	4
Interface design		✓			**.747**	.272	.234	.053
Content design		✓			**.728**	.427	.253	.049
Usability design		✓			**.723**	.395	.259	.034
Interaction design		✓			**.660**	.325	.203	.043
Accessibility and responsiveness		✓			**.570**	.376	.160	.023
Assessment		✓			**.508**	.501	.254	.054
Feedback quality		✓			**.454**	.416	.364	.153
Instructor experience		✓			**.428**	.425	.350	.132
Self-directed learning	✓				.367	.162	.206	.014
Orientation to course			✓		.409	**.637**	.334	.132
Positive interaction between instructor and learner			✓		.220	**.624**	.356	.010
Accessibility to hardware and software			✓		.337	**.611**	.268	-.099
Scaffolding			✓		.331	**.583**	.258	.090
Quality technology			✓		.417	**.573**	.151	-.066
Availability of instructors			✓		.367	**.554**	.238	.042
Learning resource			✓		.403	**.545**	.337	.071
Community tools			✓		.444	**.504**	.248	.061
Online student support			✓		.428	**.495**	.254	.047
Activity design		✓			**.439**	.472	.283	.070
Strengths of the peer cooperation				✓	.281	.326	**.742**	.114
Team leadership				✓	.314	.318	**.729**	.017
Task clarity				✓	.277	.348	**.692**	-.027
Group size (medium size)				✓	.064	.012	-.011	**.789**
Group size (small size)				✓	-.019	-.033	-.065	**-.659**

Extraction Method: Maximum Likelihood.
Rotation Method: Varimax with Kaiser Normalization.
a Rotation converged in 6 iterations.

*LF = Learner factors.
PID = Pedagogy and instructional design.
ECL = Environment and community of learner.
GPI = Group dynamic and peer impact

A maximum likelihood analysis with a rotation method of Varimax with Kaiser Normalization was applied to the rating of the twenty-three items. By choosing 0 .4 as a minimal cut-off factor loading, eight items merged into the first factor, ten into the second factor, three into the third factor, and one into the last factor. Self-directed learner was disregarded because its score was lower than 0.4. See table 19 for details.

Activity design had higher factor loading in the second factor but it is concerned with pedagogy and instructional design. After analyzing activity design's fitness with the factors, a decision was made to put it in the first factors.

Based on the result, the first factor is concerned with pedagogy and instructional design variables; it was named "Pedagogy and instructional design." Pedagogy and instructional design factors are composed of the following nine sub-factors.

1) Interface design
2) Content design
3) Usability design
4) Interaction design
5) Accessibility and responsiveness
6) Assessment
7) Feedback quality
8) Instructor experience
9) Activity design

The second factor is concerned with environment and community of learner variables; it was named "Environment and community of learners." Environment and community of learners factors are composed of the following nine sub-factors:

1) Orientation to course
2) Positive interaction between instructor and learner
3) Accessibility to hardware and software
4) Scaffolding
5) Quality technology
6) Availability of instructors
7) Learning resource

8) Community tools

9) Online student support

The third factor is concerned with group relationships; it was named "Group dynamics and peer impact." Group dynamics and peer impact factors are composed of the following three sub-factors:

1) Strengths of the peer cooperation

2) Team leadership

3) Task clarity

The fourth component only emphasizes group size: it was named "Group size."

2.5 Comparison of the effect of group size on learning achievement and team learning skills by using one way analysis of variance

Table 22 ANOVA between learning achievement and group size

Group size	Sum of Squares	Df	Mean Square	F	Sig.
Between groups	64.166	2	32.083	3.225	.041
Within groups	3441.788	346	9.947		
Total	3505.954	348			

p<.05

An ANOVA test was investigated performed about how group size influenced learning achievement. The results of the ANOVA, as shown in table 21, show that there was a significant difference in learning achievement across group size.

Table 23 Post-hoc comparison test between learning achievement and group size

(I) Group size	(J) Group size	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
3-5	6-8	-1.02	.519	.148	-2.28	.24
	more than 8	-.32	.581	.924	-1.73	1.08
6-8	3-5	1.02	.519	.148	-.24	2.28
	more than 8	.69	.390	.211	-.24	1.63
more than 8	3-5	.32	.581	.924	-1.08	1.73
	6-8	-.69	.390	.211	-1.63	.24

The Post-hoc comparison analysis using Dunnett's T3 test revealed that test post-score for the medium group size (6-8 members) was higher than that among small teams and large teams, at the .05 significance level. See table 23 for details.

Table 24 ANOVA between team learning skills and group size

Group size	Sum of Squares	Df	Mean Square	F	Sig.
Between groups	.282	2	.141	2.467	.086
Within groups	19.729	345	.057		
Total	20.011	347			

p<.05

An ANOVA test was performed about how group size influenced team learning skills. The results of the ANOVA, as shown in table 24, showed that there were no significant differences in team learning skills across group size.

2.6 The relationship between learning achievement and team learning skills and the factors affecting the design of virtual classroom environments

A multiple regression analysis was performed to determine the factors that were associated with changes in learning achievement and team learning skills while subjects learned in virtual classrooms.

Table 25 The relationship between learning achievement and the factors affecting the design of virtual classroom environments

R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
				R Square Change	F Change	df1	df2	Sig. F Change	
.223(a)	.050	.039	3.112	.050	4.515	4	344	.001	1.512

The regression analysis generated a statistically significant model ($R^2 = .050$), that explained 50 percent of the variance in each factors for learning achievement. See table 25.

Table 26 The relationship between learning achievement and the factors affecting the design of virtual classroom environments.

Factors	Unstandardized Coefficients		Standardized Coefficients	t-test	Sig.
	B	Std. Error	Beta		
(Constant)	11.989	.167		71.973	.000
Pedagogy and instructional design factors	-0.67	0.234	-0.064	-0.715	.475
Environment and community of learner factors	0.177	0.255	0.068	0.695	.488
Group dynamic and peer impact factors	0.470	0.216	0.167	2.176	.030
Group size factors	0.482	.209	0.122	2.309	.022

p<.05

Table 26 summarizes the results of the regression analysis. The results of this multiple regression analysis indicate that group dynamics and peer impact factors and group size factors were significantly positively correlated with learning achievement, but pedagogy and instructional design factors and environment and community of learner factors were not significantly correlated with learning achievement. See table 26 for details.

From the result, this regression equation was created.

Learning achievement = 11.989 – 0.67 Pedagogy and instructional design factors + 0.177 environment and community of learner factors + 0.470 group dynamic and peer impact factors + 0.482 group size factors.

Table 27 The relationship between team learning skills and the factor affecting the design of virtual classroom environments

| R | R Square | Adjusted R Square | Std. Error of the Estimate | Change Statistics | | | | | Durbin-Watson |
				R Square Change	F Change	df1	df2	Sig. F Change	
.296(a)	.088	.077	.23072	.088	8.232	4	343	.000	1.986

The regression analysis generated a statistically significant model (R^2 = .088), that explained 88 percent of the variance in each factors for learning achievement. See table 27 for details.

Table 28 The relationship between team learning skills and the factor affecting the design of virtual classroom environments

| Factors | Unstandardized Coefficients | | Standardized Coefficients | t-test | Sig. |
	B	Std. Error	Beta		
(Constant)	2.532	0.012		204.754	.000
Pedagogy and instructional design factors	0.019	0.017	0.097	1.103	.271
Environment and community of learner factors	-0.007	0.019	-0.037	-0.381	.704
Group dynamic and peer impact factors	0.052	0.016	0.243	3.232	.001
Group size factors	0.016	0.015	0.052	1.010	.313

$p<.05$

Table 28 summarizes the results of the regression analysis. The results of this multiple regression analysis indicated that only group dynamics and peer impact factors were significantly positive correlated with team learning skills. See table 28 for details.

From the result, this regression equation was created.

Team learning skills = 2.532 + 0.019 pedagogy and instructional design factors − 0.007 environment and community of learner factors + 0.052 group dynamic and peer impact factors + 0.016 group size factors.

PHASE 3: TO PROPOSE A MODEL OF VIRTUAL CLASSROOM ENVIRONMENT DESIGN FOR PROJECT-BASED LEARNING IN HIGHER EDUCATION

From the results of phase 2, show the various factors affecting the design of virtual classroom environments for project-based learning in higher education. But only two of the four main factors, group dynamics and peer impact factors and group size facts, were significantly positive correlated with learning achievement. Moreover, the results of phase 2 show that only group dynamics and peer impact factors was significantly positive correlated with team learning skills.

Group dynamics and peer impact factors concern the relationship between group members and each others and also between the group members and their tasks. Therefore, instructional designers should be aware of group dynamic and peer impact factors when creating virtual classroom environment for project-based learning. The details of group dynamic and peer impact factors are as follows:

1. Team leadership. A team leader in a virtual classroom is the student who keeps the team going and reminds members of important deadlines. The team leader was sometimes the same person as the assignment compiler. The team compiler would decide when other members should submit their work and set a timeline to finish assignments.

2. Task clarity. As with any collaborative learning project, the types of assignments in virtual team situations should be carefully considered. Establishing clear objectives and benefits before assigning tasks is especially vital in a virtual environment.

3. Strength of peer cooperation. Group work at a distance does not automatically result in collaboration. It is important to provide groups with guidelines for collaboration to increase the chances that they will actually work together. In addition, groups should be formed based on previous distance education experience, professional background, and previous knowledge.

Although other factors in this study proved not significant for learning achievement and team learning skills, instructional designers can not ignore them. All factors combine to create effective virtual classroom environment design, which will enhance learning achievement and team learning skills.