Hybrid E-Training Assessment Tool for Higher Education

R Din[1*], H Norman[1], A Karim[1], P Shah[1] F R Rahmat[1] & F Kamarulzaman[2]

Faculty of Education[1]
Universiti Kebangsaan Malaysia
43600 Bangi, Selangor,
MALAYSIA

Faculty of Economy and Business[2]
Universiti Kebangsaan Malaysia
43600 Bangi, Selangor
MALAYSIA

*Corresponding author: rosseni@ukm.my

Abstract: - As time becomes an issue in teaching and learning or training in higher educational institutions, most trainers resort to lecture-based training. When training is restraint to predominantly lecture method, meaningful learning may not be the main intention of training any longer. This is due to the fact that lecture method is essentially more pertinent for learners with auditory learning style preference only. Thus, this study attempts to develop a meaningful hybrid e-training environment for higher education and its' evaluation tool. The paper however, will focus more on the process of developing a valid assessment tool by determining the valid factors for the measurement of e-training using principal component analysis method.

Key-Words: - Principal Component Analysis, Hybrid e-Training, reliability, validity, blended learning

1 Introduction

Introduction of e-Training and e-Learning was a major step towards democratization of education in many aspects for diverse learners where didactic practice have create a culture of dependence. Surveys of several blended, mixed-mode or hybrid e-training showed some gaps in determining the factors involving authentic, meaningful learning with the hybrid method [1,2,3,4,5,6,7,8]. A study by Norman et al. [9] showed that the combination of learning technologies with the appropriate learning module, learning models, theories and strategies has the potential to promote students' context-awareness and collaboration during learning as well as reduce their cognitive load.

A blended teaching and learning program also known as hybrid e-training or hybrid e-learning provide a clear mission to achieve strategic change in education through lifelong learning and the creation of a knowledge society [7]. This phenomenon has paved the way for most higher education institutions whereby didactic practice have in turn created a culture of dependence [2]. This is further complicated by the rote learning approach resulting in the use of surface learning approaches [4]. Consequently, when e-training is implemented, students are unable to lean independently thus a training strategy is called for to assist trainers and trainees develop their professionalism through direct acquisition of knowledge.

The introduction of e-Training is a big step towards the democratization of education for learners or trainees with differentiated learning preferences. Concurrently, teachers find it increasingly difficult to ignore learners' diversity in their classrooms. Culture, race, language, economics, gender, experience, motivation to achieve, disability, advanced ability, personal interests, learning preferences, and presence or absence of an adult support system are just some of the factors that students bring to school with them in almost stunning variety [10]. Not many trainers will find their training satisfying when they simply train and deliver materials with no regard for varied learning needs. Thus, this study aims to develop a meaningful e-training environment for higher education and evaluates whether the environment achieves meaningful e-training with a reliable and valid instrument namely the Hybrid e-Training (HiT) and the Meaningful Learning questionnaires. However for the purpose of discussion in this paper, only principal component analysis to

determine hybrid e-training factors for HiT questionnaire will be discussed.

2 Problem Formulation

With the advent of knowledge-economy, people will have to continuously update their knowledge and skills to maintain a competitive edge in the global economy [11]. The Malaysian Qualification Framework (MQF) provides the structure for actualizing long life learning (LLL) because it facilitates learners in selecting a learning pathway that is most appropriate for them [11,12]. Thus, a response was made to create an academic culture capable of producing learners with qualities ranging from competencies in soft skills, intellectual qualities and affective attributes, in addition to the typical technical and professional skills [13].

To successfully create the much desired academic culture, the Committee of Deputy Vice Chancellors and Rectors of Malaysian Higher Learning Institutes [14] have drawn up four strategies: (i) having competent and professional academicians, (ii) providing conducive facilities, (iii) implementing an updated, relevant curriculum with various delivery methods, and (iv) making initiatives to improve and monitor key performance indicators. No framework or model has yet been provided to implement the third strategy although some works have been done to materialize the first through fourth strategies by various centres for professional development of various institutes of higher learning.. The second strategy has been continuously implemented, maintained and upgraded wherever and whenever needed. As for the third strategy, all academicians involved will have to do their part as a means to achieve the shared vision of the university; that is to create an academic culture comparable to international standards at the same time, able to nurture a holistic development of the learner.

In addition to the strategies outlined earlier, it is also widely accepted that ICT infrastructure enables e-Training. The technology may save university administrators costs and add a measure of convenience for learners, but educators may reason that if e-training programs do not produce workers who are capable of higher order thinking and reasoning to solve intricate and authentic problems in the workplace, then the programs are not worth much [15,16]. In the strategic planning process to implement a new e-training program or enhance existing ones, the focus should therefore not be primarily on how technology can be used to achieve educational goals, but also on the human aspects of teaching and learning particularly the return of investment. The stakeholders' need to know if learning takes place. As such, a valid instrument to measure meaningful learning in a hybrid e-training (HiT) environment is called for.

3 Conceptual Framework of HiT

The conceptual framework of HiT is an expansion of the DDLM [17,18,19,20]. The evaluation tool of the HiT system (HiTs) went through the process of integration and adaptation based on the findings from an earlier qualitative study to identify themes or components of the HiTs. Based on 24 open-ended student evaluation findings from 4 cohorts of postgraduate Computer Education students (2003-2004), interaction analysis of 616 electronic forum postings plus literature reviews and evaluation of various e-Learning models, a conceptual hybrid e-training framework was designed [Fig. 1].

The framework were further developed based on other literatures and work done by MacDonald and Gabriel [18], MacDonald and Thompson [19]; MacDonald et al. [17], Scadarmalia and Bereiter [20] and Stodel, Thompson and MacDonald [21]. The HiT evaluation tool is developed based on this framework. The HiT framework (Fig. 1) includes the five components of DDLM [17,19], where items under each component or construct were modified accordingly to suit the Malaysian Qualification Framework (MQF) requirements. The findings, as visually described in Fig. 1, were translated with details into the Handbook for Computer Training Delivery (Fig. 2). With the handbook, any trainer can easily learn the skills and contents quickly to teach the course. As for the computer education blog (Fig. 3), knowledge management (KM) components were embedded into its design.

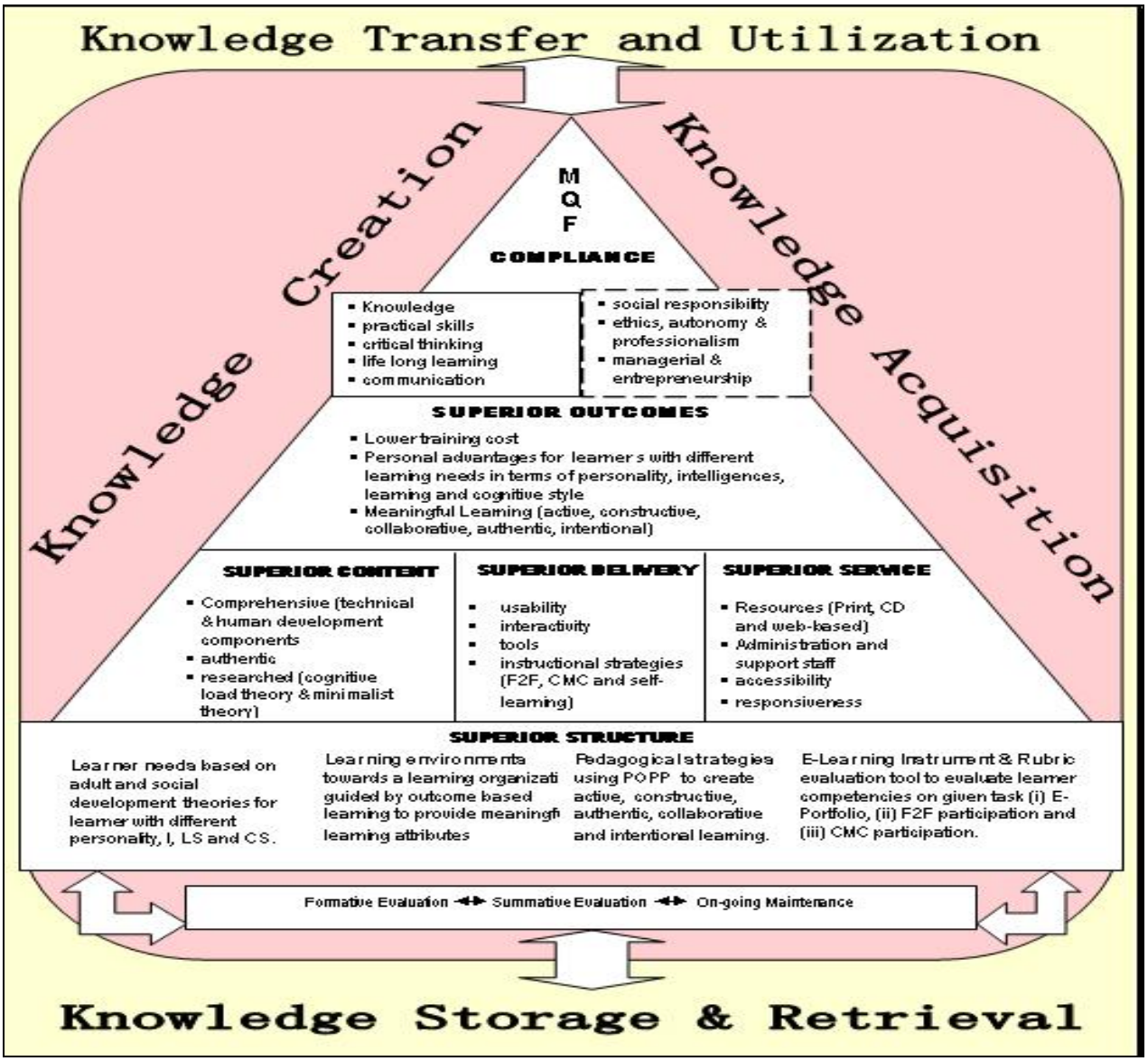

Fig. 1. Conceptual Framework of Hybrit e-Training (HiT)


Fig. 2. A handbook for Computer Training Delivery course handbook

Fig. 3. One of the postings in the course blog at http://rosseni.wordpress.com

4 Design of the e-Training modules

Design of the e-Training module was based on the **P**roblem-**O**riented **P**roject-Bas**e**d H**y**brid **e**-Training (POPeye) strategy. Problem-Oriented Project-Based Hybrid E-Training (POPeye) strategy traces back to the 1970s in Denmark when Aalborg University and Roskilde University Center were established [22]. In Denmark, the more popular term for POPeye is Problem Oriented Project Pedagogy (POPP).

The framework of this study uses POPeye as a means of providing active, constructive, cooperative, authentic and achievable learning objectives that will result in meaningful learning. In order to create contents for a meaningful learning that are appropriate to user needs, fullfil the MQA and in line with the POPeye strategy, a task analysis was conducted. The analysis was first conducted to determine the course contents and second to identify the most appropriate instructional media and delivery method to be used for the course.

Training courses that applied a hybrid combination of face-to-face, self-learning and computer-mediated communication, ensure learners have the opportunity to actively interpret their experience using internal, cognitive operations via the practice of reflective exercises embedded into their blogging project. Task analysis was conducted to identify the most needed course contents to be focused on. The findings were presented to a group of experts and refined to only three main subtopics.

Subsequently, the new adapted framework was used to design and deliver hybrid e-training courses starting in the year 2005 [5,6,7,8]. Formative evaluations were conducted and various improvements took place until the researcher decided on the final platform that was used in the pilot implementation phase in February 2008. The model has been adopted since then at the Universiti Kebangsaan Malaysia.

5 The e-Training Module and Environment

The developed meaningful e-Training module and environment was developed based on the POPeye strategy [9,23], which consisted of three components, as in Fig. 4: (i) coursework resources; (ii) teaching resources; and (iii) project work resources. The coursework resources consisted of a series of lectures handled by the instructor by referring to the Computer Training Delivery course handbook (Fig. 2) and the Computer Training Delivery e-Book (Fig. 5) . The instructors are also supported by the teaching resources that contain the lesson plans, lesson activities and lesson contents of the e-Training module.

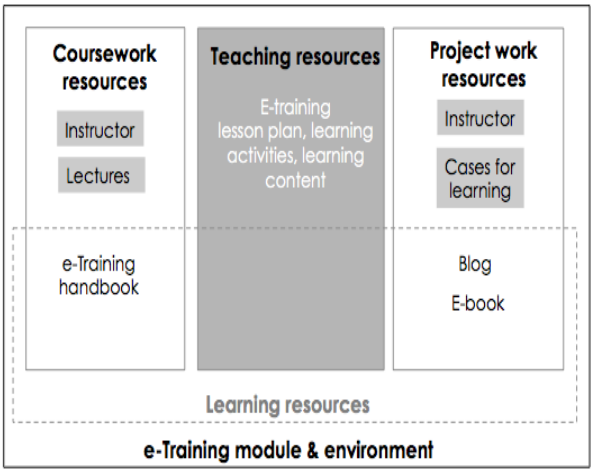

Fig. 4. The e-Training module and environment

Fig. 5. e-Book on Computer Training Delivery

6 Research Methodology

The research methodology only focuses on the development of the measurement tool particularly at the factor analysis stage to determine factors of hybrid e-training.

6.1 Development of the Measurement Tool

In development of a valid and reliable instrument for measuring hybrid e-training, a survey was carried out involving 249 ICT trainers and trainees from the Faculty of Education, Universiti Kebangsaan Malaysia. The survey was based on the following research questions:

1. Is the sample size adequate to perform principle component analysis?
2. Are there overlapping measurements (multicollinearity) among the reshuffled items?
3. What are the factors derived from the principle component analysis?

6.2 Data Analysis

In response to the main aim of the study, a valid and reliable instrument for measuring hybrid e-training is called for. As the first procedure to achieve that, a principal component analysis (PCA) was conducted to the HiT version 8.1 questionnaire before undergoing a confirmatory factor analysis (CFA) to test for convergent and discriminant validity of the instrument.

Overall reliability analysis using Cronbach Alpha test on 249 pilot data following content validity by experts showed that the questionnaire developed to measure hybrid e-training as valid and reliable. The reliability value of the questionnaire tested in the pilot test involving data collected from 249 technology trainers and trainees was α=.92 for 35 items. Rasch model was applied using Winsteps 3.68.2 software to obtain the item and person reliability [24, 25, 26] which were .96 and .83 respectively.

While obtaining item and person reliability using the Rasch model, dimensional analysis [25,26] was also carried out. Through the analysis, it was discovered that the test yield the same number of factors or dimensions as in the principal component analysis but some items are placed in different dimensions which slightly differed from the underlying theory of previous studies [6,11,12]. Thus, another field study was carried out to verify the validity of the reshuffled items for each construct with corrected sentence structure. At this time, sufficient data were collected to ensure principal component analysis (PCA) could be done.

To achieve the aim of this study, PCA was performed. Principal components analysis of a data matrix extracts the dominant patterns in the matrix in terms of a complementary set of score and loading plots [25]. The main purpose of PCA is to reduce the dimensionality of multivariate data to make its structure clearer. It does this by looking for the linear combination of the variables which accounts for as much as possible of the total variation in the data. It then goes on to look for a second combination, which is uncorrelated with the first, that accounts for as much of the remaining variation as possible. This process will be repeated. If the greater part of the variation is accounted for by a small number of components, they may be used in place of the original variables [25].

Data from HiT version 8.1 questionnaire were collected. Subsequently,PCA was performed where items were restructured and grouped into new components of the the HiT questionnaire. Next, confirmatory factor analysis (CFA) [27,28] was performed

The next objective is to obtain sufficient evidence to show construct validity of HiT 8.1. The aim is to produce a highly reliable and valid new version of the HiT questionnaire. To achieve the aim of the study, several research objectives have been determined. The following sections discusses the PCA procedure to verify the five key components that represent a useful hybrid e-training. These five components are content, delivery, outcome service and structure of hybrid e-training.

PCA is an exploratory factor analysis (EFA) technique to determine dimensions or components where items in the questionnaire belong to. This technique is important to determine the unidimensionality of each construct in the questionnaire. In general, to perform PCA using the SPSS software such as the SPSS version 16 for this study, one would first select the *analyze* function then choose *data reduction*. A dialog box will appear. In the *factor* selection section, constructs to be analyzed shall then be entered. In this case the data to be used are those collected using HiT version 8.1 questionnaire.

Subsequently, on the (i) *descriptive* option, three selections were made - the *easy image*, *KMO* and *determination*. Next on the (ii) *extraction* option, two areas were selected - *correlation* and *scree plot*. For (iii) *eigenvalues* option, the value "*1*" is selected with maximum iteration of "*25*". For (iv) *rotation* option, two things were selected - *varimax* and *oblimin data*. Next on the (v) *display* option, *rotated solution* was checked with the maximum iteration of "*25*". Finally, the (vi) *continue* button was clicked to start the process of principal component analysis.

The next step is to give notification to the system to store the input analysis by clicking on the *save as a variable* option. Finally, at the *method* section, (vii) *regression* and *display factor score* was selected. These procedures will give an output to answer the research questions. Results of data analysis will be reported in the "RESULTS" section.

7 Results and Discussion

The results of data analysis are reported based on the research questions. The first question is to determine whether PCA can be implemented based on two types of tests – the *KMO* and *Anti Image Correlation*. The second and third questions are questions about the factors derived from the restructuring process using the PCA.

7.1 Kaiser-Meyer-Olkin Measure of Sampling Adequacy

Table 1 shows the KMO to answer the first research question " *Is the sample size adequate to perform principle component analysis*?" To conduct PCA, the minimum value of KMO of not less than .50 and a significant value of < 0.05 [25] is required. By mapping these requirements to the output of the KMO analysis, it could be concluded that the HiT questionnaire met the first requirement for the implementation of PCA.

7.2 Implementing PCA According to Anti-Image Correlation Analysis

To fulfil the requirement for implementing PCA, analysis of the "*Anti-Image Correlation*" was carried out. In the output of this analysis, some of the points to note are the figures that form a diagonal line, should be valued at 0.5 or above [25]. By mapping these requirement to the output of the anti-image correlation analysis, it could be concluded that HiT questionnaire for the study of technology met the correlation requirement to enable the implementation of PCA.

Table 1. KMO dan Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.858
Bartlett's Test of Sphericity	Approx. Chi-Square	3.114E3
	Df	495
	Sig.	.000

7.3 Structuring Factors using Principal Component Analysis

Table 2 shows the total variance explained. Only a total initial eigenvalues of above 1.0 or cumulative value above 60% was considered [25]. For the HiT questionnaire, there were ten values greater than 1.0. Thus the writers conclude that there is ten constructs in this questionnaire with cumulative value greater than 60% that is 62.559%.

Table 2. Total Variation

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	9.220	26.342	26.342	9.220	26.342	26.342	2.761	7.888	7.888
2	1.982	5.664	32.006	1.982	5.664	32.006	2.722	7.777	15.665
3	1.921	5.489	37.495	1.921	5.489	37.495	2.666	7.618	23.283
4	1.605	4.586	42.081	1.605	4.586	42.081	2.641	7.547	30.830
5	1.491	4.259	46.340	1.491	4.259	46.340	2.477	7.078	37.907
6	1.368	3.908	50.248	1.368	3.908	50.248	2.010	5.742	43.649
7	1.201	3.431	53.680	1.201	3.431	53.680	1.876	5.359	49.008
8	1.075	3.071	56.751	1.075	3.071	56.751	1.791	5.118	54.126
9	1.032	2.949	59.700	1.032	2.949	59.700	1.732	4.949	59.075
10	1.001	2.859	62.559	1.001	2.859	62.559	1.219	3.484	62.559
11	.940	2.687	65.246						
12	.835	2.385	67.631						
13	.809	2.312	69.943						
14	.744	2.125	72.068						
15	.734	2.099	74.167						
16	.728	2.081	76.248						
17	.707	2.020	78.268						
18	.658	1.881	80.150						
19	.627	1.792	81.942						
20	.615	1.758	83.700						
21	.593	1.694	85.394						
22	.517	1.476	86.870						
23	.501	1.431	88.302						
24	.498	1.422	89.724						
25	.442	1.264	90.988						
26	.422	1.206	92.194						
27	.396	1.131	93.324						
28	.375	1.071	94.396						
29	.355	1.015	95.411						
30	.315	.899	96.310						
31	.300	.857	97.167						
32	.283	.809	97.976						
33	.268	.765	98.740						
34	.239	.683	99.423						
35	.202	.577	100.000						

Extraction Method: Principal Component Analysis.

Besides total variance explained, the scree plot as shown in Fig.6 can also be used to determine the number of constructs, factors or dimensions. In this case the scree plot only show 2 sub-constructs within the HiT questionnaire. Both of these methods contradicts the theories used in this study claiming that there are five principal factors that could be use to determine the usefulness of hybrid e-training towards meaningful learning which is an alternative to didactic teaching.

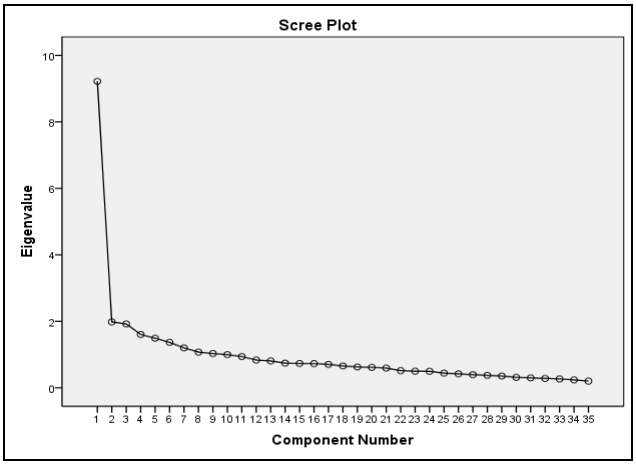

Fig. 6. Determination of total factor using scree plot

7.4 Overlapping Measurement

In order to determine factors influencing hybrid e-training, we need to segregate overlapping measures to ensure only items measuring one specific construct or factors remain as the measuring item. Analysis by rotated component matrix table stipulates that only values, which have the capacity or loading of .40 and above, will be accepted as item for the respective construct. The first extraction method using principal component analysis using Varimax with Kaiser Normalization rotation method converged in 30 iterations yielding 10 factors. After careful considerations, overlapping items were properly examined where some items were selected for certain constructs and some were dropped. These overlapping items indicated the existence of multicollinearity.

Overlapping items showed that the respective items, measured more than one construct. Thus analysis and evaluation of the items were made to determine where the respective items belonged to, in addition to taking into account the value of the items that were loaded on both constructs. This process was intended to elicit answer for the second research question – "Are there duplication of measurements (multicollinearity) among the items that measure the hybrid e-learning?

Based on the rotated component matrix, it could be concluded that the HiT questionnaire version 8.1 still contained multicollinear items that were cross loading with other constructs. This was evident with item C22, which loaded on two factors. Thus, item C22 could be specified as not valid. On the other hand with expert agreement, C22 can still be selected for one of the factors which loads higher.

The findings discussed earlier can also be used to answer the last research question - "What are the factors derived from the restructuring process using the PCA factor"? The findings revealed that there were five factors derived from the restructuring process using the PCA factors after numerous rounds of analysis using rotated component matrix where 15 items were finally dropped. Table 3 and 4 shows the last two results of the analysis where 10 original components have been trimmed down to 5 components or factors. These factors (Table 4) were subsequently named as (i) structure, (ii) media, (iii) outcome, (iv) interactivity, and (v) content. Table 5 shows the summary of constructs after the PCA and expert judgement validation.

Table 3. Structuring Factors using Rotated Component Matrix

	Component				
	1	2	3	4	5
c01	.082	.335	.002	.167	.607
c02	.139	.414	.100	-.069	.659
c05	.078	.013	.152	.175	.714
c06	.187	-.133	.184	.267	.643
c08	.613	.251	-.180	.058	.266
c09	.718	.157	.015	.186	.085
c10	.574	.264	.129	.186	.080
c11	.592	.067	.395	-.074	-.007
c12	.636	.087	.219	.243	.052
c13	.450	.022	.338	.178	.235
c14	.398	-.038	.291	.285	.186
c19	.113	.093	.679	.259	.037
c20	.082	.046	.727	.187	.114
c21	.162	.226	.698	.125	.150
c22	.132	.426	.588	-.125	.150
c26	.294	.056	.099	.561	.382
c28	.183	.217	.252	.713	.059
c29	.168	.226	.077	.704	.141
c30	.096	.618	.146	.403	-.039
c31	.109	.772	.077	.133	.151
c32	.173	.657	.070	.076	.147
c34	.160	.616	.229	.156	.020
c27	.164	.158	.163	.577	.351

Table 4: Structuring Factors using Rotated Component Matrix

	Component				
	Structure	Media	Outcome	Interactive	Content
c01	.324	.091	.004	.170	.606
c02	.420	.137	.098	-.068	.657
c05	.015	.069	.151	.168	.717
c06	-.141	.180	.188	.261	.649
c10	.230	.595	.149	.199	.085
c11	.064	.583	.406	-.072	-.001
c12	.060	.645	.239	.252	.061
c13	.029	.428	.341	.172	.242
c19	.078	.110	.686	.263	.043
c20	.035	.076	.733	.190	.120
c21	.219	.155	.703	.129	.154
c22	.434	.122	.587	-.121	.149
c26	.036	.297	.109	.563	.391
c27	.158	.150	.162	.573	.359
c28	.206	.175	.255	.715	.067
c29	.213	.166	.080	.707	.149
c30	.600	.109	.149	.417	-.039
c31	.760	.126	.079	.148	.147
c32	.682	.156	.058	.076	.144
c34	.621	.157	.227	.164	.020

Table 5. Summary of Constructs after the PCA and Expert Judgement

Construct	Item	Total Item
Content	c01, c02,c05 and c06	4
Delivery	c10, c11, c12 and c13	4
Outcome	c19, c20, c21 and c22	4
Interactivity	c26, c27, c28 and c29	4
Structure	c30, c31, c32 and c34	4
Total Items		20

8 Conclusion

Based on previous literatures [1,2,23] and the findings obtained, it would be interesting to study more about the factors found to be useful for the implementation of hybrid e-training in order to overcome didactic teaching practice which have created the culture of dependence. The study has applied the problem-oriented project-based hybrid e-training method to deliver the course. Learning strategies were based on how to reach the goal of meaningful learning which can be reflected by active, interactive, collaborative, reflective and authentic teaching and learning strategy [6].

A more specific measuring instrument to measure the ability of respondents to the items provided will be needed to confirm the 5 factors found to be useful in implementing hybrid e-training as presented in this paper. IRT (Item Response Theory) might be able to address this issue with its ability to measure both items and respondents ability simultaneously. Thus, a further study with new method of data analysis such as those employed with modern psychometrics such as the Rasch modelling and Item Response Theory will be needed in future studies.

9 Acknowledgement

In accomplishing this report, we would like to convey our greatest appreciation to Professor M Sahari Nordin, Dean of Research and Innovation Centre, International Islamic University Malaysia who had generously given us his time and insights on details of data analysis using the Principal Component Analysis, Associate Professor Dr. Norlide Abu Kassim who first taught us about Factor Analysis, Dr. Tunku Badariah Tunku Ahmad for her help in editing and reviewing the SEM report, Dr. Nur Riza Suradi for her generous opinion about SEM analysis, both my PhD supervisors Prof. Khairul Mastor and Assoc. Prof. Dr. Shanudin Zakaria, Dr. Kemboja from the Language Center of the university for reviewing and editing the language of the earlier version of the instrument, Intan Farahana, Nur Ayu Johar, Verawati, Siti Zuraida Abdul Manaf, and Nurainsyah A Mutalib for collecting and analysing the data, Prof. Mohamed Amin Embi, the E-Learning research group leader, Assoc. Prof. Dr. Saemah the Inovation and Pedagogy Research Group Leader, Dr. Norazah, Dr. Rahilah, and many others who have contributed in various ways. Last but not least, we would like to thank the government of Malaysia and all the staff at Center for Research and Innovation Management at the University Kebangsaan Malaysia for the university grant [UKM-GUP-TMK-08-03-308], [UKM-GGPM-CMNB-026-2010], [UKM-DIPM-014-2011] and [UKM-HEJIM-Komuniti-06-2010] given to support the study .

References:

[1] E.Y. Huang, S.W. Lin, T.K. Huang, What type of learning style leads to online participation in the mixed-mode e-learning environment? A study of software usage instruction, *Computers & Education*, Vol. 8, No.1, 2012, pp, 338-349.

[2] S. Campanella, G. Dimauro, A. Ferrante, D. Impedovo, S. Impedovo , M. G. Lucchese, R. Modugno, G. Pirlo, L. Sarcinella, E. Stasolla, C. A. Trullo, E-learning platforms in the Italian Universities: the technological solutions at the University of Bari, *WSEAS Transactions in Engineering Education,* Vol.5, No.1, 2008, pp.12-19.

[3] L. Seidel, R.M. Benito, M.E. Camara, J.C. Losada, F.J. Arranz, Development of an Interactive Learning Environment for Introductory Physics in Engineering, *WSEAS Transactions on Advances in Engineering Education*, Vol. 5, No. 5, 2008, pp. 306-315.

[4] R. Haripersad. 2010. Deep and surface learning of elementary calculus concepts in a blended learning environment. In *Proceedings of the 7th WSEAS international conference on Engineering education*, Philippe Dondon and Olga Martin (Eds.), pp. 470-476.

[5] R. Din, M.S. Zakaria, K.A. Mastor, N. Abdul Razak, M.A. Embi, & S.R. Ariffin, Meaningful hybrid e-training model via POPEYE orientation, *WSEAS International Journal of Education and Information Technologies*, Vol. 3, No. 1, 2009.

[6] R. Din, M.S. Nordin, N. Abu Kasim, T.B. Tunku Ahmad, K. Jusoff, N.A. Johar, M.F. Kamarul Zaman, M.S. Zakaria, M. Ahmad, A. Abdul Karim, & K. Anwar Mastor, Development and validation of meaningful hybrid e-training model for computer education, *International Journal of Computer Science*, Vol. 1, No. 3, 2010, pp. 179-184.

[7] R. Din, M.S. Zakaria, M.S. Nordin, M.F. Kamarul Zaman, N.L. Abu Kassim, T.B. Tunku Ahmad, K.A. Mastor, A. Abdul Karim, & M.A. Embi, A Meaningful Hybrid E-Training Measure for Technology in Educaion, *Asian Journal in Teaching and Learning in Higher Education,* Vol.3, No.2, 2011, pp. 71-82.

[8] R. Din, M.F. Kamarulzaman, P.M. Shah, S. Rahman, A.A. Karim, R. Omar, M.S. Nordin, M.S. Zakaria, & K.A. Mastor, Factors influencing effective professional development using the hybrid e-training method, *World Applied Sciences Journal,* Vol. 15, 2011, pp. 12-17.

[9] H. Norman, R. Din, & N. Nordin, A preliminary study of an authentic ubiquitous learning environment for higher education, *Proceedings of the 10th WSEAS Conference on Recent Researches in E-Activities*, 2011, pp. 89-94.

[10] C.A. Tomlinson, & J. McTighe, *Integrating differentiated instruction and understanding by design*, Association for Supervision and Curriculum Development, 2006.

[11] J. Reid, Perceptual learning style preference questionnaire [Online] http://lookingahead. hienle.com/filing/l-styles.htm. Accessed on December 12, 2006.

[12] J. Reid, The learning style preferenses of ESL students, *TESOL Quarterly,* Vol.21, No.1, 1987, pp. 87-111.

[13] R. Din, M. Ahmad, M.F. Kamarul Zaman, N. Mohamad Sidek, A. Abdul Karim, N.A. Johar, K. Jusoff, M.S. Zakaria, K.A. Mastor & S.R. Ariffin, Kesahan dan kebolehpercayaan soal selidik gaya e-pembelajaran (eLSE) versi 8.1 menggunakan model pengukuran Rasch, *Journal of Quality, Measurement and Assessment,* Vol.5, No.2, 2009, pp. 15-27.

[14] Committee of Deputy Vice Chancellors and Rectors of Malaysian Higher Learning Institutes, Strategi dan Piawaian Pengajaran dan Pembelajaran IPTA, 2006.

[15] T. Govindasamy, Successful implementation of e-learning: pedagogical considerations. *Internet and Higher Education,* Vol. 4, 2002, pp. 287-299.

[16] D.H. Jonassen, K.L. Peck, & B.G. Wilson, *Learning with technology*: *A constructivist perspective*, Merrill Prentice Hall, 1999.

[17] C.J. MacDonald, E. Stodel, L. Farres, K. Breithaupt, & M.A. Gabriel, The Demand Driven Learning Model: A framework for web-based learning, *The Internet and Higher Education,* Vol.1, No.4, 2001, pp. 9-30.

[18] C.J. MacDonald, & M.A. Gabriel, Toward a partnership model for web based learning. *The Internet and Higher Education: A Quarterly Review of Innovations in Post-Secondary Education,* Vol.1, No.3, 1998, pp. 203-216.

[19] C.J. MacDonald, & T.L. Thompson, Structure, content, delivery, service, and outcomes: Quality e-learning in higher education, *International Review of Research in Open and Distance Learning,* Vol. 6, No. 2, 2005.

[20] M. Scardamalia, & C. Bereiter, Computer support for knowledge-building communities, *Journal of Learning Sciences,* Vol.3, No.3, 1993, pp. 265-84.

[21] E.J. Stodel, T.L. Thompson, & C.J. MacDonald, Learners' perceptions on what is missing from online learning: Interpretations through the community of inquiry framework. *International Review of Research in Open and Distance Learning,* Vol. 7, No. 3, pp. 1-24.

[22] L. Dirckinck-Holmfeld, Designing virtual learning environments based on problem oriented project pedagogy, in, L. Dirckinck-Holmfeld & B. Fibiger (eds.), *Learning in virtual environments*, 2002, pp. 31–54.

[23] L. Dirckinck-Holmfeld, Design of a networked learning master environment for professionals – using the approach of problem based learning to establish a community of practice, in, *NLC 2010,* 2010.

[24] J.M. Linacre, Winsteps (Version 3.48) Computer software and manual, Chicago, 2003.

[25] T.G. Bond, & C.M. Fox, *Applying The Rasch Model: Fundamental Measurement in the Human Sciences,* Lawrence Erlbaum Associates Publishers, 2001.

[26] S. Wold, K. Esbensen, & P. Geladi, Principal Component Analysis, *Chemometrics and Intelligent Laboratory Systems,* Vol. 2, No. 1-3, 1987, pp. 37-52.

[27] D.J. Bartholomew, Principal Components Analysis, *International Encyclopedia of Education (Third Edition)*, 2010, pp. 374-377.

[28] A.P. Field, *Discovering statistics using SPSS*, 2nd ed., Sage, 2005.