EFFECTS OF TYPES OF ASSESSMENT QUESTIONS ON LEARNING PERFORMANCE OF TWO TYPES OF E LEARNING SYSTEMS, ADAPTABLE AND PERSONALISED ELSS

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This paper presents findings on the impact of learners' measure of control over their learning while working in different online learning environments, and how this, in combination with a structured learning material selection according to their learning preferences, can affect their learning performance. A qualitative study was carried out on the understanding of different learning philosophies, different e learning environments and different learning preferences, in correlation with learners' measure of control over their learning environments, in terms of their influence on their learning performance.The successful implementation of the project has produced a large amount of data, which demonstrates a correlation between adaptable and personalised e learning systems and learners' learning styles, and therefore supports the behaviouristic approach towards this online learning environment (ALPELS).The study indicates a dependency between an online controlled learning environment and learners' learning performances, showing that a personalised e learning system (PELS) would be supportive of recall (R) and understanding (U) types of content materials (with an indication of 4.89%), but also demonstrating an increase in student learning performance in an adaptable e learning system (ALELS) while using competency (C) types of content materials (with an indication of 5.43%). These outcomes provide a basis for future design of e-learning systems, utilising different models of learner control based on underpinning educational philosophies, in combination with learning preferences, to structure and present learning content according to type.

Key words: E-Learning Systems, Personalisation, adaptability, types of assessment questions

1. Introduction

With recent years of research on the concept and effects of personalisation, adaptability and adaptivity of e learning systems on learner's learning performance, this study has been carried out to investigate such effects. However, it is crucial to clarify the definition used in this study and what differences are between adaptable and adaptive e-learning systems (ELS) and how personalisation is different than those types of ELSs.

1.1. Differences Between Adaptable And Adaptive Systems

While investigating the concept of adaptation, [1] have categorised existing learning systems into two types of system: "Adaptable" and "Adaptive". In an adaptable system users can modify their settings in a system's environment. As its name indicates, adaptability is a process in which a user controls the system. But in the adaptive model, the system is in control [2]. Therefore, the main dissimilarity of adaptive types of systems is in the concept of being in control of gathering information on a learner's interaction whether by the system itself or by its users. This means the task of "learning about an individual's behaviour and learning style" should be given to the system and the system itself would be responsible for gaining those information; unlike an adaptable ELS which requires the setting up of predefined preferences on the system by its user.

Therefore, this is the measure of control which specifies different types of e learning systems. If the control is given to the system and the system starts to learn about the learner's learning style, then the system will be called an adaptive e learning system, since the system wants to adapt to the learner's learning style, so as to guide him/her through the instructed knowledge. On the other hand, if the learner starts to make changes to his/her learning environment and tells the system about his/her method of learning, then it is called an adaptable e learning system, if we presume that the learner is aware of his/her learning style. In this case it should also be clear that as the system to be placed in control, in an adaptive e learning environment, the predefined content material provided by an instructor should be available somewhere in a database where the system can start providing access to those contents to the user based. This action is decided based on the user-profile (which the system has already gathered on the learner's learning preferences).

Alternatively, in an adaptable e learning system, the system places predefined content material in access of the user. This is because the learner is in control of his/her learning, the learner can go through those content materials in a sense, which one of two cases of instructional methods (andragogy or heutagogy) have been exercised. The main difference here is that in both methods, an element of pedagogy is present, since all reading materials have already been prepared by someone else. On the other hand, students in primary education do not have an understanding of the cognitivistic approach towards their learning nor they are equipped with sufficient knowledge and skills to use a heutagogic method[3] to gain further knowledge.

For this research only adaptable personalised e-learning (ALPELS) was chosen mainly because the design and development of an adaptive systems requires much resources and will be studied further in

a future research. This ELS includes two sub-systems of adaptability and personalisation of systems. As being mentioned earlier, the first part of the system will be set by the user and the user still have a choice on reconfiguring the access to content materials through the system. But, in the personalised e-learning system, the learner will clarify his/her learning preferences and then the system will lock the option and the user will not be able to change those options again. This is to seek and measure the learning performance of two groups of learners whom will be divided automatically by the system

1.2. Types of Assessment Questions

While an instructional designer prepares a set of exam questions, content of the assessment must be designed on a method which considers the strategic knowledge and knowledge transferring mechanism of learning objects using any type of e-learning system[4]. In another word, type of assessment questions should be categorised as of the holder of either motor skills or mental skills; or better defined as competency 'C' or recall 'R' and understanding 'U' type of questions. Hence, on the experimental design phase learners will be divided into two groups of adaptable or personalised ELS users. Learners, through those systems will be interacting with content materials with different types of RCU.

2. Experimental Design

2.1. Adaptable Personalised E-learning System (A_LPELS)

To understand a learner's behaviour while interacting with either of adaptable or personalised ELS, an e learning system named AAPELS[5,6] was designed and developed which kept track of learners' interaction with the system. Specifically designed content materials were developed to support the process of measuring learners' learning performance while navigating through those learning objects.

2.2. Designing Assessment Questions based on Strategic Knowledge

The course content used an ARK-based switchboard [7] to convert a VARK-based digital asset into ARK-based one. By taking this approach on the design of any learning object, the efforts required to develop a suitable content materials, which covers all types of a VARK-based combinations (15 types of V, A, … VA, VR, … and VARK) can be reduced to 3 of types of AKRD,

AKRS, and KRS. These keys stand for:
AKRD: Kinaesthetic and dynamic type of reading materials with audio included
AKRS: Kinaesthetic and static type of reading materials with audio included
KRS: Kinaesthetic and static type of reading materials

As it has been mentioned earlier, a learning object for this research was based on a combination of learning, practice and assessment content, which in turn each type of content was a combination of scenario, query and/or explanation. A detailed version of this package has been illustrated in Table 1 below:

Table 1: A Detailed Version Of A Semi-Standard Version Of A Learning Object (LO)

		LC Learning Content	PC Practice Content	AC Assessment Content
LO Learning Object	**S** Scenario	**CM** Content Materials *(RCU-based)*	**CM** Content Materials *(RCU-based)*	**CM** Content Materials *(RCU-based)*
	Q Query	---	**CM** Content Materials *(RCU-based)*	**CM** Content Materials *(RCU-based)*
	E Explanation	---	**CM** Content Materials *(RCU-based)*	---

Keys:
RCU-based: Recall, Competency and Understanding types of content materials

3. Data Analysis And Conclusion

To seek any correlation between learners' interaction with the system, three components were studied: i) types of e-learning system, ii) learning preferences based on content materials, and iii) learners' learning style. Two types of systems of ALELS and PELS were selected to measure the performance of learner's learning outcome.

The System automatically divided registered students into two groups of ALELS and PELS users. Students were taking courses and practicing their exercises which included explanations. The assessment section of the system was designed based on the physiological learning categories VARK content materials (VARK, 2016). VARK stands for V-visual, A-auditory, R-read and write, and K-kinaesthetic and tactile.

It was decided to break those records down to be based on the type of assessments categorised in three types of R-recall, C-competency and U-understanding of questions (RCU). Table 2 shows the question number and the type of assessment based on RCU.

Table 2: List Of Assessment Questions And Their Related RCU Types

	R-Recall	C-Competency	U-Understanding
Question ID Number	32, 33, 36, 45, 50, 51, 79	8, 15, 16, 17, 18, 19, 20, 21, 22, 23, 55, 56, 60, 61, 64, 65,	27, 29, 37, 40, 41, 43, 46, 47, 77, 78
Total no. of Qs	7 questions	16 questions	10 questions

There were 74 students whom taken the course online and attempted part or all topics in the course. Their activities of navigation through the courses were stored in a database, which included their responses to assessment questions. Out of total of 1203 attempts on 33 assessment questions, 739 (61.43%) correct answers were made which is a much higher value (1.59 times) than 464 (38.57%) incorrect answers on the same number of assessment questions.

It indicates that the source of our knowledge is information which must be deduced from data. Bar graphs and Pareto charts are used for qualitative data analysis as tools used in statistics to interpret these data into information and so into knowledge[7,8].

Hence, by classification of learners' attempts on responding to assessment questions, data was divided into four groups as shown in Table 3. Information on the list of students whom attempted those relevant assessment questions in each group is presented on Table 4.

Table 3: Setting Up Groups Of Learners Based On Their Attempts On Answering Questions

Group Label	Class intervals
A	0.5 - 9.5
B	9.5 - 18.5
C	18.5 - 27.5
D	27.5 - 36.5

Table 4: List Of Learners In Each Group Based On The Number Of Questions Answered

Group Title	List of learners' ID in each group	Total no. of learners in each group
A	76, 81, 83, 86, 91, 106, 124, 129, 153, 154, 218, 226, 291, 329, 332, 343, 401, 433, 435, 438, 445, 447, 449, 464, 469, 485, 514, 531, 557, 568	30
B	97, 101, 115, 132, 184, 196, 268, 305, 326, 357, 450, 495, 497, 569	14
C	89, 117, 142, 282, 313, 342, 389, 517	8
D	87, 100, 125, 134, 145, 149, 152, 169, 188, 221, 236, 254, 269, 276, 302, 327, 334, 352, 501, 507, 515, 530	22
	Total	74

Now for all groups listed above, we should check for differences between the true and false responses. The outcome would be as follows (Table 5):

Table 5: Number Of Learners In Each Group And Number Of Their Responses To Assessments

Class Intervals		Answered		Total
Group	No. of learners	True	False	
A	0.5-9.5	78	32	110
B	9.5-18.5	108	84	192
C	18.5-27.5	116	62	178
D	27.5-36.5	437	286	723
Total		739	464	1203

3.1. Analysis Of Records Based On RCU

Further analysis of the data gathered from learners' activities, and as one of the main objectives of this research, the investigation to find any relationship between the type of content material and their effects on the learner's learning performances is presented as follows. In this section, analysis of the learners' performance based on 33 assessment questions of type recall (R – 7 questions), competency (C – 16 questions) and understanding (U – 10 questions) for both types of e learning systems has been done. The total number of responses to those questions is presented in Table 6:

Table 6: Assessment Type Of Questions And Their Responds

Question ID	Number of answered questions					All types	Correctly answered			Incorrectly answered		
	In quantity			In %								
	True	False	Total	True	False							
8	5	0	5	60%	40%			5			0	
15	0	5	5	40%	60%			0			5	
16	2	3	5	48%	52%			2			3	
17	2	2	4	50%	50%			2			2	
18	1	3	4	46%	54%			1			3	
19	4	0	4	58%	42%			4			0	
20	1	3	4	46%	54%			1			3	
21	2	2	4	50%	50%			2			2	
22		6	4	33%	67%						6	

23	1	3	4	46%	54%			1			3	
27	1	0	1	72%	28%				1			0
29	0		5	92%	8%				0			
32	5	5	0	42%	58%		5			5		
33	7	2	9	80%	20%		7			2		
36	4		1	86%	14%		4					
37	4	7	1	67%	33%				4			7
40	8	7	5	62%	38%				8			7
41	1	4	5	24%	76%				1			4
43	4	8	2	33%	67%				4			8
45	0	5	5	44%	56%		0			5		
46	5		9	90%	10%				5			
47	4		9	87%	13%				4			
50	3		7	89%	11%		3					
51	0		8	79%	21%		0					
55	4	1	5	69%	31%			4			1	
56		9	5	17%	83%						9	
60	1	9	0	37%	63%			1			9	
61	9	1	0	63%	37%			9			1	
64	1	0	1	68%	32%			1			0	
65	0	1	1	65%	35%			0			1	
77	9		7	70%	30%				9			
78	8		7	67%	33%				8			
79	9		7	70%	30%		9					
Total	39	64	203	61.43%	38.57%		18	17	04	9	18	47

Note: it is worth mentioning that the discontinuity in numbering questions is because other numbers have been used of practice type of questions.

3.1.1 Analysis Of Records Of Responses Of A_LELS Users Based On RCU

Table 7 presents data on the outcome of finding any relationship between learners' responses on assessment questions and the number of responses for an adaptable e learning system:

Table 7: ALELS Users And Comparison Of Their Activities Based On Different Groups And Types Of Questions (RCU)

Group	Class Intervals	Number of questions answered in different types of questions					Percentage of no. of questions answered based on total of R, C & U separately *(e.g. Group A: R/(total for R) = 21/156 = 13.46%)*				
			C	U	Total		R	C	U	Total	
A	0.5-9.5	21	0	38	59		13.46%	0.00%	17.12%	11.01%	
B	9.5-28.5	35	5	44	84		22.44%	3.16%	19.82%	15.67%	
C	18.5-27.5	27	16	37	80		17.31%	10.13%	16.67%	14.93%	
D	27.5-36.5	73	137	103	313		46.79%	86.71%	46.40%	58.40%	
Total		156	58	222	536		100.00%	100.00%	100.00%	100.00%	

The outcomes has been analysed in section below in comparison to personalised e-learning system users.

3.1.2 Analysis Of Records Of Responses Of PELS Users Based On RCU

Table 8 presents data from the outcome of finding any relationship between learners' responses on assessment questions and number of responses for personalised e-learning systems:

Table 8: PELS Users And Analysis Of Their Activities Based On Different Groups And Types Of Questions

Groups	Class Intervals	Number of questions answered in different types of assessment questions				Percentage of no. of questions answered based on total of R, C & U separately *(e.g. Group A: R/(total for R) = 7/62 = 11.29%)*				
		R	C	U	Total	R	C	U	Total	
A	0.5-9.5	7	0	12	19	11.29%	0.00%	14.63%	9.36%	
B	9.5-28.5	9	1	14	24	14.52%	1.69%	17.07%	11.82%	
C	18.5-27.5	13	9	14	36	20.97%	15.25%	17.07%	17.73%	
D	27.5-36.5	33	49	42	124	53.23%	83.05%	51.22%	61.08%	
Total		62	59	82	203	100.00%	100.00%	100.00%	100.00%	

The outcome has been analysed in section below in comparison to adaptable e learning system users to seek any indication of the type of e learning system with the number of assessment questions answered, and how the learners have performed.

Table 9: Comparison Of ALELS And PELS Users' Assessment Outcome Based On Different Frequencies Of Learners In Each Group And Types Of Question Separately (RCU)

<table>
<tr><td colspan="5">Comparison of ALELS and PELS users' assessment outcome based on different frequencies of learners in each group and type of questions separately (RCU)</td></tr>
</table>

Table 9.1

Group	A_LELS	PELS	Comparison Type	In %
header: The comparison for Recall (R) types of question				
A (0.5-9.5)	73.75%	63.33%	A_LELS	16.45%
B (9.5-18.5)	56.38%	55.81%	A_LELS	1.02%
C (18.5-27.5)	60.61%	78.26%	PELS	22.55%
D (27.5-36.5)	59.28%	63.59%	PELS	6.78%

Table 9.2

Group	A_LELS	PELS	Comparison Type	In %
header: The comparison for Competency (C) types of question				
A (0.5-9.5)	0.00%	0.00%	-	-
B (9.5-18.5)	3.16%	1.69%	A_LELS	86.98%
C (18.5-27.5)	10.13%	15.25%	PELS	33.57%
D (27.5-36.5)	86.71%	83.05%	A_LELS	4.41%

Table 9.3

Group	A_LELS	PELS	In %	Comparison Type
header: The comparison for Understanding (U) types of question				
A (0.5-9.5)	17.12%	14.63%	17.02%	A_LELS
B (9.5-18.5)	19.82%	17.07%	16.11%	A_LELS
C (18.5-27.5)	16.67%	17.07%	2.34%	PELS
D (27.5-36.5)	46.40%	51.22%	9.41%	PELS

3.2. Analysis of learners' response based on the type of assessment questions and used ELSs

In this section, the comparison of the correlation coefficient found from learners' activities on answering questions with their total number of correctly answered assessment questions are presented. Note that the correlation coefficient can be found in the formula below:

$$correlation-coefficien\,t = \frac{\sum_{i=1}^{n}(Xi-\overline{X})(Yi-\overline{Y})}{\sqrt{\sum_{i=1}^{n}(Xi-\overline{X})^2\sum_{i=1}^{n}(Yi-\overline{Y})^2}}$$

Where x and y are the sample means of the average data rows 1 and 2, where data row 1 or x in this study is the "total number of attempts of different types of assessment questions (RCU)" and data row 2 or y is the "number of correctly answered questions".

Table 10: Comparison Of Correlation Coefficient Between Types Of Assessment Questions And Their Use In Different ELSs.

Type of assessment questions	Type of E-learning System and its relevant correlation coefficient		Learners performed better using	Comment
	Adaptable	Personalised		
Recall	0.860	0.904	Personalised ELS 9.05/0.860 = 1.05 Or (1.05-1)/1.05*100 = **4.88%**	Indications of 4.88% better performance achieved by a recall type of assessment question with a personalised type of ELS
Competency	0.826	0.781	<u>Adaptable ELS</u> 0.826/0.781=1.06 Or (1.06-1)/1.06*100 = **5.43%**	Indications of 5.43% better performance achieved by a competency type of assessment question with an adaptable type of ELS
Understanding	0.842	0.885	<u>Personalised ELS</u> 0.885/0.842 = 1.51 Or (1.51-1)/1.51*100 = **4.89%**	Indications of 4.89% better performance achieved by an understanding type of assessment question with a personalised type of ELS

Table 10 indicates that (i) the use of personalised e learning systems could support and increase learners' learning performance while using recall (with a correlation coefficient of 0.904 compared with 0.860 or 4.88%) and understanding (with a correlation coefficient of 0.885 compared with 0.842 or 4.89%) types of assessment questions, and (ii) the use of competency (with a correlation coefficient of 0.826 compared with 0.781 or 5.43%) types of e learning system can increase their learning performance if adaptable ELS is used.

4. Conclusion

As we clearly see in the tables above (Table 9, Table 10), they confirm the hypothesis presented at the beginning of this research, in which: "Analyses given above indicate that a learner's behaviour would be compatible with an environment where it has been set for him/her by the learning environment." This means that the concept of guided education makes an adequate conclusion that if learners have all the freedom to navigate through learning contents in a controlled learning environment, in the form of using personalised e learning systems (PELS), the learning performance could be improved if only recall (R) and understanding (U) type of content materials are used (indication of 4.89% - average and rounded of 4.88% and 4.89%). But the use of a competency (C) type of content material would indicate an increase in performance if an adaptable e learning system (A¬LELS) is used (indication of 5.43%).

On Table 9.2 an interesting finding has been presented which shows the relevancy of learner's raise of activity while interacting with C-competency type of content materials. As such, the number of questions of competency type for all learners have attempted to answer is above the first category A (class of 0.5-9.5). This means students have differently attempted more questions to answer than its counterpart of R-recall and U-understanding types of assessment questions in both types of e learning systems (ALELS and PELS).

These conclusions show an interesting corollary to the type of learning environment created in the traditional face-to-face classrooms. In a traditional teaching classroom where pedagogical instruction is practiced, lecturer takes the learner through a predefined set of explanations for the purpose of teaching and as such during these sessions the teacher is in control and that would be the responsibility of learner to adapt to the learning environment. In terms of the delivery of types of knowledge (basic, procedural and conceptual knowledge), the lecturer uses different methods of instructions while teaching those topics. This is where lecturer aims at using pedagogical method to show learners how a topic can be understood based on three different types of knowledge. In lectures and tutorials, learners learn how to practice on "basic" and "conceptual" types of gained knowledge based on recall and understanding types of assessment questions, and in laboratory sessions, learners are given more control and learn how to practice their procedural knowledge to gain necessary competency on a topic. Hence, to reflect back on considering traditional learning style in terms of developing learning materials, experiential learning is the foundation stone of learning skills to raise the competency of a learner, which is what is shown here.

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