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ANALYSIS OF ELEARNING SUCCESS FACTORS

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Abstract: *In this paper, the DeLone and McLean's updated information system model was used to evaluate the success of an eLearning system and its courses. In order to adapt this model to eLearning, success metrics suitable for eLearning were defined for each of the evaluation stages. Furthermore, the success metrics for eLearning evaluation are expanded by providing several systems for quantifying the given success metrics. The results presented in this paper are based on courses that were taught both online and traditionally in three different subject areas: graphic design, information technology and management. Of particular interest were success metrics which can provide quantifiable data from the eLearning system itself, in order to evaluate academic achievement and usage of learning materials. The results from different courses were used to illustrate the implementation and evaluation of these success metrics for both online and traditional students.*

Keywords: *eLearning, distance learning, assessment factors*

1. INTRODUCTION

There is no doubt that computing is of great importance in today's society. Computers are involved in practically all major aspects of peoples' lives from private and social activities to business. People use computers for entertainment, learning, communication and management of home devices. It has become a regular routine for people to use computers daily for different purposes, so their lives would be almost unthinkable without them. Innovations in this area have enabled development and implementation of eLearning information systems in formal and informal education. Although substantial progress has been made to implement and use the Internet and computing technologies in learning, educators are still exploring different methods for best presentation of learning materials, as well as the best practices for effective presentation of learning materials and students' retention and understanding of presented knowledge. Many educators are interested in using eLearning systems, however, it is of great importance to have appropriate methods to evaluate the success of such systems.

While there was not much interest in evaluation of eLearning systems in the nineties, there are various opinions on ways eLearning systems success should be analyzed nowadays. Some authors suggest that evaluation of eLearning systems should be done through various aspects because of their multidisciplinary character. Models for evaluating success factors of eLearning can be: technology acceptance model, user satisfaction model, and eLearning quality model. Technology acceptance approach for evaluating eLearning mainly focuses on investigating factors that affect students when adopting eLearning system [1] [2]. User satisfaction assessment approach analyzes system success from the perspective of learner satisfaction investigating learners' perceptions of the relative criteria [3]. ELearning quality assessment approach evaluates the quality of the entire eLearning system, not just the service quality. Success is analyzed in terms of structure, content, delivery, service, outcomes and the quality perception of the eLearning [4] [5].

DeLone and McLean model investigates factors which are used for evaluating the success of designing and delivering information systems [6]. In this model authors took into account both the technological aspects of an information system, as well as different individual and organizational impacts. Holseapple and Lee-Post adapted DeLone and McLean's updated success model and used it to expend it for assessment of the eLearning system [7]. Holseapple and Lee-Post have fully defined a success metrics for evaluation of a Blackboard eLearning system. This paper examines the success factors adopted from DeLone and McLean's model, while expanding on the success metrics which are used for evaluation of eLearning systems. The evaluation and definition of success metrics is crucial for successful and effective eLearning system. Evaluation of an eLearning system is vital both for accepting its value and efficiency as for its understanding and acceptance in the society, which is crucial for the further development and expansion of eLearning.

This paper adopts DeLone and McLean's updated information systems model, and adapts its success metrics given for eCommerce in order to evaluate eLearning system. Evaluation was conducted by providing several systems for quantifying the defined success metrics. Sample metrics are evaluated based on the data gained from an eLearning system built on iOracle platform. The

results presented in this paper focus on analyzing quantifiable success metrics data such as usage of learning materials and academic achievements of students. In order to evaluate usage of learning materials and academic achievements of students, data from 136 courses in the area of information technology, graphic design and management were evaluated. The paper is organized as follows. Section 2 presents an eLearning assessment model based on DeLone and McLean's updated information systems model. This model is adapted and extended with success metrics which are specific to the eLearning system. In this section evaluation system for measuring specified success metrics is given. Section 3 presents the results of this research. Section 4 concludes the paper.

2. ELEARNING ASSESSMENT MODEL

The eLearning assessment model presented here is adopted from DeLone and McLean's updated information systems model [6]. This model presumes that evaluation is conducted by incorporating assessment factors grouped in six categories: information quality, system quality, service quality, use, user satisfaction, and net benefits (Figure 1). Even though this model has been used for evaluation of many different types of information systems, success metrics for each evaluation dimension needs to be specified. These success metrics may differ for different types of information systems. For example, some success metrics for eCommerce will differ from success metrics defined for eLearning systems. Delone and McLean in their work specified success metrics related to evaluation of eCommerce systems, while Holsapple and Lee-Post defined sample metrics for evaluation of eLearning systems based on the Blackboard platform [7].

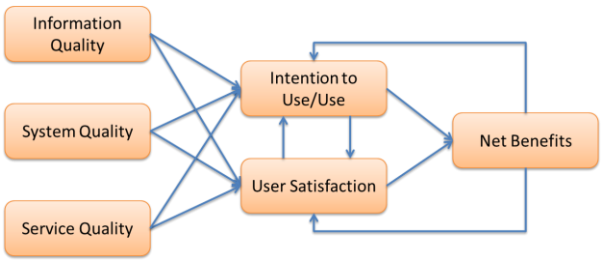

Figure 1. DeLone and McLean's updated information systems model

A particular interest of this paper is to investigate the model in the context of eLearning information systems The results which are discussed later in this paper are collected from the eLearning that uses iOracle eLearning system. Furthermore, metrics which are used are related to this platform. Evaluating eLearning systems on other platforms may vary with different metrics.

Three major dimensions of assessment model are system quality, information quality and service quality. These three dimensions represent quality assessment for system design. In the context of eLearning, system quality evaluates the characteristics and effectiveness of the used platform such as flexibility, stability, reliability, security, responsiveness and user-friendliness. Information quality evaluates the quality of course content and can use success metrics such as clarity, organization, presentation and currency of course materials. Service quality evaluates the quality of student-instructor interaction and can use metrics such as promptness, availability and helpfulness. The proposed success metrics for these three evaluation dimensions are given in Table 1. Furthermore, Table 1 compares the originally suggested success metrics for eCommerce developed by DeLone and McLean to success metrics which are more suitable for eLearning. It can be seen that the metrics in both cases are closely related, even though their application is different. However, the following three dimensions are system specific, and therefore, the success metrics for eLearning system will significantly differ from the eCommerce success metrics.

Table 1. Comparison of eCommerce and eLearning success metrics

Success factor	DeLone and McLean's eCommerce Success Metrics	eLearning Assessment Model Success Metrics
Systems quality	Adaptability Availability Reliability Response time Usability	Flexible for adaptation Flexible for personalization Stable Reliable Secure Responsive User-friendly
Information quality	Completeness Ease of understanding Personalization Relevance Security	Well-organized Consistent Clearly written Systematic Useful Personalizable to the individual learning needs Relevant to the subject
Service quality	Assurance Empathy Responsiveness	Displayed knowledge Availability Promptness Helpfulness

The use evaluation dimension measures to which degree the learning material is used and to which degree it is effective. These materials may include audio narrated power point presentations, video clips, reading assignments, examples, tutorials, homework assignments, practice examples, practice examinations, etc. The user satisfaction quality factor takes into consideration students' overall satisfaction with the course, their experience and whether they would recommend this course and style of learning to others.

The final stage of evaluating the success of eLearning system is the analysis of the system's outcome, both positive and negative. Ultimately, it is necessary to evaluate learning enhancement, academic achievement, time saving, and overall received and retained knowledge by students. However, according to DeLone and McLean's updated information systems model part of the evaluation has some negative aspects, as well. In context of eLearning negative aspects that should be taken into

consideration there are social isolation, dependence on technology and quality concerns.

Some of the aforementioned metrics in all six dimensions of evaluation of eLearning are not easily quantifiable. Some of them are based on the attitude of students, and their intent to use certain materials, while others take into consideration individual perceptions. Table 2 shows success metrics and proposes several methods which can be used to provide quantifiable results for their evaluation. Even though the surveys can be used to quantify the majority of the given metrics, their susceptibility to individual perception and attitudes may give bias results.

Table 2. eLearning success metrics for Use, User Satisfaction and Net Benefits

Success factor	*eLearning Assessment Model Success Metrics*	*System for evaluating success metrics*
Use	- Audio narrated Power Point presentation - Video clips - Tutorials - Reading assignments - Examples - Homework assignments - Practice examples - Practice examination	- Frequency of usage of learning materials
User satisfaction	- Overall satisfaction - Student's experience - Recommendability	Student survey: - Number of complaints - Evaluation grade for instructors given by students - Perceived importance of learning material - Whether a student would recommend this course - Active involvement in the learning process - Understanding the course materials - Stimulating interest in the subject - Understanding the professor - Obtaining feedback from the professor - Applying course material
Net benefit	- Learning enhancement - Academic achievement - Time saving - Gained knowledge	- Percentage of students that submit their assignments on-time - Percentage of students who fulfill the requirement to take final exams in the first examination period - Average passing grade percentage of students that passed the course - Average length of studies

3. RESULTS AND DISCUSSION

In this section we investigate the statistical metrics that can be derived from use and net benefit success factors. These data were obtained from the eLearning system based on iOracle platform. In the presented results we try to find the relation between these two success factors. The presented results involve iterations through net benefit and use stages of evaluation. First, in the net benefit factor we focus on two success metrics: percentage of students who took the final exams in the first examination period, as well as successive examination periods, and percentage of students that passed the course. Second, we analyze whether academic achievement relates to the frequency of usage of learning materials.

Part of the success metrics which were described in the previous section were analyzed based on the results from undergraduate programs for which all of the courses were offered parallely for online and for traditional students. Three undergraduate programs which were analyzed were courses in management (41 courses), graphic design (46 courses) and information technology (49 courses). As stated previously, the first evaluation stage focused on the success metrics for evaluating net benefits. Of particular interest was to determine the percentage of students who took the final exam (taken-exam rate) and percentage of students who passed the final exam (passing rate). Taken-exam rate represents the ratio of number of students who took the exam and total number of students registered for the course. Passing rate is defined as the ratio of the number of students who passed the exam and the total number of students registered for the course. These indicators are given aggregated, but also separately for traditional and online students. These two indicators were chosen due to the educational style at the University. It is mandatory that students complete their tests, homework tasks, and projects with a satisfactory grade, before they are allowed to take final exam. Students are allowed to take final exams during any of the eight provided examination periods, once they have completed their requirements.

Figure 2 shows taken-exam and passing rates for all of the undergraduate courses at the university, and compares the results for the online and traditional students. It is noticeable that both rates are much higher in case of traditional students when compared to percentages of online students. Compared to the traditional students whose taken-exam rate is 68%, online students had lower taken-exam rate of 23%, which lead to 34% of overall taken-exam rate for both groups of students combined. On the other hand, it can be noticed that passing rate does not differ much from taken-exam rate, which indicates the high level of preparation. In order to further analyze this success metrics, all three areas, management, graphic design and information technology, were analyzed separately.

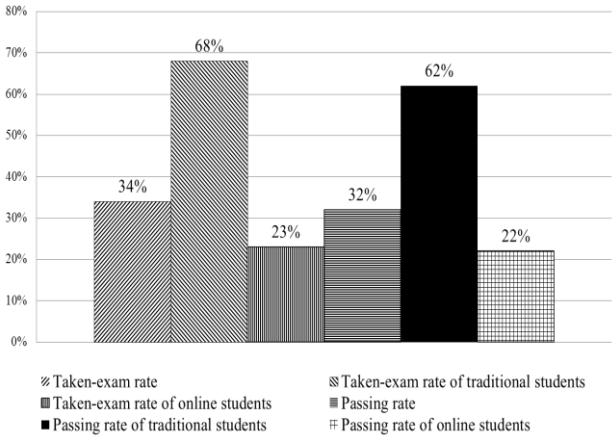

Figure 2. Taken-exam and passing rates for all undergraduate courses

Figure 3 shows comparison of taken-exam and passing rates for online and traditional students. These results are shown for all three areas: graphic design (GD), management (MG), and information technology (IT).

Results show that taken-exam rate for traditional students is the highest for IT, 73%, while the lowest is for MG, 55%. On the other hand, taken-exam rate of online students is highest for IT, 24%, while it is lowest for GD, 20%. As in the previously shown results in Figure 2, taken-exam rate does not differ much from passing rate. It can be noticed that differences in taken-exam and passing rates for each subject area shown in Figure 3 and cumulative results shown in Figure 2 are not that significant. It can be noticed that online students are remarkably less successful at all of three areas.

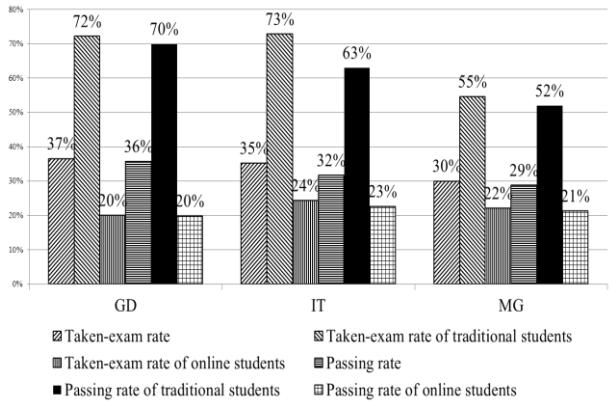

Figure 3. Taken-exam and passing rates for GD, IT and MG courses

Table 3 shows taken-exam rates for courses in all three areas, analyzed based on the examination periods. Eight examinations periods that are available throughout the academic year are labeled based on the month when they are conducted. It can be seen that the final examination periods taken in January, April and June are the periods when most students fulfill the requirements to take the exams, as the taken-exam rates are higher.

Nevertheless, taken-exam rates for online students, when analyzed for individual examination periods, is lower than the same rates for traditional students. January and June examination periods occur a few days after the end of the semester. Hence, this may indicate that students who are consistent with their course activities throughout the semester are most likely to be ready to take exams at the earlier times.

Table 3. Taken-exam rates compared at different examination periods („T“ and „O“ represent rates for traditional and online students, respectively)

	January		April		Jun		September	
	T	O	T	O	T	O	T	O
IT	25	7	8	4	20	6	7	2
GD	26	5	9	4	24	5	5	3
MG	20	8	15	4	15	4	7	3
	October 1		October 2		November		December	
	T	O	T	O	T	O	T	O
IT	4	1	6	2	1	1	1	1
GD	2	0	5	3	1	1	1	0
MG	1	2	5	3	0	1	1	1

In order to make comparisons at course level, analyses were conducted for six different courses, two courses from each area. Courses were selected based on their exam passing rates, so that within one area two courses can be compared, one with higher and another with lower passing rates. IT course 1 and IT course 2 were analyzed in IT area, MG course 1 and MG course 2 were selected courses in MG and GD course 1 and GD course 2 were analyzed courses in GD. Figures 4, 5 and 6 show chosen indicators at course level for IT, GD, and MG, respectively. In all three cases the first course (displayed on the left) is a course with a lower passing rate and the second one (displayed on the right) is a course with a higher passing rate. All of the shown rates indicate more success of traditional students compared to online students.

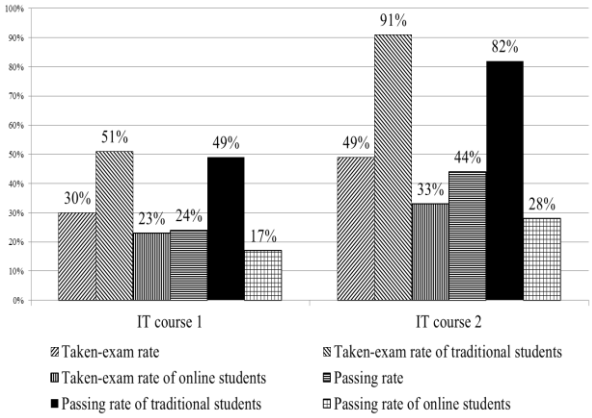

Figure 4. Taken-exam and passing rates for *IT course 1* and *IT course 2*

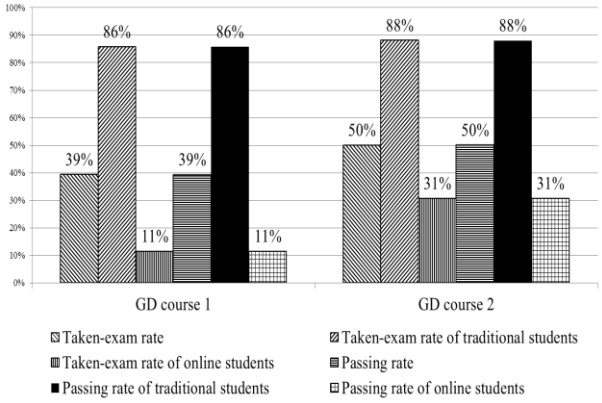

Figure 5. Taken-exam and passing rates for *GD course 1* and *GD course 2*

These findings are consistent with the previous results which were analyzed on the cummulative level. However, even though both rates are lower for online students when compared to traditional students, these metrics do differ between individual courses. Due to these findings we move away from net benefits success metrics, and further analyze use success metrics for these particular courses. It is of particular interest to analyze whether these academic success findings relate to the frequency of learning material usage. In particular, it is of interest to determine the usage of audio narrated power point presentations

along with the reading materials. In all six courses, materials are devided in 15 separate lectures, each providing one audio presentation and one written lesson for each lecture.

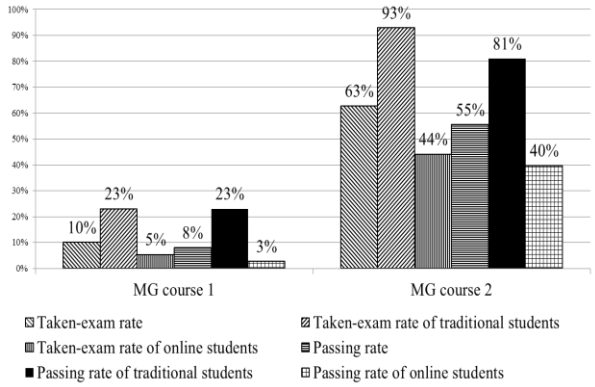

Figure 6. Taken-exam and passing rates for *MG course 1* and *MG course 2*

The usage of the audio narrated power point presentations is measured through the amount of the listened portion of the material, while the usage of written lessons is determined whether they have downloaded the lecture from the system. The usage of audio presentations is divided into eleven intervals, ranging from *"never used",* meaning that they have never attempted to open the material, to *"more than 55 hours",* meaning that they have used mostly all of the material. The provided results are presented as number and percentage of all students. The average time of use is compared to the average duration of presentation, which is expressed in percentages.

Tables 4, 5 and 6 show comparison of used audio narrated power point presentations among previously analyzed courses, IT course 1 and IT course 2, *GD course 1* and *GD course 2*, and *MG course 1* and *MG course 2*, respectively. Table 4 shows a noticeable difference in percentage of students who have never used presentation (55% compared to 25%), as well as less time spent per student (92 minutes compared to 227 minutes). The average time of use compared to the average duration of presentation shows a significant difference between two courses - students have approximately used only 5,25% of full presentation in case of *IT course 1* and 33,78% at *IT course 2*. Similar results were found in the other two course groups, where students have approximately used only 7,38% of full presentation in case of *GD course 1* and 33,3% in *GD course 2* (Table 5). Furthermore, 6,6% of average presentation was listened in the case of *MG course 1* and about 35% of *MG course 2* audio narrated material (Table 6).

Figure 7 summarizes the results of the average time of use compared to the average presentation duration. Students have approximately used only about 5-7% of average presentation in case of *IT course 1, GD course 1* and *MG course 1*, which are courses with lower exam passing rate. On the other hand, more than 30% of presentations were used at *IT course 2, GD course 2* and *MG course 2* higher passing rate courses. It can be noticed from these findings that in courses which have lower passing rate, students spent less time viewing and analyzing learning materials.

Table 4. Comparison of *IT course 1* and *IT course 2* in terms of usage of audio narrated power point presentations

Duration of a presentation use	IT course 1 (lower exam passing rate - 17%)		IT course 2 (higher exam passing rate- 28%)	
	Number of students	Percentage of students	Number of students	Percentage of students
Never used presentation	65	55%	36	25%
Less than 5min	6	5%	18	12%
5min-30 min	5	4%	32	22%
30min-60min	3	3%	8	6%
60min-5h	13	11%	27	19%
5h-15h	12	10%	15	10%
15h-25h	5	4%	3	2%
25h-35h	2	2%	3	2%
35h-45h	1	1%	2	1%
45h-55h	1	1%	0	0%
More than 55h	5	4%	1	1%
Total	118	100%	145	100%
Average time of use per student	92 min 17sec		227 min 28sec	
Average time of use compared to average duration of presentation (%)	5.25%		33.78%	

Table 5.Comparison of *GD course 1* and *GD course 2* in terms of degree of audio narrated power point presentation use

Duration of a presentation use	GD course 1 (lower exam passing rate - 11%)		GD course 2 (higher exam passing rate - 40%)	
	Number of students	Percentage of students	Number of students	Percentage of students
Never used presentation	13	52%	25	51%
Less than 5min	3	12%	4	8%
5min-30 min	5	20%	3	6%
30min-60min	1	4%	1	2%
60min-5h	1	4%	3	6%
5h-15h	1	4%	6	12%
15h-25h	1	4%	4	8%
25h-35h	0	0%	1	2%
35h-45h	0	0%	1	2%
45h-55h	0	0%	0	0%
More than 55h	0	0%	1	2%
Total	25	100%	49	100%
Average time of use per student	73 min 49sec		313 min	
Average time of use compared to average duration of presentation (%)	7.38%		33.33%	

We also compare these findings with the usage of written lessons, which students download from eLearning system in pdf format. Usage of these learning materials were analyzed in three different categories: *never used, used less than half, used more than half*. Table 7 shows comparison of usage of written materials for all six courses. We can notice that taken-exam rate can be related to the number of students who have accessed learning materials. For instance, in the *IT course 1* 36.44% have accessed written lessons, while taken-exam rate for this course was 30%. Similarly, 52.58% have

accessed the material, while 63% was the taken-exam rate for the *MG course 2*. It can be seen that these findings are consistent with the usage of audio materials and passing rates for each course. It is intuitive to notice that students who have not accessed learning materials will most likely not be able to complete their homeworks, tests and projects, leading to a lower taken-exam and passing rates.

Table 6. Comparison of *MG course 1* and *MG course 2* in terms of degree of audio narrated power point presentation use

Duration of a presentation use	MG course 1 (lower exam passing rate - 3%)		MG course 2 (higher exam passing rate - 40%)	
	Number of students	Percentage of students	Number of students	Percentage of students
Never used presentation	30	67%	42	43%
Less than 5min	1	2%	3	3%
5min-30 min	11	24%	18	19%
30min-60min	2	4%	3	3%
60min-5h	0	0%	22	23%
5h-15h	0	0%	3	3%
15h-25h	0	0%	3	3%
25h-35h	1	2%	1	1%
35h-45h	0	0%	0	0%
45h-55h	0	0%	0	0%
More than 55h	0	0%	2	2%
Total	45	100%	97	100%
Average time of use per student	47min 37sec		281min 20sec	
Average time of use compared to average duration of presentation (%)	6.60%		35.00%	

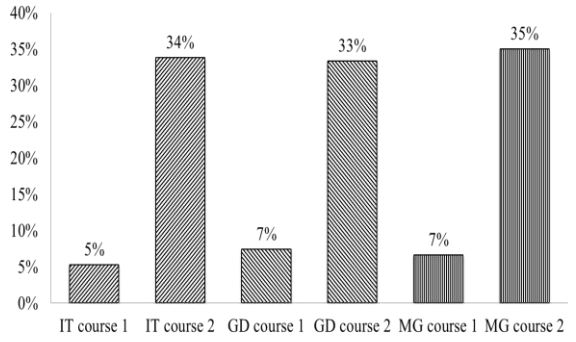

Figure 7. Average time of use compared to average presentation duration for given courses

Table 7. Usage of written lessons

	Never used	Used < 1/2	Used > 1/2
IT course 1	63.56%	15.25%	21.19%
IT course 2	31.03%	32.42%	36.55%
GD course 1	60.00%	24.00%	16.00%
GD course 2	57.14%	14.29%	28.57%
MG course 1	64.44%	4.44%	31.11%
MG course 2	47.42%	24.74%	27.84%

4. CONCLUSIONS

A model for evaluation of eLearning success factors and its success metrics were presented. Of particular interest were metrics that provide quantifiable data independent of students' perception. Compared to traditional students, online students have shown lower taken-exam and passing rates. It was shown that while online students had lower passing rates in courses, one of the contributors for this may lay in the fact that majority have never used the assigned learning materials. Future work should further analyse quantitative along with qualitative success metrics presented in the model. Combined qualitative and quantitative metrics should point out not only students' attitude towards eLearning and learning in general, but also their learning styles and lifestyle attitudes which can be used for further improvement and personalization of eLearning.

5. ACKNOWLEDGMENT

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