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Design, development, and implementation of a new adaptive education system: Case Study; Misurata University

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Abstract:

Research into computing-based education recommends considering the individual differences among students because that will positively impact their performance and engagement. This paper, by designing a new adaptive education system and applying an empirical experiment, aims to investigate deeply the impact of using the new adaptive system on the performance of students. Whereby, three experiments were conducted with (40 undergraduate students) in total. The results revealed a statistically significant difference between the scores of the students when they learned using the new system and their scores when they learned without it.

Keywords: design- development- Educational system- Individual differences.

تصميم، تطوير وتنفيذ نظام تعليمي متكيف جديد:

دراسة حالة؛ جامعة مصراتة

د.الزين مفتاح الزين

جامعة مصراتة

الملخص:

البحث العلمي في مجال التعليم القائم على الحوسبة يوصي بالنظر في الفروق الفردية بين الطلاب لأن ذلك سيؤثر بشكل إيجابي على أدائهم ومشاركتهم. هذه الورقة، ومن خلال تصميم نظام تعليمي متكيف جديد وتطبيق تجارب تجريبية عليه، تهدف إلى التحقيق بعمق في تأثير استخدام هذا النظام على أداء الطلاب. حيث أجريت ثلاث تجارب على (40 طالبًا جامعيًا). وكشفت النتائج عن فروقات ذات دلالة إحصائية بين درجات الطلاب عندما تعلموا باستخدام النظام الجديد ونتائجهم عندما تعلموا بدونه.

الكلمات المفتاحية: تصميم– تطوير – نظام تعليمي– الفروق الفردية.

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1 Introduction

1.1 Adaptive Education Systems

Although considering individual differences among learners play an important role to increase students engagement in the classroom, traditional educational systems usually offer the same educational resources and teaching methods for all learners (Brusilovsky 2001,p88). For this reason, researchers in the computing-based education field have developed adaptive education systems, to take into account students' differences, needs, and abilities . In order to achieve the adaptation process and match the students' needs with available educational material, the system first needs to detect the preferred learning style of students. In 2012 Feigh defined Adaptive Education Systems as a "technological component of joint human–machine systems that can change their behavior to meet the changing needs of their users, often without explicit instructions from their users" (Feigh, Dorneich et al. 2012,p1008). In this context, Özyurt carried out a review study in 2015, this study revealed that about (69.6%) of previous adaptive education systems relied on learning style instruments to find out students' preferences (Özyurt, Özyurt 2015, p349).

1.2 Learning Style

Although researchers present a number of slightly different definitions of learning style, these definitions are generally tackling the styles of learners in terms of the way of receiving new information and how interacting with it (Truong 2016,p1185, Hawk, Shah 2007,p11); for example, the learning style was defined by Kolb as a "generalized difference in learning orientation

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based on the degree to which people emphasize the four modes of the learning process" (Kolb 2014, p40).

Based on the above, it can be said that the learning style is the patterns of educational materials and teaching way that students prefer (Alshammari 2016,p94, Alzain, Clark et al. 2016,p30).

1.3 Learning style instruments

As mentioned earlier, learners have different learning styles. Therefore, based on learning style models, researchers have designed many instruments to detect the preferred style of students. in this research, the proposed adaptive system has relied on the ALSI instrument to detect the learning preferences of participants. ALSI was developed in 2016 by Alzain, who followed a rigorous procedure to ensure the validity and reliability of the instrument. Moreover, the items of instrument was designed using different forms of information (visual and verbal) this is for the purpose of motivating all types of students equally.

1.4 Research question

What is the impact of using the new System on the performance of students ?

To answer this question three experimental studies was conducted using a new adaptive education system.

2 Research methodology

2.1 Systems Design and Development

The new adaptive educational system was a Web-based . This system provide the most suitable educational material that fit different needs of students. ASP.NET programming language and MSSQL database system

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were used to develop this system. in order to achieve the adaptation process and provide students with the most suitable materials and activities, The architecture of the system was as follows:

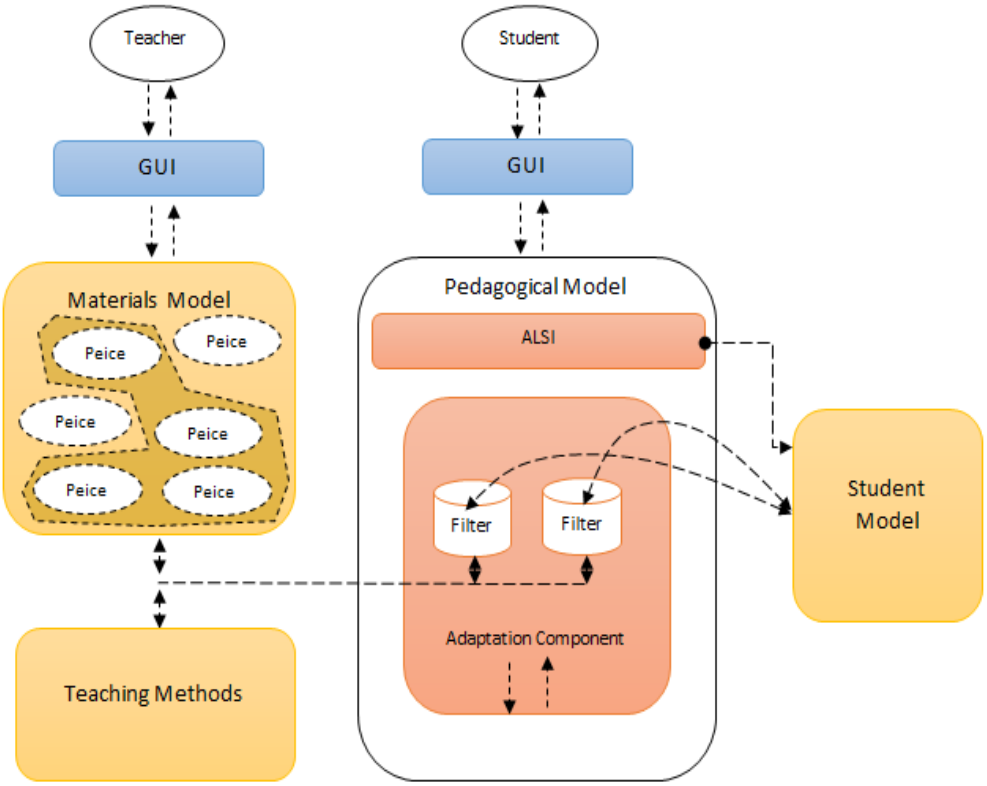

Fig1: architecture of proposed system

As shown above, the system includes four domains which are:

- Materials Model: contains the pieces of educational content; which presented in different styles.
- Student Model: contains details of students and their preffered learning style.

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- Model of Teaching methods : includes details of different teaching strategies and relevant activities.
- Pedagogical Model: this model consists of two sub components which are :
    - Preferences Detection Unit: contains the ALSI instrument to find out the preferred learning style of student; where the student needs to answer the items of ALIS, which is 16 questions; each of which has 4 choices; and each choice corresponds to one learning preference. The student has to determine the priority level from 0 (least important) to 3 (most important). Based on the above, the highest possible score for each learning style is 48;
        - Visual Preferences (VP) = $\sum_{Q=1}^{16} V$;
        - Verbal Preferences (EP) = $\sum_{Q=1}^{16} E$;
        - Preferred Style of Receiving new information (PSR) = VP – EP;
        - Active Preferences (AP) = $\sum_{Q=1}^{16} A$;
        - Reflective Preferences (RP) = $\sum_{Q=1}^{16} R$;
        - Preferred Style of Interacting new information (PSI)= AP-RP;
    - Adaptation unit: contains the rules that organize the relationship between the three previous models (student model, Materials model and teaching methods model). These rules determine which piece of content and teaching strategy are most suitable for a specific learning style; Figure 2 explains

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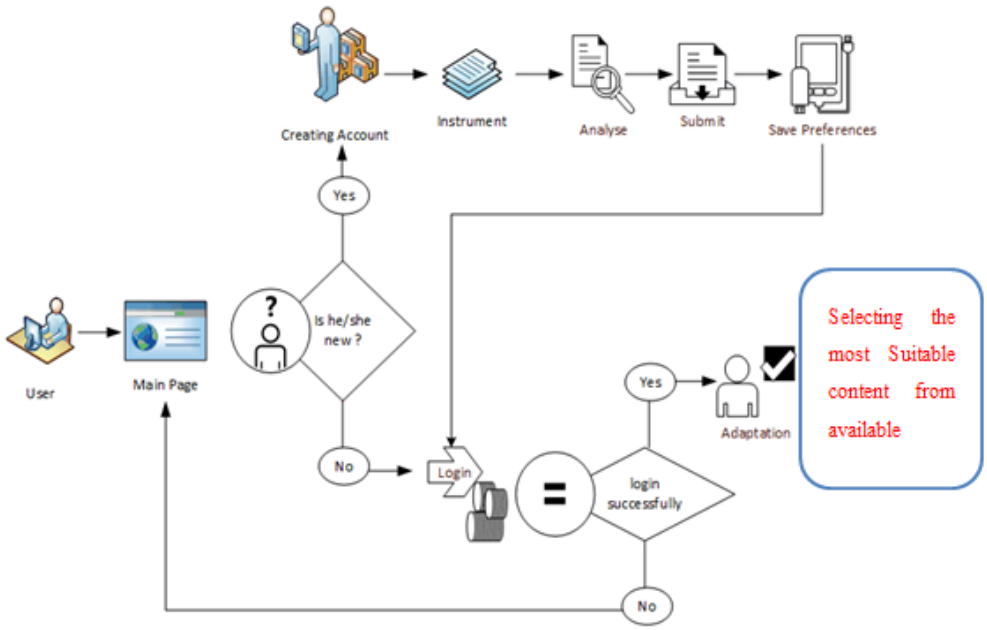

Fig2: adaptation unit of proposed system

2.2 Systems Implementation

As mentioned above, the key research point was investigating the impact of using the new adaptive system on the performance of students, therefore; three experiments were conducted to know, if students who learned using the system got more knowledge than others who learned without the system.

3 Results

3.1 Experiment I

10 undergraduate students participated in this experiment, and the module title was (Formal Languages and Automata Theories), which is offered by the Faculty of Information Technology at Misurata University. The results of investigating the preferred learning style using ALSI indicated that the

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participants were more visual and active than verbal and passive, and most of them had moderate learning preferences. In this experiment, the student performance was measured using (pre-test and post-test). Generally, the mean participant scores when they learnt using the new system (Mean = 9.60) which is greater than the mean scores when they learnt without the system (Mean = 5.30). To know if there is any significant difference between the mean scores a dependent sample t-test was also conducted, and the results of this test were as following

Table1 : Experiment I - Results of t-test(n=10)

.Paired Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	With Out System	5.30	10	4.547	1.438
	With System	9.60	10	5.038	1.593

Table2 : Experiment I - Results of t-test(n=10)

Paired Samples Test									
		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	With Out System – With System	-4.30	5.926	1.874	-8.539	-0.061	-2.294	9	0.047

As shown in Table 1, 2 the results indicate that there was a statistically significant difference between the mean scores of the participants when they

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learnt with and without the system .t (10) = -2.294, p = 0.047. Moreover, the results of the effect size test (Cohen's d) revealed that the visual students had the highest effect size (d = 1.31) followed by the active students (d = 0.89).

3.2 Experiment II

another experiment was conducted with a different course titled (Computer Fundamentals), which was offered by the Education Faculty at Misurata University. In this experiment, sixteen students participated, and the results of investigating the preferred learning style using ALSI indicated that the participants were more visual and active than verbal and passive. The same methodology (pre-test and post-test) was used to measure the impact of using the new adaptive system on students' performance, who learned once a time without this system and another time with using the system. The results show that the mean participant score when they learnt using the new system was (16.13) which is greater than the mean scores when they learned without the system (9.94). To know if there is any significant difference between the mean scores a dependent sample t-test was also conducted, and the results of this test were as follows:

Table3 : Experiment II - Results of t-test(n=16)

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Without System	9.94	16	8.744	2.186
	With System	16.13	16	9.667	2.417

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Table4 : Experiment II - Results of t-test(n=16)

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Without System – With System	-6.188	10.815	2.704	-11.950	-0.425	-2.289	15	0.037

As shown in Table 3, 4 the results indicate that there was a statistically significant difference between the mean scores of the participants when they learned with and without the system. t (16) = -2.289, p = 0.037. Moreover, the results of the effect size test (Cohen's d) revealed that the visual students had the highest effect size (d = 0.771) followed by the verbal students (d = 0.32)

3.3 Experiment III

The last experiment was also conducted at the Faculty of Education at Misurata University with a number of students (n = 14) studying for (the Programming Languages) module. As a result of applying the ALSI, the participants were found to be more active and visual than passive and verbal. furthermore, The performance of students was measured whereby, the mean participant score when they learned without the system (14.29) was less than the mean participant scores when they learned using this system (22.14). The results of a dependent sample t-test (t (14) = -1.724, p = 0.048) indicated a statistically significant difference between the results of students. See table 5,6.

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Table5 : Experiment III - Results of t-test(n=14)

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	WithOut System	14.29	14	12.83	3.43
	With System	22.14	14	11.21	2.99

Table6 : Experiment III - Results of t-test(n=14)

Paired Samples Test

		Paired Differences					t	df	Sig. (1-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	WithOut System – With System	-7.857	15.281	4.084	-20.160	4.445	-1.724	13	0.048

According to the results of Cohen's d test, the highest effect size (d = 0.56) was in the active style followed by the visual style (d = 0.55).

4 Conclusion

In general, it is clear that individual differences among students (learning styles) are one of the most important things that should be considered in our teaching strategies, adaptive education systems have been designed to

manage these differences. In this study, three empirical experiments were conducted using the new adaptive education system, and the results revealed that using the new adaptive education system has a positive impact on student performance, the results also indicate that IT students were found to be more visual and active than verbal and passive. Moreover, the students with the visual style were the most affected by the system.

References

- ALSHAMMARI, M.T., 2016. Adaptation Based On Learning Style And Knowledge Level In E-Learning Systems, Ph.D thesis, University of Birmingham.
- ALZAIN, A.M., CLARK, S., IRESON, G. and JWAID, A., 2016. A study of the reliability and validity of the first Arabic learning styles instrument (ALSI), Sustainable Technologies (WCST), 2016 World Congress on 2016, IEEE, pp. 29-34.
- BRUSILOVSKY, P., 2001. Adaptive hypermedia. User Modeling and User Adapted Interaction. Ten Year Anniversary Issue (Alfred Kobsa, ed.), 11(1/2), pp. 87 - 110.
- FEIGH, K.M., DORNEICH, M.C. and HAYES, C.C., 2012. Toward a characterization of adaptive systems: a framework for researchers and system designers. Human factors, 54(6), pp. 1008-1024.
- HAWK, T.F. and SHAH, A.J., 2007. Using learning style instruments to enhance student learning. *Decision Sciences Journal of Innovative Education*, **5**(1), pp. 1-19.
- KOLB, D.A., 2014. *Experiential learning: Experience as the source of learning and development.* FT Press.
- ÖZYURT, Ö and ÖZYURT, H., 2015. Learning style based individualized adaptive e-learning environments: Content analysis of

Scientific Journal of Faculty of Education, Misurata University-Libya, Vol. 9, No. 23, Sep. 2023
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تاريخ الاستلام 2023/04/28 تاريخ النشر 2023/09/01

the articles published from 2005 to 2014. Computers in Human Behavior, 52, pp. 349-358.

- TRUONG, H.M., 2016. Integrating learning styles and adaptive e-learning system: current developments, problems and opportunities. *Computers in Human Behavior,* **55**, pp. 1185-1193.