Developing a Teaching Model Using an Online Collaboration Approach for a Digital Technique Practical Work

By MUCHLAS

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Muchlas
Ahmad Dahlan University, Yogyakarta , Indonesia
muchlas.te@uad.ac.id

ABSTRACT
This research is aimed to produce a teaching model and its supporting instruments using a collaboration approach for a digital technique practical work attended by higher education students. The model is found to be flexible and relatively low cost. Through this research, feasibility and learning impact of the model will be determined. The model has been tested by some experts of learning multimedia, digital engineering, e-learning and instructional design, and analyzed using a Delphi technique. The model was also tested by 10 instructors and 25 students of the Electrical Engineering Department. The perception of the subjects was then analyzed using a percentage method. The determination of learning impact was done using a different average score. From the results obtained, the developed model: (1) could be implemented with more flexible and low cost to support the practical work in higher education; (2) has a positive impact on the learning, i.e. it can improve significant students' learning achievement; and (3) shows good perception from the subjects.

Keywords: developing, teaching model, online collaboration

INTRODUCTION
In academic activities, practical work (practicum) that is usually run using hands-on labs has a weakness such of costly, inflexible and lack of student motivation. Further work, Ma & Nickerson (2006) reported that the characteristics of a hands-on labs introduces some disadvantages such of: (1) materials procurement and operation are expensive; (2) require more time for instructors; (3) makes students feel less comfortable during their work; (4) can not provide a special needs for students; and (5) can not serve the needs of the distance learning.

Elawady & Tolba (2009) reported that use of virtual laboratory in the practical work can offer an alternative technique of a practical work with more flexible, appropriate for purpose conceptual understanding, low cost, and has a better pedagogic aspects compare than other laboratory types. Macias & Mendez (2007) illustrate that the costs needed in that technique is much cheaper than the cost of a traditional laboratory. In addition, the use of virtual labs also provides benefits of increasing number of lab sessions and number of teams/groups of students per week.

Practical work run using a virtual lab can increase the financing efficiency because the system is based on a simulator that uses the available computer program. Previous studies showed that using simulators: (1) can increase students' understanding of learning material in practical work activity (Colace, et al., 2004), (2) can be as effective as using a real laboratory (Kantzavelou, 2005; Tzafestas, et al., 2006; Corter, et. al, 2007; Lang, et al., 2007; Wolf, 2010; Goodwin, et al., 2011), (3) can be more efficient than using a real laboratory (Candelas, et. al, 2006; Saleh, et al., 2009), and (4) provides convenient and high flexibility in practical work (Mateev, et al. 2007; Bailey & Freeman, 2010). By referring to the above advantages, we can say that the use of simulators to substitute a hands-on lab can enhance a students' learning achievement.

Shokri & Faraahi (2010) refer to the work of Malki & Matarrita (2002), and also Palagin, et al. (2007) reported that by using the simulator they have obtained some advantages of (1) relatively low cost of product, (2) more secure during the experiment from any hazardous substances, (3) practical work activities are more flexible because students can change the work environment, procedures or types of experiment quickly with low cost, (4) broad accessibility, because it can be accessed from anywhere and anytime, and (5) enable to create collaborative work.

Alessi & Trollip (2001) reported that by comparing with the real activities, simulation model provides some advantages such as: (1) increasing safety when interacting with objects or physical phenomena being studied; (2) providing an experience that is difficult to be experienced in the real world; (3) easy in setting the time of activity; (4) making the rare events become regular events; (5) enabling a complex learning situation can be controlled; and (6) allowing to save cost. Meanwhile, by comparing between media and other methods such as books, regular lectures, or tutorial, the use of simulation provides some advantages such of: (1) build the motivation; (2) improve the transfer of knowledge; (3) perform more efficient; (4) perform more flexible; (5) apply to all phases of a learning process; and (6) show more adaptive for different educational philosophy.

Practical work using the virtual lab can be more flexible if this technique could be implemented using an online learning. Therefore, one solution to overcome that weakness is using an online system to run the practical work activities. The online teaching models has been developed by Candelas, et. al. (2006), Mateev, et al. (2007), Saleh, et al. (2009), Radu (2010), Shokri & Faraahi (2010), Hassan, et al. (2010), and Goodwin, et. al. (2011). Their works were done using online learning system, but has not facilitated using a collaboration method that is considered able to improve the results. The online collaboration is an approach that will determine the success of practical work because this approach can motivate the individuals in group work, and as a medium of learning among individuals (Kask, 2009).

In this research, the model and its supporting instruments will be produced, and derived from Anderson (2008), for an online teaching for practical work. The developed model will provide an online collaborative environment to support practical work in digital technique. This study is also aimed to determine the feasibility and learning impact of the model. The results of this research can be used as an alternative learning model in higher education that introduces more flexible and low cost of practical work.

RESEARCH METHOD

Experiment was done using a method consists of some sections below.

(i) Research Type and Procedure

This research was conducted through several steps of preliminary study, planning, preliminary model development, preliminary test, main model revision, field test, final model revision and model dissemination, from Borg & Gall (1983). Furthermore, the model was validated and revised by some experts. The model was tested by subjects in online practicum activities for 8 sessions. Based on the results of testing, the model is then conducted into the final revision. The final stage of the model development is dissemination to potential users.

(ii) Research Subjects

The subjects were divided into two categories i.e. the subjects for preliminary testing and field testing. In preliminary testing, the model was tested by four experts of learning multimedia, digital engineering, e-learning and instructional design, respectively which were selected purposively. Meanwhile, the subjects of the field testing were 10 instructors and 25 students of the Department of Electrical Engineering, which were participants of the digital technique lecture/lesson.

(iii) Data, Instruments, and Data Collection Techniques

In this research, type of data is classified into three categories i.e. data for the purposes of analyses of: (1) the experts judgement; (2) the learning impact; and (3) perception of the subjects to the developed model in the instructional and presentation aspects. The instruments to measure data related to the expert judgement is a questionnaire form. In this study, aspects of the experts validation includes: (1) identification of the problems; (2) determination of priority in type and model manufacture; (3) determination of the program goals; (4) structure and components of the model; and (5) instruments of the model. To obtain data for validation of the lessons plan (one of the supporting intruments of the model), it was used a questionnaire containing aspects of: (1) identity of the subjects matter; (2) basic competencies and indicators of the learning outcomes; (3) subject matter; (4) students activities in the learning process; (5) lecturer activities in the teaching; (6) assessment of learning; and (7) references. Data to validate the Digital Technique textbook were obtained through questionnaire including aspects of: (1) cover; (2) basic competencies and objectives; (3) subject matter; (4) graphics; (5) presentation; (6) language; (7) evaluation; and (8) references. Data related to the validation of the manual for an online practicum for lecturers/instructors/students as well as the manual for breadboard simulator were obtained through the questionnaires containing aspects of: (1) cover; (2) subject matters; (3) graphics; (4) presentation; and (5) language. Meanwhile, data to validate the manual for digital technique practicum were obtained through questionnaire with aspects of: (1) cover; (2) subject matters; (3) presentation; (4) language; and (5) evaluation.

Test of the learning effect was done by using the data obtained through the *pre-test* and *post-test* instruments. *Pre-test* instrument was given before a practical work and the post-test done. Both tests were done at each practical work session. The instrument of perception test in an instructional aspect is questionnaire containing some components of: (1) clarity of basic competences and goals; (2) clarity of the learning instructions; (3) ease of understanding the subject matter of practicum; (4) the breadth and depth of the subject matter; (5) the accuracy of the sequence of presentation; (6) interactivity; (7) flexibility; and (8) the accuracy of evaluation. Data related to the perception test in the model presentation aspect were obtained through questionnaire containing some components of: (1) clarity of the instructions for use; (2) legibility; (3) quality of image and animation; (4) composition of color; (5) quality of communication facilities; and (6) ease of operation.

(iv) Data Analysis Techniques
To find out the validity of the developed model, a Delphi technique was used based on the consensus accepted by the experts. The consensus included the aspects of: (1) identification of the problem through a needs analysis; (2) determination of priority (type and model manufacture); (3) determination of program objectives; and (4) determination of the problem solution. Percentage of each aspect of the validation was predetermined before analysis. To determine the feasibility of the model, some criteria were used as shown in Table 1. To determine the effect of model developed, different test of average score between *pre-test* and *post-test* was used. Subject perception was determined through descriptive analysis using percentage of criteria as tabulated in Table 1.

Table 1. Criteria of the feasibility model and perception

Range	Level
80% - 100%	Very Good
66% - 79%	Good
56% - 65%	Poor
0% - 55%	Very Poor

FINDINGS AND DISCUSSION

From the research, model validity justified by the expert are shown in Figure 1. Based on that figure, the consensus given by the experts on the aspect of problem identification is 86.5% or categorized as 'very good' level. This means that the model developed based on a needs analysis is accurate respect to: (1) demands on needs of education; (2) demands on the development of science, technology and dynamics of the work places; (3) needs of potential users of the model; (4) demands on the effectiveness and efficiency improvement in an educational process; (5) a comprehensive needs analysis; and (6) type of model which can applied to the real world. Based on the analysis and validity criteria, it can be argued that from the problem identification aspects, the developed model considered by the experts is very feasible for further implementation.

From the aspects of determination to model type, the experts consensus toward validity of the model gives a percentage of 89.6%. The experts have agreed that: (1) determination of the developed model type is a priority for problems solution; (2) the developed model type can contribute to satisfy the needs of education; (3) the development of the model is an appropriate solution to solve the problem; (4) the developed model can improve the efficiency and effectiveness of education; (5) the model development is feasible by the reseacher; and (6) the developed model type can be applied into the real world.

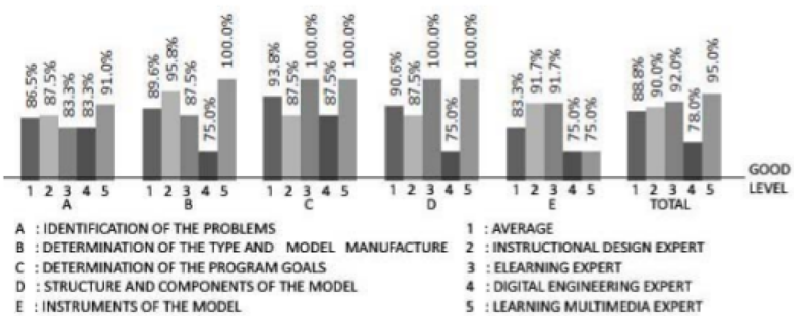

Figure 1. Histogram of experts' consensus for the model.

The results show that three experts mark a level of consensus over 80% except the digital engineering expert that gives a feasibility level for 75% or worthy category. This is due to the consideration of digital engineering expert that determination of developed model should be based on the character of the subjects matter that will be practiced. Not all courses can be conducted in practical work through virtual online models, but the proposed model could cover wider scope of courses. However, from the aspect of determination of model type, with the consensus level of 89.6 %, the model is very feasible for implementation.

For determination of the program goals aspects as shown in Figure 1, the experts agree that the goals of the model development correlates to the problem solution that is a priority problem to be solved and the formulation has directed to the increase of educational effectiveness and efficiency. Consensus of average percentage of

93.8% has shown that the developed model, based on goal-setting aspects of the program is very feasible for implementation.

Furthermore, from the aspect of the structure and components of the model as shown in Figure 1, it is seen the experts have agreed that the developed model has adequate structures and components. In this case, the developed model: (1) has been described in forms of the structure that contains the components, (2) has its structure that is different from the existing models, (3) has relationships among its components that has been described clearly; (4) contains a clear and appropriate setting, (5) contains a syntax that can support achievement of competency standards, in line with the methods and learning approaches used, and can be implemented easily.

For the aspect of model determination and the structure and components, the consensus of digital engineering expert has a lowest percentage i.e. 75% (good level), meanwhile three other experts have categorized as 'very good' level of consensus. They consider that the structure and components of the model are not a new model at all, but rather the development of one component i.e. innovation in part of interaction among the students from offline into online collaboration approach, particularly in the use of simulator. The expert suggests to describe the difference between the developed model and the existing models. However, as a whole, from the aspect of the structure and its component, with an average consensus percentage of 90.6%, this developed model is very feasible for implementation.

The final aspect of the validity used by some experts to determine the feasibility of the model in this study is the instruments of model. In this case, the instruments of model cover all learning instruments supporting the implementation of the model. With an average percentage of 83.3%, from the graph (Figure 1), it can be argued that the experts agree to declare that the developed model has been equipped with adequate learning instruments which is easy to understand, implement, and can help the implementation of the model.

From Figure 1, it is shown that two experts of learning multimedia and digital engineering expert give a 'good' level of consensus and two other experts give a 'very good' level of consensus. This is because the learning multimedia expert considers that when this model was being consulted, the virtual lab as one instrument of the model that able to support the practical work. This still needs a revamping process in presentation and content aspects. Meanwhile the digital engineering expert considers that the textbook and manual of simulator as the instrument of the model should be revised in some parts to satisfy the characteristics of digital engineering field. However, in general the experts have agreed that the instrument aspect point of view, the developed model is very feasible to be implemented.

Figure 1 shows that the average consensus for all aspects respect to the model developed is 88.8 %. This result shows that the experts agree that this model of research is 'good' to be implemented. The interesting phenomenon we could see from the result is that e-learning expert and learning multimedia expert give about 100% for three of five aspects obtained.

The results of the learning impact analysis for the application of the model are shown in Table 2. Analysis of the learning impact has been done to determine the effectiveness of the model that has been validated by the experts in a learning process in the digital engineering practical work. Research subjects were given as a pre-test before attending the practical work activity with the developed model, and doing the post-test after the end of session. Pre-test and post-test were conducted in online with a monitoring through video conference facilities by the instructor.

In this test of learning impact, measurement of effectiveness is done by determining the significant difference between the average of value test of group before practical work (pre-test) and after practical work (post-test) at each session using a t-test. The criteria used are the value of the post-test and pre-test defined significantly different if the resulting t-test has error probability (p) less than 5%.

Table 2. Summary of analysis of learning impact

Session	Variable	Average	Standard Deviation	Average Diff.	t	p	Significance
I	Post-test 1	71.25	23.831	17.50	3.911	0.001	Significantly (p<0.005)
	Pre-test 1	53.75	25.844				
II	Post-test 2	60.83	13.805	11.25	3.576	0.002	Significantly (p<0.005)
	Pre-test 2	49.58	12.676				
III	Post-test 3	77.50	14.521	10.00	2.533	0.019	Significantly (p<0.005)
	Pre-test 3	67.50	19.393				

IV	Post-test 4	72.08	12.504	4.16	2.095	0.047	Significantly (p<0.005)
	Pre-test 4	67.92	13.181				
V	Post-test 5	55.83	16.659	9.16	2.247	0.035	Significantly (p<0.005)
	Pre-test 5	46.67	18.805				
VI	Post-test 6	47.50	13.270	9.17	3.817	0.001	Significantly (p<0.005)
	Pre-test 6	38.33	10.072				
VII	Post-test 7	70.41	25.449	19.58	3.230	0.004	Significantly (p<0.005)
	Pre-test 7	50.83	15.581				
VIII	Post-test 8	62.50	16.746	11.25	2.261	0.034	Significantly (p<0.005)
	Pre-test 8	51.25	17.770				
Average	Post-test	64.74	9.376	11.46	8.857	0.000	Significantly (p<0.005)
	Pre-test	53.28	8.158				

By referring to Table 2, it is shown that each practical work session, the calculation of the t-test value gives the p-value less than 5%. This result indicates a significant difference between the post-test and pre-test values for all sessions. The table also shows a positive sign in all the mean difference between the value of the post-test and pre-test, which means that there is an increase average value significantly at each practical work session. Results of data analysis to the overall mean value also show very significant increase by 11.46 points due to the effect of the application of the developed model in practical work activities.

From the analysis, it can be argued that the use of online learning model applied to each session of digital engineering practical work activity was proven it can gave a positive impact such of the ability to increase student achievement. To elaborate the impact of the developed model application, Figure 2 shows the learning impact occurred during the implementation of the practical work sessions.

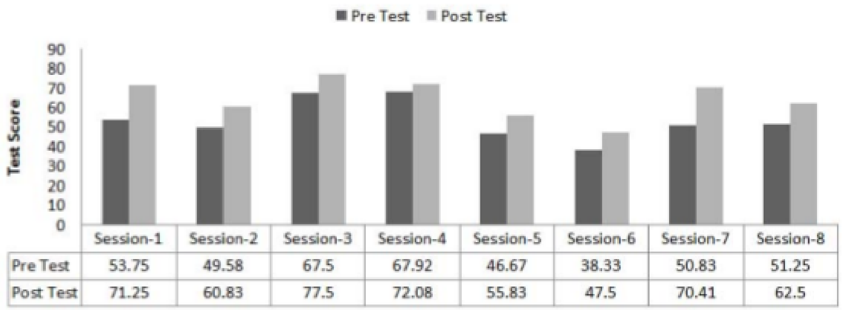

Figure 2. Graph of learning impact of the model.

From that figure, it can be seen that achievement of the student's learning is fluctuated yielded by the model introduced. This fluctuation follows the initial capability of students that could be due to the lesson's difficulty experienced by the students. The lesson was practiced differently for different sessions.

Graph shows good achievement of the students occur at session- 1, 2, 3, 4 and 7, respectively. For a moderate/sufficient category, it occurs at session- 2, 5 and 8, respectively. Session-6 is the practical work session with the worst achievement for the students. In this session, the students learnt a flip-flop lesson that is considerably most difficult lesson among the other lessons. This difficulty is common as the topic is new and as an introduction to the sequential logic lesson. Meanwhile, the other 5 sessions, the topics are logical combination that is relatively easy for the students. The worst achievement in this session is not due to the model introduced but due to the higher lesson difficulty compare than that of the other lessons. Based on the above results, the model implemented through online learning for a digital technique lesson developed in this research leads to positive impact to increasing student's achievement.

The analysis toward the subject perception is shown in Figure 3. As shown in that figure (left side) for the total score, the average percentage of instructor perception (81.8 %) is higher than for the students (73.1 %). The percentage of the instructor is categorized 'very good'. For the student, that percentage is categorized 'good'. This situation occurs because the instructor has attended the training in online practical work, more intensive compare than the students. Beside, based on the observation, the lecturer always emphasizes the instructor for his/her high responsibility of successful for the online implementation. With this, they are encouraged to have more knowledge and skill compare than the students. This self-awareness improves higher perception of the instructional and model aspects for the instructors.

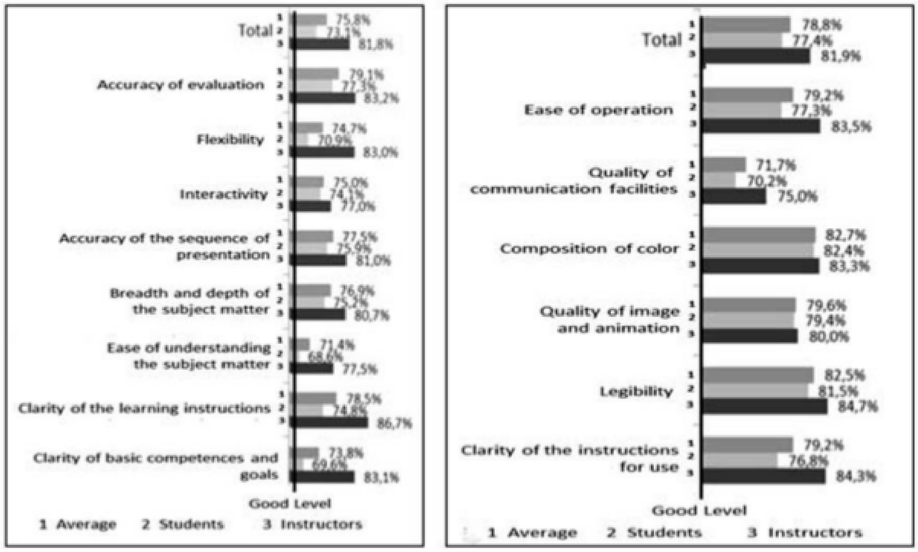

Figure 3. Histogram of subject perception in instructional aspects (left side) and presentation aspects (right side).

By referring to the results obtained, generally the subject has provided a positive perception of 75.8 % respects to the instructional aspect from the model developed through this research. However, in this research it was found that the students are still experiencing difficulties as shown by the perception level of 56 %. The difficulty arises due to the constraints related to the internet facility such of limited bandwidth leads low speed of data access needed for this online practical work.

The analysis result of the subject perception toward the model display is shown in Figure 3 (right side). From that figure, it is found that model developed has shown better performance and ease for operation with an average perception level of 78.8 %.

CONCLUSION AND RECOMMENDATION

The research done has produced an online teaching model for practical work and its supporting instruments of digital technique lesson that could introduce more flexible, and low cost in higher education institutions. The online system was supported by using an online collaboration approach. Model produced from this research is a portal of Virtual Laboratory at http://elab.uad.ac.id. Beside other products of a *Manual for an Online Learning Model for Practical Work*, *Lessons Plan for Digital Technique*, *Digital Technique Textbook*, *A Manual for Breadboard Simulator*, *A Manual for Online Practicum for Lecturers/Instructors/ Students*, and *A Manual for Digital Technique Practicum* with the guided inquiry method.

The model produced from this research shows a positive impact toward the student learning by increasing the significant achievement. The model also obtained positive perception from the related subject of instructional and model display aspects. Management of practical work under study program in electronic/electrical engineering is suggested to use this model as an alternative online learning as the model offers more flexible and low cost in operation.

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REFERENCES

Alessi, S. M. & Trollip, S. R. (2001). *Multimedia for learning: Methods and development.* Boston: Allyn and Bacon.

Anderson, T. (2008). *The theory and practice of online learning*. Edmonton: Athabasca University Press.

Bailey, C. & Freeman, M. J. (2010). A java bread-board simulator: Digital circuit simulation with an open-source toolset. *IADIS International Journal on Computer Science and Information System, 55*(1), 13-25.

Borg, W. R. & Gall, M. D. (1983). *Educational research: An introduction*. New York: Longman.

Candelas, F. A., Torres, F., Gil, P., Puente, S., & Pomares, J. (2006). Including the virtual laboratory concept in an on-line collaborative environment. *Published in advances in control education* (pp. 571-576). Laxenburg: International Federation of Automatic Control.

Colace, F., De Santo, M. , & Pietrosanto, A. (2004). Work in progress-virtual lab for electronic engineering curricula. *Published in frontiers in education 2004* (pp. T3C/22-T3C/24). Piscataway, NJ: The Institute of Electrical and Electronics Engineers, Inc.

Corter, J. E., Nickerson, J. V., Esche, S. K., Chassapis, C., Im, S. & Ma, J. (2007). Constructing reality: A study of remote, hands-on, and simulated laboratories. *ACM Transactions on Computer-Human Interaction, 14*(2), 7-27.

Elawady, Y. H. & Tolba, A. S. (2009). Educational objectives of different laboratory types: A comparative study. *International Journal of Computer Science and Information Security (IJSIS), 6*(2), 89-96.

Goodwin, G. C., Medioli, A. M., Sher, W., Vlacic, L. B., & Welsh, J. S. (2011). Emulation-based virtual laboratories: a low-cost alternative to physical experiments in control engineering education. *IEEE Transaction on Education, 54*(1), 48-55.

Hassan, R., Omari, N., Arshad, H., Sahran, S., & Yusof, N. H. (2010). DigiLab: A virtual lab for IT students. *WSEAS Transactions on Advances in Engineering Education*, *7*(5), 151-160.

Kantzavelou, I. (2005). A virtual lab model for an introductory computer science course. *Facta Universitatis (Nis), Ser.: Elec. Energ., 18*(2), 263-274.

Kask, K. (2009). *A study of science teacher development towards open inquiry teaching through an intervention programme.* Unpublished Ph.D. dissertation, Tartu University, Estonia.

Lang, D., Mengelkamp, C., Jäger, R. S., Geoffroy, D., Billaud, M., & Zimmer, T. (2007). Pedagogical evaluation of remote laboratories in emerge project. *European Journal of Engineering Education*, *32*(1), 57-72.

Ma, J. & Nickerson, J. V. (2006). Hands-on, simulated, and remote laboratories: A comparative literature review. *ACM Computing Surveys, 38*(3), 1-24.

Macias, M. E., & Mendez, I. (2007). Elab-remote electronics lab in real time. *Published in 2007 37th Annual frontiers in education conference-global engineering: knowledge without borders, opportunities without passport* (pp. 1512-1517). Piscataway, NJ: The Institute of Electrical and Electronics Engineers, Inc.

Mateev, V., Todorova, S. & Smrikarov, A. (2007). Test system in digital logic design virtual laboratory tasks delivery. In B. Rachev, A. Smrikarov & D.Dimov (Eds.), *Proceedings of the 2007 international conference on computer systems and technologies* (pp. IV.11-1-IV.11-6). New York, NY: ACM Inc.

Radu, T. (2010). Virtual and remote control lab experiment using matlab. *Annals of the Oradea University. Fascicle of Management and Technological Engineering, 9*(19), 78-81.

Saleh, K. F., Mohamed, A. M., & Madkour, H. (2009). Developing virtual laboratories environments for engineering education. *International Journal of Arts and Sciences, 3*(1), *9-17.*

Shokri, A. & Faraahi, A. (2010). Designing of virtual laboratories based on extended event driving simulation method. *World Academy of Science, Engineering and Technology, 68*, 1357-1359.

Tzafestas, C. S., Palaiologou, N. & Alifragis, M. (2006). Virtual and remote robotic laboratory: Comparative experimental evaluation. *IEEE Transactions on Education, 49*(3), 360-369.

Wolf, T. (2010). Assessing student learning in a virtual laboratory environment. *IEEE Transactions on Education, 53*(2), 216-222.

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