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COMPARISON STUDY BETWEEN MULTIMEDIA AND SIMULATION COURSEWARE TOWARD STUDENTS' ACHIEVEMENT BASED ON DIFFERENT LEVELS OF MOTIVATION

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Abstract. The teaching-learning approach used in all core subjects at Universiti Malaysia Perlis (UNIMAP) is the 'hands-on' approach. Students will be exposed to real-life apparatus to increase the awareness and understand more on the engineering concepts. Nevertheless, the lacking of these equipments, partly due to its size, cost and space, has hardened the learning process. Therefore, suitable learning aids can be used to ensure students' comprehension between theory and reality part. In this research, two types of learning aids for self-paced learning were introduced to the student with different level of internal motivation; courseware *Simulation-based Actuators System*, which is emphasizes the used of animation and *Multimedia-based Actuators System*, presentation module which developed using all the multimedia features. A specific topic was used as a model for testing the efficiency of the learning aids. Therefore the objective of this research is to study the achievements of the student which different level of internal motivation in self-paced learning using developed learning aids. This study was identifying and comparing the significant difference in overall achievement of using both learning aids. The result has shown the usage of *Simulation-based Actuators System* can contribute to more positive and high overall achievement to the Low Internal Motivation's student achievement.

Keywords: Practical-oriented, simulation-based, multimedia-based, internal motivation, self-pace learning

Abstrak. Pendekatan pengajaran-pembelajaran bagi semua subjek teras di Universiti Malaysia Perlis (UNIMAP) adalah pendekatan 'berorentasikan-praktikal'. Pelajar didedahkan kepada peralatan sebenar bagi meningkatkan kefahaman konsep kejuruteraan. Malangnya kekurangan peralatan atau alat bantuan mengajar yang sesuai, mungkin disebabkan saiz, kos dan ruang, menyukarkan proses pembelajaran. Dalam penyelidikan ini, dua jenis bantuan pembelajaran bagi pembelajaran kendiri telah diperkenalkan kepada pelajar yang mempunyai tahap motivasi dalaman yang berbeza; koswer *Sistem Aktuator Berasaskan Simulasi*, yang mana menekankan penggunaan animasi dan modul persembahan *Sistem Aktuator Berasaskan Multimedia*, yang telah dibangunkan dengan menggunakan semua keupayaan multimedia. Satu topik tertentu telah digunakan sebagai model untuk menguji keupayaan bagi bantuan pembelajaran tersebut. Sehubungan itu, objektif penyelidikan adalah untuk mengkaji pencapaian pelajar yang

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mempunyai motivasi dalaman yang berbeza melalui pembelajaran kendiri menggunakan bantuan pembelajaran yang dibangunkan. Penyelidikan ini telah membandingkan dan mengenalpasti perbezaan yang signifikan dalam pencapaian keseluruhan bagi penggunaan kedua-dua bantuan pembelajaran. Hasil penyelidikan menunjukkan penggunaan koswer *Sistem Aktuator Berasaskan Simulasi* telah menyumbang kepada pencapaian keseluruhan yang tinggi dan positif kepada pelajar yang bermotivasi dalaman rendah.

Kata kunci: Orientasi-amalan, berasaskan simulasi, berasaskan multimedia, motivasi dalaman, pembelajaran kendiri

1.0 INTRODUCTION

Learning is a lifetime process. In Surah Al-Alaq, verses 1-5, Allah s.w.t. reminds us about the importance of education and encourages human being to explore new discovery in education. Hence, this research is being conducted to explore new technique in teaching and learning of engineering subjects. Different approaches of learning are needed to suit various backgrounds of engineering areas. Some of them requires more calculations, whereas others may concentrate on practical and in-depth attention (Sergey, 2002) especially for physically invisible element like the movements of components inside an apparatus.

The engineering education situation shows the existence of a step-by-step process of learning, which begins with the explosions towards the theory of the subject. Then, students need to perform practical tasks in the laboratory or workshop to understand more on the concepts, as shown in Figure 1. However, the shortage of suitable devices for teaching aids and unsuitable approach of teaching (Eigen & Komoski, 1989) has contributed towards the problem for students to understand the engineering concepts. This has been proved by previous researches (Entwilse, 1989) and (Zol Bahri, 1998) where the problems of Mechanical Engineering education through lecture occur due to unsuitable teaching aids or approach. Most of the contents of Mechanical or Mechatronics Engineering subjects consist of theories about moving components. Hence, explanation about these components should be included with demonstration or usage of suitable teaching aids (Martin & Mats, 2005) to make sure students can observe the relationship between theory and reality.

In this research, practical work of Actuator System subject was used as a research aids because the practical parts of this subject is very difficult for students to understand theoretically in the classroom. Actuator System is used in industries as automation and robotic bases which combine four main elements that are pneumatic components, electric components, pneumatic circuits and electric circuits. These four elements are functioning simultaneously and it was discovered that explanation about the operation is very difficult to explain to the students without suitable teaching aids.

Figure 1 Students perform practical task in the laboratory

To produce graduates who are excellence and effective in engineering fields, their knowledge, experience and skills in the engineering subjects are the main factor. Another factor that is also played the important role is individual behavior. In psychology perspective, every individual has different cognitive and effective style to process, analyze, interpret or judge their perception results towards the acceptable stimulation (Luordusamy, 1994). Furthermore, researched by Luordusamy (1994) showed a proof that cognitive style has strong influence towards learning. As example, some student is more enthusiastic towards analysis skills learning orientation as learning of engineering subject and teaching method in instructive condition, while other students are prefered towards social learning orientation which involve interpersonal relationship and teaching method that shows interaction with students. Besides effective style which are 'Low Internal Motivation (LM)' and 'High Internal Motivation (HM)' should be taken as consideration in student achievement. This is because effective style also has impact towards a received storage, process and information usage modes.

Regarding to current education scenario, a radically different approach towards the education of Mechatronics was initiated at UNIMAP. This approach placed the main emphasis on practical oriented engineering supported by traditional theory.

UNIMAP is a government-funded public institution of higher learning. Its undergraduate academic programs have the aim of producing engineers who are capable of planning, designing, building, testing, and maintaining devices, systems, and processes. UNIMAP graduates are also hoped to be capable of solving engineering problems in an innovative and creative manner (Zuraidah, 2003).

The curriculum used in UNIMAP is designed so that it is comparable to other recognised engineering curriculums elsewhere. The courses focused on the

combination of both theory and practical skills according to industrial requirement. Students are given skills such as communication, entreprenuership, management, accounting, personal development and are also required to take Islamic and Asian Civilisation. It is hoping that UNIMAP are not only producing graduates who are effective in the engineering field, but are also capable of being independent and possess commendable and praiseworthy traits (Zuraidah, 2003).

The teaching-learning approach used in all core subjects is the 'practical-oriented'/ 'lab-intensive' approach. Here, students learn via practical and theory in the ratio of 60:40 throughout his/her time in UNIMAP. This means, approximately 60% of the official study time of the student is spent doing practical (ie. lab work, industrial training, engineering skills training, final year project), whereas doing theory (ie. attending lecture sessions) comprise of approximately 40% of the student's time (Zuraidah, 2003).

UNIMAP emphasized the 'practical-oriented' or 'lab-intensive' activities that require the manipulation of physical artifacts or physical experimentation. 'Lab-intensive' experience is a vital ingredient of any high-quality engineering program and some reasons why 'lab-intensive' experience is so important are:

(1) Students need to be exposed to the practice of engineering in addition to engineering science (Burford & Gregory, 2002).
(2) Engineering graduates must be able to "design and conduct experiments, as well as analyze and interpret data" (Zuraidah, 2003).
(3) Students need to become familiar with the instruments and equipment common in engineering practice for subsequent work in industry or advanced study (Zuraidah, 2003).
(4) A large percentage of engineering students are visual, sensing, and active learners (Felder & Silverman, 1988), and it is necessary for them to see, touch and feel things before they can fully process engineering concepts.

Based on the facts above, the usage of multimedia elements in computer-aided learning is expected to fulfill the learning needs for students, which have different effective styles (Zol Bahri, 2005). The multimedia elements that integrate the source of color, animation, texts, graphics, video and audio (Heinich *et al*., 1996) can be fully controlled in supplying teaching aids to students. This can make the teaching and learning process more interesting, exciting and efficient and can be repeated several times. Finding of other researches has stated that, to understand the learning concept, a student needs to do revision several times (Gagne, 1987).

The ability of learning is different for each of students, thus the learning and study skills are absolutely different (Zol Bahri, 2005). So a flexible study time should be based on student's ability. This problem requires a solution and the usage of *Simulation-based Actuators System or Multimedia-based Actuators System*, which is emphasized on animation and a Power Point presentation module, respectively, is expected to be one of suitable approach.

2.0 RESEARCH OBJECTIVE

The *Simulation-based Actuators System* and *Multimedia-based Actuators System* were designed for students in self-study format. This research's scope covers the development both learning aids, by its definition, designation and testing. Practical work of Actuator System subject was used as a research topic for testing the efficiency of the models or approaches. Hence the main objective of this research is to study the achievements of the different level of internal motivation's student by self-paced learning of both learning aids. This study identifies and compares the significant difference in overall achievement. This research also will help to recognize which group of students that will gain a maximum impact of using the learning aids.

3.0 METHODOLOGY

The research involves two variables as below;

(1) Independent Variable
- Simulation courseware (*Simulation-based Actuators System – SbAS*) and PowerPoint presentation (*Multimedia-based Actuators System – MbAS*)
- Effective style, Low Internal Motivation (LM) and High Internal Motivation (HM)

(2) Dependent Variable
- Student learning achievement for the groups of student.

The pre-test and post-test control group, which was designed in 2×2 factorial, will be applied as research approach. This factorial designs (Figure 2) are used because it involves two editions of independent variables. The design experiment is showed as below;

R —— G —— O1 —— X —— O2

R – Random sample distribution
G – Sample group of students
O1 – pre-test
X – Treatment using learning aids
O2 – post-test

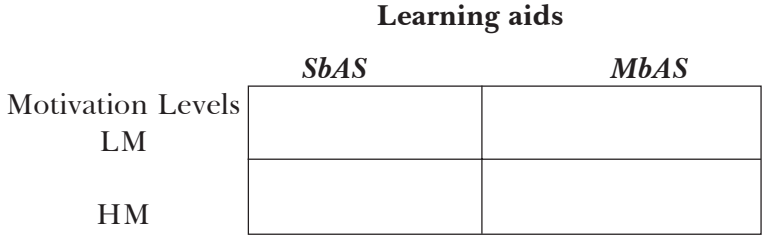


Figure 2 Factorial design

Sixty students have been chosen randomly in order to execute this study. The study population consists of fourth semester students in the course of Mechatronics Engineering in UNIMAP. All the samples were randomly chosen and distributed into two groups, high internal motivation (HM) and low internal motivation (LM) based on survey of "Responsible towards Intellectual Achievement" (Maznah & Ng, 1985). Selections of sixty subjects were made with assumption that each of the group has more than ten subjects being implemented, in order to make ANOVA analysis easier.

Before execution of the treatment and pretest, a lecture of Actuator System has been given to equip the samples with some learning foundations. All samples were then through a treatment in learning by using the learning aids before the execution of test assessment and post test. One week period, has been given to the samples for self study before the tests.

Ng (1997) has suggested execution procedure for display screen development based on Gagne Learning Action (Gagne, 1987) as Table 1 below.

Table 1 Teaching action and execution procedure for screen development

Teaching action	Execution procedure
1. Acquire attention music	Interesting graphic display screen with background to catch attention
2. Presentation of objective	Have menu to state the expectation of learning result.
3. Revision of previous skills	Have "hotword" text to refresh previous information for better content understanding.
4. Scenario presentation	Interesting texts and graphics presentation.
5. Provide learning guideline	Have multi linked icons and texts at display screen on beginning of teaching.
6. Need student action	Provide quiz assessment on every end of sub-topic for understanding evaluation.
7. Provide feedback	Feedback will be given in every action on suitable mode.
8. Skill evaluation	Student ability shown in display screen.
9. Memory improvement	Extra quiz assessment will be given for remembrance on very learning repetition.

4.0 COMPARISON OF BOTH LEARNING AIDS

Simulation-based Actuators System – The simulation courseware is an animation-based system. While using this courseware, students need to develop respective circuit as the real one used during the laboratory session. It can be activated after the circuit has been fully developed. The circuit functions as an animation in allowing students to understand clearly on the movement of the input, sensors, solenoid valves, actuators as well as other output components.

Multimedia-based Actuators System – This is a PowerPoint presentation-based multimedia module. Through this method students are exposed with the same circuit as the one being used in the laboratory session. It is well prepared step-by-step in a separate slide so that when one plays the presentation, it will look like an animation. From here, students would get a better view on how a system works and also the movement of input, sensors, solenoid valve, actuators and the output components.

5.0 DESIGN OF LEARNING AIDS

The design of the ***SbAS*** and ***MbAS*** were based on *Instructional Design System Approach Model* (Dick and Carrey, 1985). Improvement has been done on the *teaching aids selection and development* component, using *Instructional System Design Model* (Alessi and Trollip, 1985), which has ten steps of systematic development of learning aids. At the same time, learning theories of *Gagne Learning Action* (Gagne, 1987) and *ARCS Motivation Model* (Keller, 1987) have been followed in order to produce effective learning aids. Motivation should encourage activities and learning thus several variations of strategies of ARCS have being included into learning aids, especially for student to control an action and screen design.

Self-paced learning using *SbAS* (Figure 3 and Figure 4) and *MbAS* (Figure 5a, Figure 5b and Figure 5c) as shown in the example screen appearance could help students in conquering electrical and pneumatics circuit's integration in its sequence. The animated simulation appearance in *SbAS* and slide-by-slide PowerPoint presentation in *MbAS* could show in detail the type of movement occurs inside the actuator, processor as well as other devices.

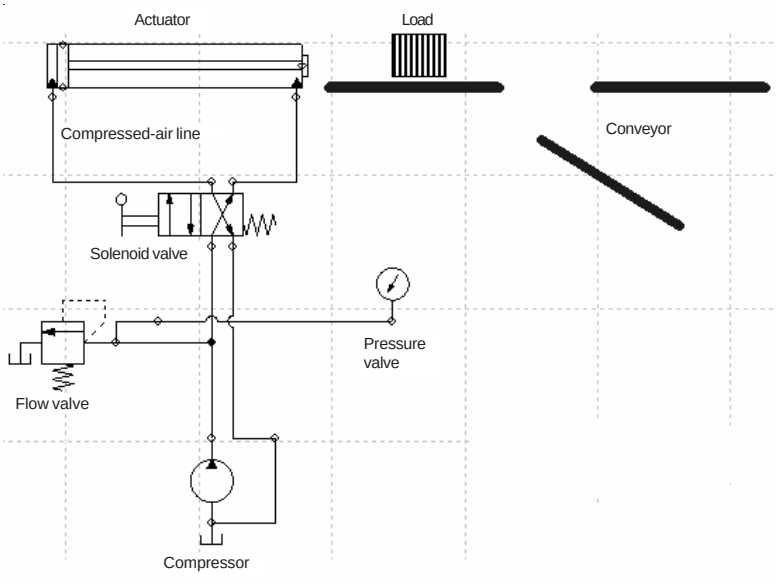


Figure 3 Example of animated simulation-based working screen

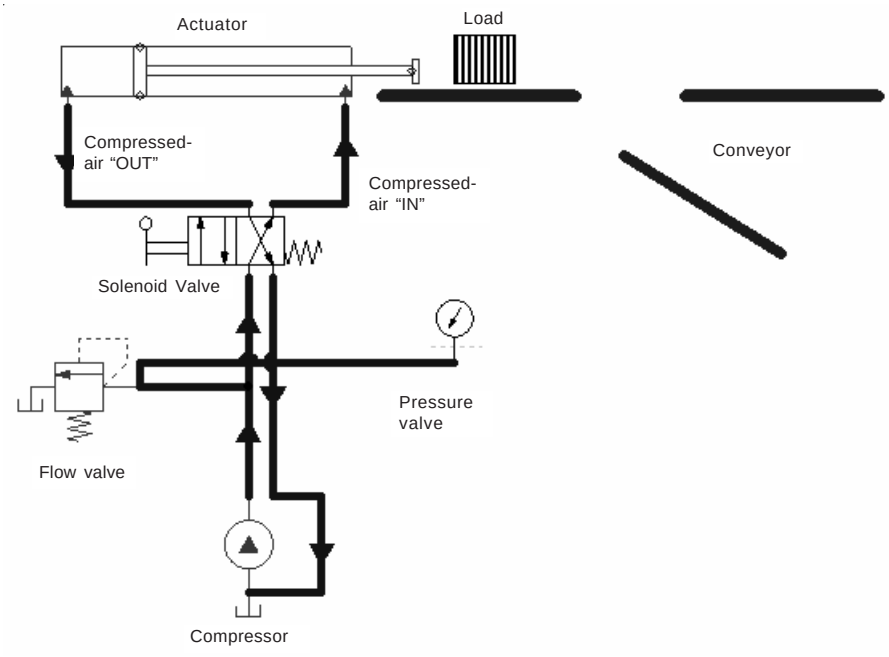
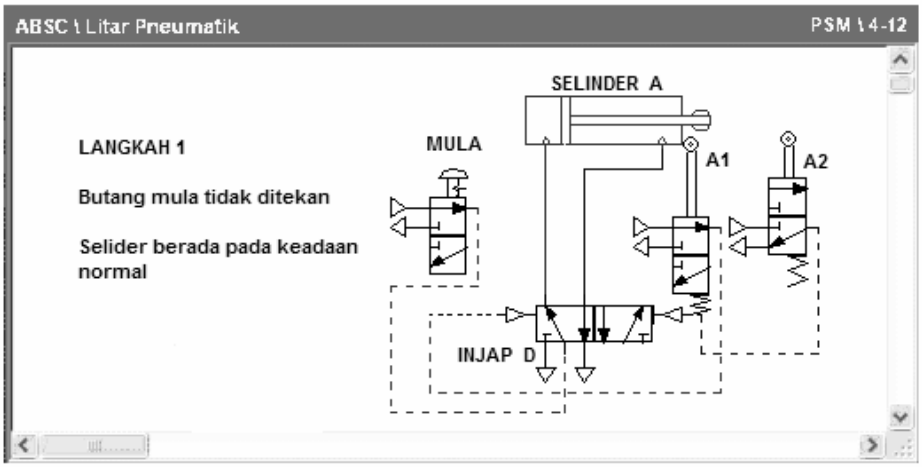
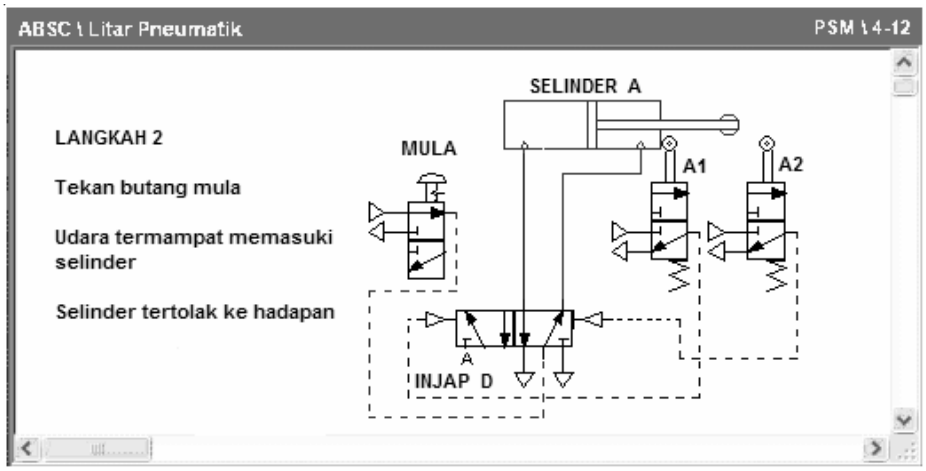


Figure 4 Example of animated simulation activity when the system running

(5a)



(5b)



(5c)

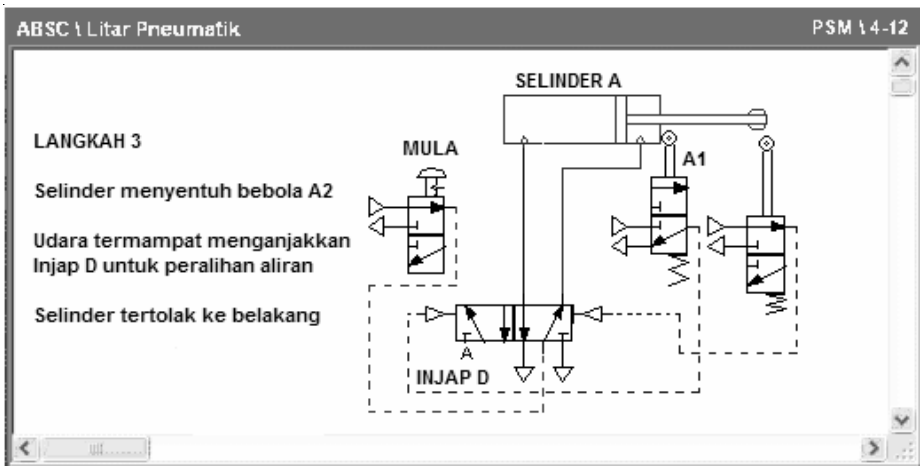


Figure 5a, 5b and 5c Example of step-by-step power Point presentation screen

To strengthen students' knowledge and skills, a tutorial display screen is also being prepared. The tutorial is a solution-based preparation, where students are being asked to solve the given problems using the most optimum system as the solution. Students are free to choose the design to solve the problems through input and output screen. Every single problem can be solved using various methods, but the best solution is through designing a circuit using a minimum number of components.

6.0 DATA ANALYSIS

In analyzing the data, students are segregated into four groups as shown in Figure 6.

	Learning aids	
	(***SbAS***)	(***MbAS***)
Motivation Levels (LM)	SbLM	MbLM
(HM)	SbHM	MbHM

Figure 6 Factorial design of grouping students

For this research, the LM and HM students have been separated to SbAS and MbAS groups. The combination has produced four separated groups; SbLM. SbHM, MbLM and MbHM. The frequency of student for each of group is stated in Table 2 as below.

Table 2 Student frequency distribution

Abb.	Student group	Frequency	Percentage
SbLM	Low Internal Motivation with Simulation-based	12	20
SbHM	High Internal Motivation with Simulation-based	17	28.3
MbLM	Low Internal Motivation with Multimedia-based	11	18.3
MbHM	High Internal Motivation with Multimedia-based	17	28.3
	*Student being dropped	3	5
	Total Student	60	100.00

7.0 RESULT

Based on analysis description (Table 3), the overall mean score for *SbAS* group of student is 6.09, higher than *MbAS* group of student (5.21) by significant difference ($p = <0.001$). This indicate that there is significant difference in overall achievement (pre test score- post test score) in *SbAS* group compare to *MbAS* group. Thus, the Animation-based Simulation Actuator courseware is found more meaningful to *SbAS* group in helping their achievement than *MbAS* group.

Table 3 T-test: The differences of mean increment in pre test, post test and achievement between *SbAS* and *MbAS* group

Learning aids	Variables	N	Mean	sd	*t*	df	*p*
1 (SbAS)	Pre test	29	11.88	1.43	-5.915	56	0.000*
2 (MbAS)		28	13.55	1.20			
1 (SbAS)	Post test	29	17.97	1.28	-3.244	56	0.002*
2 (MbAS)		28	18.76	1.00			
1 (SbAS)	Achievement	29	6.09	1.09	3.692	56	0.001*
2 (MbAS)		28	5.21	0.97			

(p = <0.05) (Learning Aids = 1 – SbAS,
= 2 – MbAS)

Referring to Table 4, mean score achievement of pre and post test for HM student is higher than LM student. There is also big difference between HM and LM student for pre test (p = <0.000) and post test (p = <0.037). However, overall mean achievement for LM student is 5.83, which is higher than HM student (5.21) by significant different (p = <0.005). This indicate, there is significant difference in overall achievement (pre test score-post test score) in LM student compare to HM student, after using the Learning Aids.

Table 4 T-test: The differences of mean increment in pre test, post test and achievement between LM and HM group

Efective style	Variables	N	Mean	sd	*t*	df	*p*
1 (LM)	Pre test	23	12.32	1.56	-4.031	56	0.000*
2 (HM)		34	13.48	1.23			
1 (LM)	Post test	23	18.20	1.27	-2.113	56	0.037*
2 (HM)		34	18.69	1.00			
1 (LM)	Achievement	23	5.83	1.16	2.872	56	0.005*
2 (HM)		34	5.21	0.91			

(p = <0.05) (Internal Motivation = 1 – LM,
= 2 – HM)

Table 5 shows overall mean score for SbLM student (6.44) is higher than SbHM student (5.67), with small significant different (p = <0.048). This shows, that there is significant different in student overall achievement for SbLM and SbHM after using learning aids. From the result obtained, Simulation-based Actuator

System courseware is found more helpful in LM student achievement compare to HM group of student.

Table 5 T- test: The differences of mean increment in pre test, post test and achievement between *SbAS* group of low motivation (SbLM) and high motivation (SbHM)

Group	Variables	N	Mean	sd	*t*	df	*p*
1 (SbLM)	Pre test	12	11.75	1.34	-2.438	28	0.021*
2 (SbHM)		17	12.33	1.11			
1 (SbLM)	Post test	12	17.81	1.47	-0.412	28	0.683*
2 (SbHM)		17	18.00	1.00			
1 (SbLM)	Achievement	12	6.44	1.09	2.065	28	0.048*
2 (SbHM)		17	5.67	0.98			

(p = <0.05) (Group = 1 – SbLM,
= 2 – SbHM)

From Table 6, research result has shown that mean overall score for MbLM student is 5.48, slightly higher than MbHM student (5.03). However, this result was not showed any significant different. Thus we can conclude that, Multimedia-based Actuator System module was helpful to MbLM student but not have to MbHM student.

Table 6 T- test: The differences of min increment in pre test, post test and achievement between *MbAS* group of low motivation (MbLM) and high motivation (MbHM)

Group	Variables	N	Mean	sd	*t*	df	*p*
3 (MbLM)	Pre test	11	13.00	1.35	–	27	0.004*
4 (MbHM)		17	13.91	0.95	3.031		
3 (MbLM)	Post test	11	18.48	1.12	–	27	0.82*
4 (MbHM)		17	18.94	0.87	1.769		
3 (MbLM)	Achievement	11	5.48	1.08	1.761	27	0.084*
4 (MbHM)		17	5.03	0.86			

(p = <0.05) (Group = 3 – MbLM,
= 4 – MbHM)

Table 7 shows that the usage of Simulation-based Actuator System courseware is more helpful to the students compare to Multimedia-based Actuator System module with significant differences.

Table 7 T-test: The mean increment differences of overall achievement between low and high motivation group with both learning aids

Group	Variables	N	Mean	sd	*t*	df	*p*
1 (SbLM)	Achievement	12	6.44	1.09	2.712	22	0.010*
3 (MbHM)		17	5.48	1.08			
2 (SbHM)		17	5.67	0.98	2.315	33	0.025*
4 (MbHM)		17	5.03	0.86			

(p = <0.05) (Group = 1 – SbLM, 2 – SbHM,
= 3 – MbLM, 4 – MbHM)

By overall, group of student with *SbAS* and LM elements have achieved better result compare to student with *MbAS* and HM elements, after using learning aids. In the other words, the Simulation-based Actuator System courseware is more helpful to students who have low internal motivation.

8.0 CONCLUSION

The result of the research has shown increment in student score after using Simulation-based Actuator System courseware and Multimedia-based Actuator System module. The design of the multimedia learning aids has proven its ability to enhance learning effectiveness. Furthermore, if elements of learning theories and some multimedia exploitation being intepreted in the learning aids, the design will much better and more systematic.

The result also shown the usage of Simulation-based Actuator System courseware gives better result in student achievement compare to Multimedia-based Actuator System module. For pre and post test result, student with effective style of high Internal Motivation (HM) acquire high score. However, an overall achievement of students (pretest score-post test score) indicates opposite result, which is overall mean achievement of *SbAS* and LM student s higher. This gives us understanding that the usage of *SbAS* for LM student gave score much better, compare to other group.

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