Testing the Effectiveness of the Use of Animation in Mechanical Engineering Education

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ABSTRACT

Today's education is fully integrated with technology and computers. Students living in such an environment often use several kinds of technologies in most of their daily life activities. As such, students are confident in using technologies to facilitate more effective education. As a multimedia technology, animation allows the presentation of things and ideas in realistic ways, which can assist in easing the understanding of complex ideas and concepts. Animation is particularly useful in regards to the use of complex machines that are either not available or hard to visualize by using speech and text.

Keywords: analysis, regression analysis, animation, mechanical engineering and education.

1 INTRODUCTION

Mechanical engineering education can be improved and supported by using animation technology as a tool to present certain learning content. Mechanical engineering is a practical subject that containsseveral live experiments that need to be presented carefully and in detail. Applying animation technology in engineering is possible if it is well prepared and carefully designed to suite all different types of learning styles. Holzinger et al. (2008) agreed that in today's education, dynamic media is very well known, widespread, and is almost universal in a media society. Therefore, the idea of including animation presentations as a supporting material in mechanical engineering is both reasonable and can be effective.

2 QUESTIONNAIRE PREPARATIONS

2.1 PARTICIPANTS

A total of 24 final year/year 4 undergraduate students from the Mechanical Engineering Department of the International Islamic University Malaysia (IIUM) participated in the pilot questionnaire during the last semester in December/2012.

2.2 MATERIALS

The online survey website surveymonkey.com was used to present the questionnaire. Adobe Flash CS3 was the software used to design the animation by using Action Script 3.0. The animation link was added to the online questionnaire.

2.3 PROCEDURE

In the primary round of gathering data, 24 students were randomly selected and managed to participate. This round was conducted when busy preparing for exams and submitting assignments. The researcher was forced to conduct the first round during this period because of time limitations.

The researcher managed to gather the students in the mechanical engineering department's computer lab (E4-2-6) CAD LAB in order for the respondents to view the questionnaire and animation online.

3 ANALYSIS AND FINDINGS

This study consisted of two separate stages of data gathering. First is the primary (Pilot) round followed by the secondary (Final) round. Two different methods of analysis were adopted. One is the regression analysis used in the pilot round to test and measure the validity and reliability of the questionnaire, while the other is the factor analysis, which is used twice; once in the pilot study and second in the final round. This paper focuses solely on the regression analysis.

3.1 Descriptive Statistic of Respondents

The descriptive statistic employed by the researcher in this survey addresses the degree of performance, frequency, percentage, mean, and standard deviation of the respondents and each answer to the items given in the study indicates the responses opinion of the five options given in the questionnaire.

These options are: 1- Strongly agree. 2- Agree. 3- Averagely agree. 4- Disagree. 5- Strongly disagree. This aimed to determine the total aggregate of the responses on the impact of animation in enhancing mechanical engineering students' knowledge. However, to simplify the findings of this research, the researcher matched between agree and strongly agree as well as between disagree and strongly disagree by considering the first two as (Agreed) only, and the last two as (Disagreed).

Table 1 shows the percentage, mean, and standard deviation of opinions of the respondents on the items that measure the description of animation effects on level four mechanical engineering students. The respondents when asked about the clarity of the animation's function 58.3% strongly agreed that the animation functions well, and 33.3% agreed and 8.3% averagely agreed with (μ = 1.50) and (SD = .66).

This shows that the majority of respondents agreed that the animation which is developed to measure the students' ability of adopting technology in their studying functions accurately. This also justifies that the system of collecting the data is on average standard to measure the students' ability of using animation in their study. The results of the respondents' opinion about the flow of the animation and whether it gives an appropriate feedback within reasonable time or not shows that the number of students who strongly agreed and agreed were equal with 45.8% and for those who averagely agreed 8.3% with (μ = 1.63) and (SD = .65). This result assures that more than 50% of the students were satisfied. In addition, this also means that the animation flow is smooth and the content is displayed evenly.

When the students were asked about the appearance of the information, 54.2% strongly agreed that the information appears in a natural and logical order, 37.5% agreed and 8.3% averagely agreed with (μ = 1.54) and (SD = .66). As a result, the majority of students had a positive perception about the animation and they are able to link between the information presented since in mechanical engineering the flow of the information is interdependent especially in engine operations. The table also listed the respondents' feedback about whether the animation matches the engine in reality or not. 45.8% of the respondents strongly agreed that the animation matched the engine in the real world, 41.7% agreed and 12.5% averagely agreed with (μ = 1.67) and (SD = .70).

The overall result confirms that the animation fulfills the multimedia presentation requirements and standards. In addition, the result signifies that based on the respondents' satisfaction, animation can take place in presenting mechanical engineering content. When the students were asked about their intention on how free they felt in controlling the animation content such a, going back to a specific scene or moving to the next scene, 66.7% strongly agreed, 25.0% agreed and 8.3% disagreed with (μ = 1.50) and (SD = .88).

This indicates that more than 50% of the students strongly agreed that there was flexible control over the animation. Regarding the 8.3% of respondents who disagreed, the animation designer should consider enhancing the animation to suit all users. However, the strong agreement of the majority ensures that they were able to successfully interact with the animation and benefit from it. When the students were asked whether the animation content was consistent and follows the standards of multimedia presentations,50.0% strongly agreed, 37.5% agreed and 12.5% averagely agreed with (μ = 1.63) and (SD = .71). This result shows that half of the students were satisfied with the animations' presentation and identified its goal. This also means that this animation can be designed once again with the same guidelines and structures to present other engine operations. More than half of the students (54.2%) strongly agreed that the animation design was sufficient to prevent errors from occurring or causing them to mistakenly choose the wrong option; 37.5% agreed, 4.2% averagely agreed and 4.2% disagreed with (μ = 1.58) and (SD = .78).

According to this result, the majority of students were able to recognize and manage the animations' content but only a few of the respondents could have encountered choosing the wrong option. This may be due to the weak knowledge that some mechanical engineering students' may have about using multimedia tools or because it is somehow different than their field of study. The table further displays the respondents' answers about whether the instructions for use of the animation such as objects, actions, and options were visible enough and could be easily retrieved with 58.3% who strongly agreed, 33.3% who agreed, 4.2% who averagely agreed and 4.2% who disagreed with (μ = 1.54) and (SD = .78). This indicates that the maximum number of respondents agreed that the instructions were sufficiently clear.

As such, the animation can be a suitable tool for presenting a mechanical engineering topic. As shown in Table 1, 50.0% of the respondents strongly agreed on the flexibility in content and actions while using the animation, 41.7% agreed and 8.3% averagely agreed with (μ = 1.58) and (SD = .65). This result confirms the researcher's initial hypotheses where half of the participants agreed that the animation is easy to use and interact with. This result in the efficiency of using animation to present engine operations, which acts as a supporting tool to enhance the performance of mechanical engineering students.

The table further shows the distribution of the respondents' answers about the efficiency of the animated presentation in teaching the internal parts and the operation for the four-stroke petrol engine, 50.0% strongly agreed that the animation was effective, 37.5% agreed, 8.3% averagely agreed and 4.2% disagreed with (μ = 1.67) and (SD = .82). The overall result confirms that the maximum number of respondents found the animated presentation useful and clear in teaching the internal parts and operation of the four-stroke petrol engine.

According to the analysis, animation elements are successful in describing the engines' internal parts that are known for their complexity. As a result, animation technology can be used in situations where the engine is unavailable or hard to get which confirms the proposed solution and the objectives of this study. The table carries on listing the respondents' feedback about the animation, when the respondents were asked about the simplicity of the animation's design and whether it offers the basic requirements, 62.5% of the respondents strongly agreed that the animation's design was uncomplicated and convincing, 29.2% agreed and 8.3% averagely agreed with (μ = 1.46) and (SD = .66). This means that the animation was able to deliver the information accurately without causing users any distraction or confusion. In addition, when the animation is simple it gives the possibility to use it in presenting more complex content.

Likewise, the table demonstrates the respondents' feedback about the irrelevant or rarely needed information in the animation's contents where 29.2% strongly agreed that there are some unnecessary content, 20.8% agreed, 20.8% averagely agreed, 12.5% disagreed and 16.7% strongly disagreed with (μ = 2.67) and (SD = 1.46). The researcher designed the animation short to present specific content regarding the four-stroke petrol engine. Many features and functions were planned to be added to the animation as future enhancements. In addition, the researcher plans to engage in additional study of mechanical engineering topics in order to enhance the animation to contain more formulas and other features.

The animation was simply designed as an evaluation tool in order to determine that the idea of merging animation technology with mechanical engineering education is successful. The respondents' answers about the ease of being able to recognize, identify, and avoid errors was 45.8% strongly agreed that it was simple to distinguish and identify the preferred actions while interacting with the animation, 41.7% agreed, 8.3% averagely agreed and 4.2% disagreed with (μ = 1.71) and (SD = .81). This result verifies that the majority of respondents were able to interact with the animation successfully. Based on that, the animation managed to display the engine's operation accurately. The table finally shows the respondents' opinion regarding the animation needs help and documentation to list user's task and concrete steps to be carried out, 41.7% strongly agreed that it is necessary to provide a help option, 33.3% agreed, 20.8% averagely agreed and 4.2% strongly disagreed with (μ = 1.92) and (SD = 1.02).

Since that the animation contained only a limited amount of information, the researcher didn't provide a help option. In addition, the respondents' general overview about the animation was positive. Perhaps what caused the respondents to request a help option might be when the animation is extended and more features are added. Moreover, respondents with different learning styles and backgrounds require additional instructions when the content is extended.

3.2 Inter-Item Correlation Matrix

Ideally the correlation co-efficiency deals with variances in the overall effect of the variables on the animation. However, it may be that one or more sub-factors account for most of the impact of the variables on the animation. Therefore, the comparative analysis shows which animation factors are more useful in providing the overall effective performance of the animation. This helps in reducing the number of sub-factors if they do not contribute to measuring overall performance of the animation which leads to focusing on the specific practical and direct aspects that form the most significant parts of the animation on which mechanical engineers should focus while learning the engine's operation from the animation's presentation.

In Table 2 the correlation co-efficient shows the relationship between each of the independent variables such as utility, reliability, and flexibility. Each factor has a high correlation and a strong concordance with this animation. The analysis in this section shows which independent variables are more significantly related to animation. Anything ≤0.05 is significant while anything >0.05 is not significant. This is called the significance relationship. As shown in table 2, the variable material is negatively significant in relation with the animation function at (sig. -0.49). This means that the mechanical engineering material being introduced in the animation is understandable. In addition, animation functions offers a useful explanation. Material is also negatively significant in relation with the variable appropriate time at (sig. -0.42).

This result ensures that the presentation of the animation's content occurs within a suitable time and that each part of the animation is given a suitable presentation time. This point is significant due to the type of mechanical engineering learning materials since the engine's operations goes through several stages which requires accuracy. The table also shows that material is negatively significant in relation with natural manner at (sig. -0.27). This shows that the material was successfully designed to be presented in a natural manner that prevents users' from distraction while learning especially because the engine's operation is complicated and requires careful attention. The variable material is also negatively significant in relation with reliability at (sig. -0.18). This result indicates that the material is reliable and effective in teaching the engine's operation.

Table 2 further illustrates the inter-item correlation between variables, material is negatively significant in relation with flexibility at (sig. -0.07). This result points out the easiness of using the material, namely the animated engine. If the animation is flexible then users from different backgrounds and learning styles will be able to effectively view it and benefit from it. Material is also negatively significant in relation with the variable standard at (sig. -0.57).

This confirms that the animation design meets the multimedia presentations standards and is qualified to present complicated subjects such as mechanical engineering. In addition, material is negatively significant in relation with the variable error free at (sig. -0.04). This means that the animation is constructed to contain minimum errors. Consequently, the user rarely chooses the wrong option. Moreover, the variable material is negatively significant in relation with instructions at (sig. -0.06). This result denotes that the animation is understandable without a need for providing instruction for the users.

This also means that the user is able to follow the sequence of the engine's operation presented in the animation successfully. Material is also negatively significant in relation with presentation at (sig. -0.16). A learning material won't be effective unless it is presented in the right way, in this table the results confirm that the material being presented meets the requirements which leads to better understanding. Furthermore, material is negatively significant in relation with simplicity at (sig. -0.12).

This means that the animation is simple enough to be understood and easy enough to be retrieved. The simplicity in this animation design does not mean that it is weak or not qualified but the simplicity in the design it is to ensure students' understanding and focus. The variable material is also negatively significant in relation with contents at (sig. -0.18). This ensures that the animation is able to present mechanical engineering topics effectively.

In addition, animation can be used as a supporting tool to enhance or replace missing or unavailable mechanical machines. The table continues explaining the relation between the variable material and other variables, material is negatively significant in relation with accuracy at (sig. -0.14). This indicates that the animation is accurate enough to be clear and understandable for the students. In addition, animation has the power to explain the procedure of complex operations in mechanical engineering. The variable material is also negatively significant in relation with the help option variable at (sig. -0.03).

This result means that there is no need to provide a help option for the users. The animation is exact enough to be understandable for the students without the need for instructions. This will actually reduce the time taken to manage to establish how the animation works and try to figure out what it is intended to teach which leads to saving time by directly starting the lesson.

Table 2 continues listing the inter-item correlation matrix where the variable utility is negatively significant in relation with the animation compatibility at (sig. -0.06). This result demonstrates that the animated engine is well-suited and the presentation is utilized effectively to help student's establish how this specific engine operates. This means that if the engine is not available in the real world the animation can take place in replacing it which will be useful especially in cases where certain universities don't have sufficient budget to provide such engines or there is difficulty obtaining the engine. Utility is also negatively significant in relation with the variable animation function at (sig. -0.23).

This means that the degree of the animation's usefulness is high enough to make the presentation functions correctly. Moreover, utility is negatively significant in relation with the variable appropriate time at (sig. -0.06) which authenticates that each part of the engine's animation occurs in an appropriate time and each action spends a reasonable time to be completed. As a result, the respondents didn't feel bored.

Consequently, the table shows that utility is negatively significant in relation with natural manner at (sig. -0.02). This relation proves that the animation utilization is designed to occur in a natural manner that promotes better and faster understanding. As a result, the student will be able to follow the four different stages of the engine's operations. Utility is also negatively significant in relation with reliability at (sig. -0.07). This result confirms that it is possible to rely on the animation's presentation to teach mechanical engines' operation effectively. Hence, the animation is able to explain the important stages that the engine goes through. The table also illustrates that utility is negatively significant in relation with the variable standard at (sig. -0.27).

The variable standard determines whether the animation is qualified to be used as a teaching tool. In this result the utilization of the animation is up to multimedia standards and can be used as a supporting learning method for mechanical engineering students. Utility is also negatively significant in relation with error free at (sig. -0.03). This result confirms that the degree of error occurring is minimum and animation functions clearly without any obstacles. This is important because it helps in preventing the students' attention and focus from any distraction especially in the mechanical engineering subjects due to its complexity and details.

Furthermore, utility is negatively significant in relation with instructions at (sig. -0.21). This means that the explanation that the animation provides for the users about the four-stroke petrol engine operation is reasonable and can be easily established. In addition, this result confirms that dynamic instructions are successful in teaching mechanical engineering topics. The variable utility is also negatively significant in relation with the variable presentation at (sig. -0.06).

This result indicates that the animation utilization suits the content being presented. In addition, the presented elements in the animation can be reliable in teaching mechanical engines' operations. Utility is positively significant in relation with the variable simplicity at (sig. 0.02). This result means that the effectiveness of the engine's animation outcome is actually simple and easy enough to be understood.

Those results ensure that the animation as a learning tool can be helpful regardless of content complexity. The table also shows that utility is negatively significant in relation with accuracy at (sig. -0.27). This result illustrates the detailed feature that the animation has in terms of specifically elaborating how each stage of the engine's operation works. According to that result, lecturers will be sure that students will definitely go through each and every part of the lesson. The variable utility is finally negatively significant in relation with the help option at (sig. -0.13). This means that the animation is useful enough without any need for help and instructions. Unless the animation is further enhanced and the contents of it are upgraded, certain parts of the animation might need a little extra explanation.

Table 2 continues displaying the inter-item correlation matrix where the variable natural manner is negatively significant in relation with the variable contents at (sig. -0.03). This shows that the contents are being presented in a commonly viewed manner that is familiar to the users. This specific point is important because users can link between similar actions which will help them better understand the subject. Finally, the variable flexibility is negatively significant in relation with the variable contents at (sig. -0.10). This result ensures the ease of the animation's presentation that is very significant since students come from different backgrounds and have different learning styles in conjunction with the mechanical engineering education type, which requires attention and accuracy.

3.3 Reliability Statistics

Indiana State University (2005) found that reliability investigations give the opportunity to determine the features of measurement scales together with the items that formulates them. The progress of analyzing the reliability measures a number of regularly used measures of scale, which are considered under reliability besides giving details about the relationships that takes place between individual objects in the specific scale. When it comes to the best effective way of measuring the reliability statistics, Laerd Statistics and Lund Research Ltd. (2013) agreed that "cronbach's alpha is the most common measure of internal consistency ("reliability").

It is most commonly used when you have multiple Likert questions in a survey/questionnaire that form a scale, and you wish to determine if the scale is reliable". Therefore, Cronbach's alpha is the method used in testing the reliability of this study since that this research contains "multiple Likert questions in a survey/questionnaire that form a scale".
Surveyed items in Table 3 was carried out through Cronbach's Alpha which led to the determent of the seventeen items used during the pilot test. The researcher found that the Cronbach's Alpha 85% in the group of items under the description of effect of animation on the mechanical engineering students. Having 85% as a result of Crobach's Alpha indicates that the data items are reliable. It also indicates that the number of respondents is enough and capable to measure the impact and quality of animation in enhancing mechanical engineering students' performance in their studies.

This positive result also ensures that the respondents agreed that animation can enhance their technical performance and can replace missing parts of practical lessons. Moreover, animation technology can be implemented in mechanical engineering education if the designer followed the specific design guidelines that ensure the accuracy and the details of the application before giving it to the end users. In addition, implementing animation in that specific area of education might not be only for presenting dynamic engine operations but can be also used to create quizzes and exercises to name a few, that can take place in enhancing and supporting the students' learning and performance.

The result of the Crobach's Alpha in this primary round of collected data proves that animation as a multimedia element and as a dynamic technology is able to be embedded successfully in education, especially disciplines that requires practice and live experiments. However it must be kept in mind that in order to achieve that success it is important to design the animation correctly and implement the dynamic features in a proper structure. Consequently, animation could probably be used not only in presenting an engine's operations and replacing missing mechanical engineering tools but it could also be used in designing full applications that gives more information about the topic and provide other interactive activities for the users.

3.4Anova with Friedman's Test And Tukey's Test for Nonadditivity

When the study contains a categorical independent variable (consisting of two or more categories) together with a normally distributed interval dependent variable a one-way analysis of variance (ANOVA) test is used in order to measure and calculate the differences in the means of the dependent variable which is broken down by the levels of the independent (UCLA Statistical Consulting Group, 2013).

Weiers (2010) found that Chi-Square is a probability distribution that takes place in analyzing data by determining the source of the sample and the type of population distribution it's coming from, verifies whether two nominal variables are independent of each other, and concludes whether two or more independent samples could have the same population quantity. Weiers (2010) continues by saying that Chi-Square distribution can be utilized in "constructing confidence intervals and carrying out hypothesis tests regarding the value of a population variance". UCLA Statistical Consulting Group (2013) described the Chi-Square performance in analyzing a set of collected data by saying that "in SPSS, the chisq option is used on the statistics subcommand of the crosstabs command to obtain the test statistic and its associated p-value".

Table 4 is the result of analysis of variance in the data set. The probability i.e. $p=0.05$ and Chi-Square test statistic is 198.20. Based on the rule of thumb that where $p\leq 198.20$ and significant at .000 the null hypothesis accepted that animation is capable of enhancing the performance of engineering students in IIUM. The table further justified the inclusion of most of the variables i.e. indicating that the variables are the correct model to be use in testing the effective correlations between engineering and IT professions. Another vital indicator is the standardized residual value as displayed in the table above is positive value 24.96 significant at .000 indicating that animation is over-represented in the actual sample compared to the expected frequency. This showed that there were more subjects in the variables than was expected.

4 CONCLUSION

In the pilot round, the researcher was able to determine the strengths and weakness. In this case, it is possible to enhance and reorganize the questionnaire for greater clarity. In addition, the pilot round is important for establishing how users are satisfied with the overall idea of the study and whether they understood the aim of the questionnaire.The regression analysis calculated values and extracted tables that showed a strong relation among variables in the survey. The positive result made it possible to progress and analyze the data using the factor analysis in order to confirm the positive results retained from the regression analysis.

5 REFERENCES

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6 LIST OF TABLES

Table 1: Descriptive Statistic of Responses

Give your rating on a scale starting from 1 to 5 about the animation's presentation (1 indicates absolute accepting and 5 indicate total disagreement):

Variables	Frequency	Percent (%)	Mean (μ)	Standard Deviation
- The Animation functions clearly (Animation Function):				
1- Strongly agree.	14	58.3		
2-Agree.	8	33.3	1.5000	
3- Averagely agree.	2	8.3		.66
4- Disagree.	.0	.0		
5- Strongly disagree.	.0	.0		
- The flow of the animation gives an appropriate feedback within reasonable time (Appropriate Time):				
1- Strongly agree.	11	45.8		
2-Agree.	11	45.8	1.6250	.65
3- Averagely agree.	2	8.3		
4- Disagree.	.0	.0		
5- Strongly disagree.	.0	.0		
- The information appears in a natural and logical order (Natural Manner):				
1- Strongly agree.	13	54.2		
2-Agree.	9	37.5	1.5417	.66
3- Averagely agree.	2	8.3		
4- Disagree.	.0	.0		
5- Strongly disagree.	.0	.0		
- The animation matches the engine in reality (Reliability):				
1- Strongly agree.	11	45.8		
2-Agree.	10	41.7	1.6667	.70
3- Averagely agree.	3	12.5		
4- Disagree.	.0	.0		
5- Strongly disagree.	.0	.0		
- It feels free while controlling the animation contents such as, going back to a specific scene or moving to the next scene (Flexibility):				
1- Strongly agree.	16	66.7	1.5000	.88
2-Agree.	6	25.0		
3- Averagely agree.	.0	.0		
4- Disagree.	2	8.3		
5- Strongly disagree.	.0	.0		
- The animation contents are consistent and follow the standards of multimedia presentations (Standard):				
1- Strongly agree.	12	50.0	1.6250	.71
2-Agree.	9	37.5		
3- Averagely agree.	3	12.5		
4- Disagree.	.0	.0		
5- Strongly disagree.	.0	.0		
- The animation design is good enough to prevent errors from occurring or causing you to mistakenly choose the wrong option (Error Free):			1.5833	.78
1- Strongly agree.	13	54.2		
2-Agree.	9	37.5		
3- Averagely agree.	1	4.2		

4- Disagree. 5- Strongly disagree.	1 .0	4.2 .0		
- Instructions for use of the animation such as, objects, actions, and options are visible enough and can be easily retrieved (Instructions): 1- Strongly agree. 2-Agree. 3- Averagely agree. 4- Disagree. 5- Strongly disagree.	14 8 1 1 .0	58.3 33.3 4.2 4.2 .0	1.5417	.78
- Flexibility in contents and actions while using the animation (Bendable): 1- Strongly agree. 2-Agree. 3- Averagely agree. 4- Disagree. 5- Strongly disagree.	12 10 2 .0 .0	50.0 41.7 8.3 .0 .0	1.5833	.65
- The animation presentation is effective in teaching the internal parts and the operation for the four-stroke petrol engine (Presentation): 1- Strongly agree. 2-Agree. 3- Averagely agree. 4- Disagree. 5- Strongly disagree.	12 9 2 1 .0	50.0 37.5 8.3 4.2 .0	1.6667	.82
- The animation design is simple and offers the basic requirements (Simplicity): 1- Strongly agree. 2-Agree. 3- Averagely agree. 4- Disagree. 5- Strongly disagree.	15 7 2 .0 .0	62.5 29.2 8.3 .0 .0	1.4583	.66
- There are some irrelevant or rarely needed information in the animation's contents (Contents): 1- Strongly agree. 2-Agree. 3- Averagely agree. 4- Disagree. 5- Strongly disagree.	7 5 5 3 4	29.2 20.8 20.8 12.5 16.7	2.6667	1.46
- You are easily able to recognize, identify, and keep away from making errors (Accuracy): 1- Strongly agree. 2-Agree. 3- Averagely agree. 4- Disagree. 5- Strongly disagree.	11 10 2 1 .0	45.8 41.7 8.3 4.2 .0	1.7083	.81
- The animation needs help and documentation to list user's task and concrete steps to be carried out (Help Option): 1- Strongly agree. 2-Agree. 3- Averagely agree. 4- Disagree. 5- Strongly disagree.	10 8 5 .0 1	41.7 33.3 20.8 .0 4.2	1.9167	1.02

Table 2: Inter-Item Correlation Matrix

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1																	
2		Materials	Utility	Animation Compatibility	Animation Function	Appropriate Time	Natural Manner	Reliability	Flexibility	Standard	Error Free	Instructions	Presentation	Simplicity	Contents	Accuracy	Help Option
3	Materials	1	0.114	0.078811	-0.48795	-0.42276	-0.2689	-0.18334	-0.0727	-0.5657	-0.0415	-0.061951	-0.1576221	-0.12224	-0.1757	-0.1396	-0.0316
4	Utility	0.113961	1	-0.062869	-0.23355	-0.059514	-0.0195	-0.07313	0	-0.2708	-0.0331	-0.214153	-0.0628695	0.019503	0.0701	-0.2705	-0.1261
5	Animation Compatibility	0.078811	-0.06	1	0.161515	0.452735	0.47207	0.404577	0.60193	0.11235	0.38909	0.6721492	0.60869565	0.499044	0.04848	0.60527	0.22668
6	Animation Function	-0.48795	-0.23	0.1615146	1	0.5606119	0.55115	0.751469	0.59628	0.78836	0.25507	0.4655281	0.64605828	0.350731	0.18009	0.53146	0.38865
7	Appropriate Time	-0.42276	-0.06	0.452735	0.560612	1	0.60009	0.670222	0.34188	0.72085	0.45498	0.5931377	0.65852358	0.625623	0.45891	0.61464	0.34663
8	Natural Manner	-0.26893	-0.02	0.4720687	0.551149	0.6000869	1	0.784416	0.70957	0.63897	0.63191	0.7598312	0.75530987	0.707113	-0.0301	0.6384	0.32996
9	Reliability	-0.18334	-0.07	0.4045774	0.751469	0.6702222	0.78442	1	0.70014	0.60985	0.45257	0.7420637	0.78386869	0.533403	0.09868	0.58882	0.50705
10	Flexibility	-0.07274	0	0.6019293	0.596285	0.3418817	0.70957	0.70014	1	0.38022	0.38023	0.6624243	0.84270097	0.485494	-0.1007	0.51801	0.38624
11	Standard	-0.5657	-0.27	0.1123509	0.788356	0.7208468	0.63897	0.60985	0.38022	1	0.49286	0.5397087	0.6741053	0.569267	0.33406	0.63511	0.31541
12	Error Free	-0.04149	-0.03	0.3890863	0.255069	0.4549834	0.63191	0.45257	0.38023	0.49286	1	0.7496328	0.59507319	0.816507	0.10208	0.70097	0.22947
13	Instructions	-0.06195	-0.21	0.6721492	0.465528	0.5931377	0.75983	0.742064	0.66242	0.53971	0.74963	1	0.77468044	0.766899	0.16513	0.81605	0.44318
14	Presentation	-0.15762	-0.06	0.6086957	0.646058	0.6585236	0.75531	0.783869	0.8427	0.67411	0.59507	0.7746804	1	0.701359	0.1212	0.70432	0.43592
15	Simplicity	-0.12224	0.02	0.499044	0.350731	0.6256226	0.70711	0.533403	0.48549	0.56927	0.81651	0.7668994	0.70135916	1	0.30078	0.75448	0.38405
16	Contents	-0.17575	0.07	0.0484786	0.18009	0.458912	-0.0301	0.09868	-0.1007	0.33406	0.10208	0.1651335	0.12119654	0.300777	1	0.24541	0.21386
17	Accuracy	-0.13964	-0.27	0.6052733	0.531461	0.6146389	0.6384	0.588825	0.51801	0.63511	0.70097	0.8160501	0.70431807	0.754477	0.24541	1	0.49873
18	Help Option	-0.03161	-0.13	0.2266791	0.38865	0.3466303	0.32996	0.507046	0.38624	0.31541	0.22947	0.4431812	0.43592128	0.384053	0.21386	0.49873	1

Table 3: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.853	.786	26

Table 4: ANOVA with Friedman's Test and Tukey's Test for Nonadditivity

			Sum of Squares	df	Mean Square	Friedman's Chi-Square	Sig
Between People			53.532	23	2.327		
Within People	Between Items		96.917[a]	25	3.877	198.204	.000
	Residual	Nonadditivity	8.187[b]	1	8.187	24.958	.000
		Balance	188.281	574	.328		
		Total	196.468	575	.342		
	Total		293.385	600	.489		
Total			346.917	623	.557		

Grand Mean = 1.5417

a. Kendall's coefficient of concordance W = .279.

b. Tukey's estimate of power to which observations must be raised to achieve additivity = -.530.