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Designing a Motivated Tangible Multimedia System for Preschoolers

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***Abstract*—**The paper examined the capability of a prototype of a tangible multimedia system that was augmented with tangible objects in motivating young preschoolers in learning. Preschoolers' learning behaviour is highly captivated and motivated by external physical stimuli. Hence, conventional multimedia which solely dependent on digital visual and auditory formats for knowledge delivery could potentially place them in inappropriate state of circumstances that are frustrating, boring, or worse, impede overall learning motivations. This paper begins by discussion with the objectives of the research, followed by research questions, hypotheses, ARCS model of motivation adopted in the process of macro-design, and the research instrumentation, Persuasive Multimedia Motivational Scale was deployed for measuring the level of motivation of subjects towards the experimental tangible multimedia. At the close, a succinct description of the findings of a relevant research is provided. In the research, a total of 248 preschoolers recruited from seven Malaysian kindergartens were examined. Analyses revealed that the tangible multimedia system improved preschoolers' learning motivation significantly more than conventional multimedia. Overall, the findings led to the conclusion that the tangible multimedia system is a motivation conducive multimedia for preschoolers.

***Keywords*—**Tangible multimedia, preschooler, motivation, multimedia.

I. Introduction

MOTIVATION denotes the internal conditions of a person that result in the pursuit of specific goals [1]. Correlational research works reveal that there exists a close relationship between motivation and academic performance, where motivation instigates and sustains positive goal-directed academic learning, particularly for young children [2]-[4]. However, it is not long-standing. Motivation is conceived to be faded by the time young children reach formal schools. In this respect, preschools have been criticised for contributing to such a negative motivational trend [5].

Depleted motivation among preschoolers is one of the major problems encountered by most education practitioners. In view of the importance of motivation to academic performance, there is an imperative need to intensify research to search for educational technologies or strategies capable of fostering a more endurable learning motivation among preschoolers, such as rendering certain unique features that are fascinating for preschoolers to multimedia [6], [7].

There are evidences supporting the fact that a young child has an innate need within to interact with the environment to acquire knowledge [8], [5]. Tangible objects themselves are real-world concrete materials. Thus, they perfectly facilitate intuitive interaction between young children and environment. By looking at the children's intrinsic motivation and preoperational stage of mental model [12], [13], it is possible to resolve the problem of depleted motivation through use of tangible objects embraced into a multimedia system. Not only because it is theoretically aligned with motivational dimensions, but also because educational technologies that are high in intuitiveness support, in turn, is expected to lead to high motivation on learning [9]. Such multimedia is termed as tangible multimedia.

This paper aims to find out whether a prototyped tangible multimedia system entitled "*TaLearns*" addressed the use of tangible objects that could be used to motivate preschoolers in learning. Minimal attention has also been given to the factor of motivation as well as attributes adaptable to preschoolers' innate needs. Previously, multimedia research works have mainly focused on conventional multimedia systems which knowledge delivery is often solely dependent on visual and auditory sensory channels. For preschoolers, such multimedia is insufficient to motivate a preschooler for learning.

In this paper, the researchers discuss the objectives of the research, research questions, hypotheses, ARCS model of motivation adopted for macro-design and how it was applied, and Persuasive Multimedia Motivational Scale deployed for measuring motivation. A succinct report of the research is provided at the end of the paper.

II. Objectives of the Research

The objectives of the research are to assess the extent the motivation effect of a tangible multimedia learning system on Malaysian preschoolers and gather empirical evidence on the impact of the effect on preschoolers of different gender. Using motivation score as a measurement, the research were set to investigate whether the group of young preschoolers using tangible multimedia would be more motivated than conventional multimedia (CMM) that another group of preschoolers were under.

III. Research Questions

The research sought to answer the following Research Questions (RQ):

- RQ1: Do learners of the *TaLearns* system demonstrate a significant difference in their motivation (as measured by

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PMMS score) compared to the learners engaged in CMM system?

- RQ2: Is there any interaction effect in the dependent variable (motivation) between learners in the *TaLearns* group as compared to the CMM group with different gender (male and female learners)?
- RQ3: Is there any significant difference in the dependent variable (motivation) between learners in the *TaLearns* group as compared to the CMM group with different gender (male and female learners)?

IV. Research Hypotheses

As the research involved a system augmented with a novel element, and there was no prior similar research, it was hypothesised that the research has null effects on the learners. The level of significance of the research, $\alpha = 0.05$.

- $H_0 1$: There is no significant difference in motivation between learners using *TaLearns* and those using the CMM system.
- $H_0 2$: There is no interaction effect between the learning modes (*TaLearns* and CMM systems) and gender (male and female) on motivation.
- $H_0 3$: There is no significant difference in motivation between male and female learners in *TaLearns* and the CMM groups.

The hypotheses seek to answer RQ1, RQ2, and RQ3 to confirm firstly, whether there are any differences in the motivation among learners using system designed accorded to the manifestation of tangibility (*TaLearns*) and those using CMM system, secondly, whether there exist interaction effects between the learning modes and gender (male and female) on the motivation, and lastly, whether there are significant differences in the motivation between male and female learners of each type of learning mode (*TaLearns* or CMM).

V. Design of the *TaLearns* System

TaLearns is a prototype of tangible multimedia system unified with tangible objects. CMM, on the other hand, was a normal multimedia system without augmentation of tangible objects. With tangible objects in *TaLearns*, the children possess the opportunity to directly grasp objects with two hands, hold, move, and release in a multimedia context. The architecture of the *TaLearns* system is depicted in Fig. 1.

TaLearns comprised of two arenas, namely physical and virtual arenas. The physical arena consisted of a display table, keyboard, monitor, CPU, two mice, earphones, five tangible objects, RFID tags, RFID reader and sensor devices (slider, spatial, and touch sensors) that were deployed to implement the binding of tangible objects and multimedia expressions. The virtual arena composed of corresponding virtual learning objects that were bound to sensor augmented tangible objects placed irregularly on display table in front of the subjects (preschoolers).

During the learning lesson, the subjects were required to pick a tangible object on the display table. Depending on the type of sensor attached to the tangible objects, the subject either needs to point it to sensor devices or perform gestural movements to trigger corresponding virtual learning objects to display learning contents on the computer screen. With concrete experience of the tangible object in hand, they are in a better position to comprehend the object they learned.

Fig. 1 Mapping nonlinear data to a higher dimensional feature *TaLearns* system architecture

Fig. 2 Learning with *TaLearns*

The motivation of learners was measured using a research instrument termed Persuasive Multimedia Motivational Scale (PMMS) after completion of the whole lesson.

VI. ARCS Model of Motivation

The ARCS model of motivation [14] is an instructional design model that explains how people can attain "motivation". Measuring motivational aspect of a learner is important because when (s)he enjoys the learning task, the chances are great that (s)he will tend to repeat the task as well as being engaged for a longer period of time on the learning task. The four key factors essential in stimulating a person's motivation state in ARCS model are shown in Table I.

"Attention" refers to strategies for arousing and sustaining curiosity and interest. A person being engaged in motivation can be for intrinsic (motivation coming from the learner such as sense of achievement) or extrinsic (like the need for monetary reward, entertainment, promotion, and status) purposes. "Relevance" refers to relevancy of a system to a learner's personal situation. Strategy such as using meaningful

examples that linked to learner's needs and interests is likely to motivate a learner. "Confidence" refers to a learner's expectations of success. If a learner knows a task is doable, (s)he will develop a positive expectation for successful achievement, and thus be more motivated to continue. To build-up confidence upon a learning task that a learner encounters, a system can be designed with learning process accommodated to learners' cognition. "Satisfaction" refers to the results of the learning experience. The success or failure of any learning tasks is closely correlated to a learner's motivation. Motivation to continue the pursuit of certain goals will be enhanced if rewards are given.

TABLE I
ARCS MODEL OF MOTIVATION [14]

A	Attention	Grab the attention and stimulate them
R	Relevance	Meet learner' requirements
C	Confidence	Convince them that they will succeed
S	Satisfaction	Give satisfactory reward

The ARCS model of motivation was chosen because it is a renowned model of instructional design [10]. It is simple, yet powerful, and rooted in a number of notable motivational theories such as the expectancy-value theory [15].

VII. APPLICATION OF ARCS MODEL OF MOTIVATION

ARCS model [1], [14] was adopted in the macro design of *TaLearns*. "Attention" motivational elements were applied in a way that tangible objects were placed in front of the preschoolers. This greatly attracted the attention of the subjects, and subsequently invited them to perform deliberate discovery, like performing actual visual search for the tangible objects that they were interested in.

Fig. 3 "Attention" motivational elements in *TaLearns*

Apart from that, the cute 2D virtual character that always appeared at the side of the screen served as an "entity" not only capable of drawing the attention of the subjects towards the *TaLearns*, but also served as "teacher" that could enhance subjects' confidence.

The authentic environment scene that is prescribed by ARCS model as vital "attention" elements for learning were applied intensively in *TaLearns* in a way that it resembles real and familiar environments of Malaysia such as an office, garden, and the national zoo. By "real environment", it means an integrated and realistic scene that represents the multiple complexity of the real world [16]. Unlike many screens of CMM systems that are filled with menus and buttons written with school terminologies, *TaLearns* began with a complete learning scene that potentially drives the subjects to feel motivated.

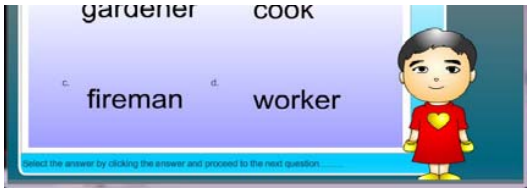

Fig. 4 A cute 2D virtual character in *TaLearns*

Fig. 5 Realistic virtual scene in *TaLearns*

Compliant with the "relevance" motivational element, relevant daily tangible objects from the surrounding were chosen as the target learning objects for preschoolers. These recognisable objects were directly mapped into the virtual arena. They were not used to represent distinct domains, or made visual properties discarded like abstract manipulatives. Manifestation of virtual learning objects in this way was concrete in the epitome of feeling that the virtual objects could be felt and relevant.

Supporting links such as search, video gallery, dictionary, terms definition, and help links signified the application of "confidence" motivational element on *TaLearns*. In the quiz session, the subjects could further obtain additional information from "Related Cases" and "Information Resources" instructional supporting tools. These supporting tools provided useful hints whenever required, thereby making the subjects' learning process more confident.

Tangible objects implicated the application of "confidence" motivational elements on *TaLearns*. Tangible objects were applied in a way that firstly, tangible objects chosen for learning were recognisable objects from the surroundings. Secondly, symbolic and abstract objects were not chosen because of concerns that preschoolers may have difficulties in interpreting them [17]. Thirdly, tangible objects are materials that "cognitive-developmentally" appropriate for children aged 5 and 6 [12], [13]. Because of this, minimal training was required for using *TaLearns*.

Fig. 6 Supporting links in *TaLearns*

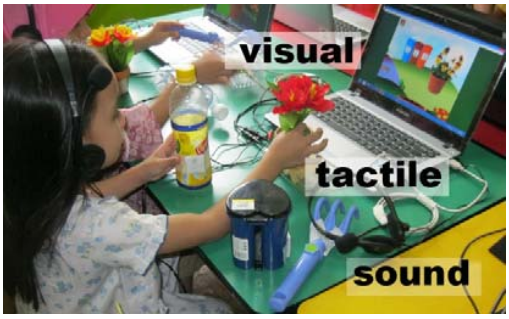

Fig. 7 "Cognitive-developmentally" tangible objects enhanced children's confidence

TaLearns denotes the application of "satisfaction" motivational element by incorporating meaningful feedback that could scaffold the subjects. Both positive and negative feedback are important means of motivation reinforcement. It not only instigated subjects' motivation, but also facilitated positive attitude towards learning. Among the instances of feedback given are "motivational prompts" embedded in the quiz session the sound "Congratulations! You have shown the right object" and rewards in the form of points given to subjects for each correct answer given. Apart from that, various fascinating animations and videos accompanying the quiz questions provided a strong sense of satisfaction to the young subjects.

VIII. PMMS (Persuasive Multimedia Motivational Scale)

PMMS was adopted for measuring the level of motivation of the subjects towards the experimental systems, namely *TaLearns* and CMM learning modes. PMMS, which originally deployed in persuasive multimedia learning environment [19], was adapted from the Malay language version [18] of the Instructional Materials Motivation Scale [14].

PMMS consists of 10 worded Likert-type statements that are based on opinions. The overall motivational measures to the *TaLearns* and CMM modes include whether their interface was eye-catching, interesting, easy, and a pleasure to use. The subjects were required to respond to each of the statements by circling their opinions on a set of five faces of smiley, which are a pictorial representation of different kinds of happy faces to discern and represent different levels of motivation. In PMMS, the scale ranges from a scale of 5 (strongly agree), 4 (agree), 3 (neither agree nor disagree), 2 (disagree) to 1 (strongly disagree). A response of 5 means a high level of motivation, whereas a response of 1 indicates low motivation. There were no correct or wrong answers for this instrument. The total motivation score was the total scale of a subject circled, converted to percentage (100%) for analysis.

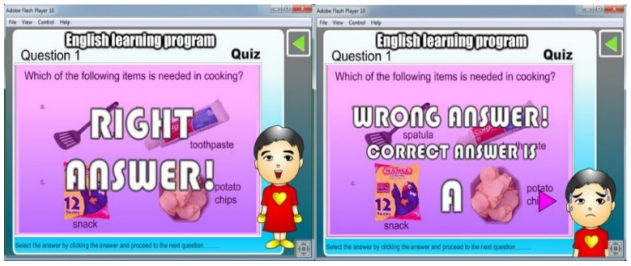

Fig. 8 Positive and negative feedback

Fig. 9 PMMS test in progress

PMMS was chosen as instruments for measuring the level of motivation of subjects because first, the PMMS scale was specially catered for young children's level, which suits the target subjects of the current research. Second, it was made child-friendly by the use of a smiley scale. A smiley is proven to be an effective method to gauge the response from children in many empirical research works. Third, Cronbach's alpha coefficient for the validity and reliability of PMMS was satisfactorily reliable, showing that PMMS was suitable to be deployed in the research. IMMS's, the original form of PMMS, Cronbach's alpha coefficient was 0.81. Besides, the instrument's content validity and reliability in Malaysia had

been reviewed by experienced teachers and tested by children in a research work conducted by Sobihatun [19].

IX. Overview of Dataset

A seven-day research for assessing the motivation level of 248 preschoolers (subjects) after treatment using *TaLearns* had been conducted in seven private kindergartens in Malaysia. Each lesson lasted one hour per day, for seven days consecutively in each kindergarten. Table II shows the categories and number of subjects in each cell. A total of 248 preschoolers' data were taken into analysis, of which, 128 (51.6%) were in the *TaLearns* group and 120 (48.4%) in the control group (CMM mode). A total of 121 (48.8%) of the research subjects were males and 127 (51.2%) females.

TABLE II
STATISTICS FOR EACH CELL IN THE RESEARCH

Variable		Frequency (N=248)	Percentage (%)
Learning Mode	*TaLearns*	128	51.6
	CMM	120	48.4
Gender	Male	121	48.8
	Female	127	51.2

Table III reports different combinations of cells and sizes for each cell based on the learning modes. In respect of gender, *TaLearns* was used by 58 male and 70 female subjects, whereas CMM was used by 63 male and 57 female subjects.

TABLE III
STATISTICS FOR GENDER BY LEARNING MODE

Learning mode	Gender	
	Male	Female
TaLearns (n_T = 128)	58 (45.3%)	70 (54.7%)
CMM (n_{CMM} =120)	63 (52.5%)	57 (47.5%)
Total	121	127

X. Appropriateness Of Dataset for MANCOVA Analyses

MANCOVA allows researchers to look at the overall pattern of dependent variables in combination to give an indication of which group, if any, came out best in terms of learning performance [20]. The cells of the dataset are appropriate for MANCOVA analyses. This is based upon the situation that first, the cells were derived from the research which was a complete between-participants research. The two compared learning modes consisted of different subjects; hence, ensuring each cell is not influenced by other cells. Second, independence of cells was maintained. As each subject appeared under only one mode, unnecessary interaction between cells was not only avoided, the scores obtained from the subjects were also independent of each other. Third, there was a sufficient dataset for each cell (n>30). Lastly, the ratio of the largest group variance was not more than three times the smallest group variance, thereby forming a robust dataset for testing. Besides, the normality of distributions for motivation score is satisfied. Skewness and kurtosis values for motivation, as shown in Table IV, was between -1.0 and +1.0, indicating the existence of reasonable normality of the dataset.

TABLE IV
STATISTICAL ANALYSES OF SKEWNESS AND KURTOSIS MEASURES

	Mean ($\bar{X}$)	SD	Skewness	Kurtosis
Motivation	70.42	11.73	0.240	-0.382

XI. Testing of Hypotheses

In view of the absence of a major violation of the assumptions of MANCOVA, the researchers can continue with MANCOVA to examine the possible main effects and interaction effects of using the *TaLearns* and CMM across the groups with a high degree of confidence. The main effects are tested at an alpha level of 0.05. Each simple effect, if any, are tested at an α level of 0.017 (0.5 divided by three univariate tests), making use of the Bonferroni adjustments [21] to take into account the family-wise error so as to guard against inflating Type I error [20].

XII. The Main Effect of Learning Mode

The main effect of the two learning modes, *TaLearns* and CMM on the motivation score is analysed and presented based on the following hypothesis:

$H_0$1: There is no significant difference in motivation between learners using *TaLearns* and those using CMM mode.

A. Descriptive Statistics Analysis of the Effects of Learning Mode on the Motivation Score

Table V provides a preliminary view of the PMMS motivation score of both *TaLearns* and CMM treatments in descriptive statistics.

TABLE V
MEAN SCORES ($\bar{X}$) AND STANDARD DEVIATIONS (SD) OF MOTIVATION SCORE BY LEARNING MODE

	Mode	$\bar{X}$	SD	difference of $\bar{X}$
Motivation	*TaLearns*	74.50	10.64	8.42
	CMM	66.08	11.31	

For motivation, *TaLearns* ($\bar{X}$=74.50; SD=10.64) results in higher $\bar{X}$ of motivation score than CMM subjects ($\bar{X}$=66.08; SD=11.31) by 8.42.

B. The Interaction Effects between Gender and Learning Mode on the Motivation Score

The interaction effect between the two groups of different learning modes and gender on the motivation score is presented in this section. The hypothesis tested is:

H_o2: There is no interaction effect between the learning modes (*TaLearns* and CMM) and gender on motivation.

Table VI demonstrates descriptive statistics of motivation scores achieved by male and female subjects after treatment using *TaLearns* and CMM modes.

Table VI reveals that the average motivation scores for the male and female subjects differ by 0.69 (70.68-69.99), on average, with male subjects doing better. The effect of learning mode on motivation score can also be observed

(74.53-66.13). Fig. 10 provides a clear graphical representation of a main effect of gender and a main effect of learning mode.

TABLE VI
DESCRIPTIVE STATISTICS (MEAN SCORES ($\bar{x}$) AND STANDARD DEVIATIONS (SD)) OF MOTIVATION SCORE BY LEARNING MODE AND GENDER

	Learning mode		
Gender	CMM ($\bar{x}$)	*TaLearns* ($\bar{x}$)	Average
Male	65.14	74.83	69.99
Female	67.12	74.23	70.68
Average	66.13	74.53	

The figure demonstrates that the effect for learning mode is greater for the female subjects than it is for the male subjects. The cross-over lines indicates a fairly large interaction effect. Table VII shows its inferential statistics, indicating that the main effect of gender on motivation score was not significant ($F(1,244)=0.243$, $p=0.622$). The main effect of learning mode on motivation score was significant such that male subjects received higher scores than female subjects ($F(1,244)=35.926$, $p=0.001$). This indicates that male and female genders were affected differently by the learning mode. Non-significant interaction effect between gender and learning mode on the motivation score ($F(1,244)=0.848$, $p=0.358$) concludes that $H_0 2$ hypothesis was accepted.

C. Analysis of the Difference of Motivation by Gender in Learning Mode

This section analyses and presents the difference of motivation by gender at each level of learning mode. The hypothesis tested is:

$H_o 3$: There is no significant difference in motivation between male and female learners in *TaLearns* and CMM groups.

TABLE VII
ANALYSIS OF MAIN AND INTERACTION EFFECTS OF GENDER AND LEARNING MODE ON MOTIVATION SCORE

Source	type III sum of squares	*df*	mean square	*F*	*Sig.*
Corrected Model	4516.220[a]	3	1505.407	12.459	0.000
Intercept	1218619.196	1	1218619.196	10085.419	0.000
gender	29.363	1	29.363	0.243	0.622
Learning mode	4340.983	1	4340.983	35.926	0.000
gender x learning mode	102.412	1	102.412	0.848	0.358
Error	29482.473	244	120.830		
Total	1264084.000	248			
Corrected Total	33998.694	247			

a. R Squared = 0.133 (Adjusted R Squared = 0.122)
Tests of Between-Subjects Effects
Dependent Variable: motivation

TABLE VIII
PAIRWISE COMPARISONS OF THE DIFFERENCE OF THE MOTIVATION SCORE BETWEEN SUBJECTS OF DIFFERENT GENDER IN LEARNING MODE

Gender	(I)treatment	(J)treatment	mean difference(I-J)	std. error	*Sig.*[a]
Male	CMM	*TaLearns*	-9.685*	2.000	0.000
Female	CMM	*TaLearns*	-7.106*	1.961	0.000

* The mean difference is significance at the 0.05 level.
a. Adjustment for multiple comparisons: Bonferroni.
Dependent Variable: motivation

Table VIII reports that the motivation score for male subjects in *TaLearns* is higher than the males in CMM by -9.685; a similar trend was observed for females with -7.106.

Table IX reveals that the mean differences of motivation score for male ($F(1,244)=23.441$, $p<0.001$) and female ($F(1,244)=13.129$, $p<0.001$) subjects in *TaLearns* and CMM are significant, thus that $H_o 3$ was rejected.

TABLE IX
UNIVARIATE ANALYSIS OF THE DIFFERENCE OF THE MOTIVATION SCORE BETWEEN SUBJECTS OF DIFFERENT GENDER IN LEARNING MODE

Gender		sum of squares	*df*	mean square	*F*	*Sig.*[a]
Male	Contrast	2832.423	1	2832.423	23.441	0.000
	Error	29482.473	244	120.830		
Female	Contrast	1586.320	1	1586.320	13.129	0.000
	Error	29482.473	244	120.830		

Dependent Variable: motivation

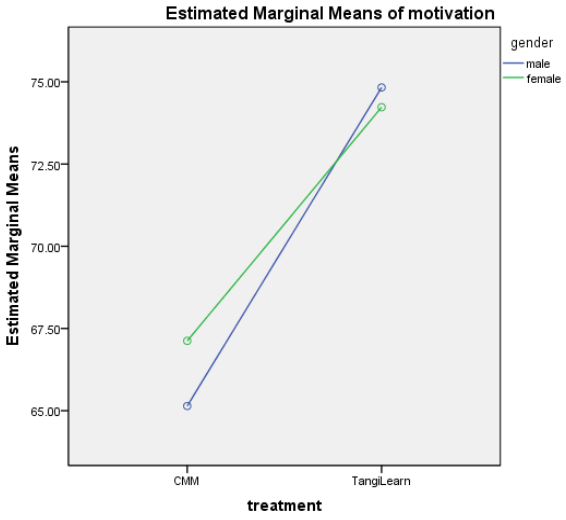

Fig. 10 Plot of effects on motivation between learning mode and gender

XIII. SUMMARY OF THE TESTING RESULTS OF HYPOTHESES

The results of the hypotheses tested are summarised in Table X.

TABLE X
SUMMARY OF THE TESTING RESULTS OF HYPOTHESES

Hypotheses	Decision	General implications
$H_0$1: There is no significant difference in motivation between *TaLearns* learners and CMM learners.	reject	*TaLearns* is able to enhance preschoolers' motivation more than CMM. *TaLearns* could serve as alternative to current multimedia.
$H_0$2: There is no interaction effect between the learning modes (*TaLearns* and CMM systems) and gender on motivation.	fail to reject	*TaLearns* is motivated for both male and female preschoolers.
H_o3: There is no significant difference in motivation between male and female learners in the *TaLearns* and CMM groups.	reject	*TaLearns* enhances male and female preschoolers' motivation more than CMM.

XIV. DISCUSSIONS

This section presents discussions on the findings drawn from the research, which will lead to the conclusion of whether the tangible multimedia, *TaLearns*, differentially kindled learning motivation for preschoolers of different gender. In discussion of the results, the researchers attempts to infer underlying reasons in the light of some of the learning theories and multimedia theoretical framework.

A. The Main Effect on Motivation Score

In comparison to CMM, the *TaLearns* mode had significant positive main effect on motivation scores. This indicates a causal relationship between *TaLearns* and motivation score where *TaLearns* had affected the subjects significantly to gain higher PMMS scores than CMM subjects. In this respect, a conclusion is drawn that the *TaLearns* kindled motivation of subjects towards learning. Motivation suggests a reflective of an individual's level of willingness and participation in an activity [22]. Such positive effect on motivation in *TaLearns* suggests the chances that the subjects will continue to use, or reuse *TaLearns* for more learning in future.

Ability to perform effortless navigation along the *TaLearns* mode provides one of the plausible explanations to the finding that *TaLearns* significantly motivated its subjects. In accordance with the Keller's [14] "confidence" component of the ARCS model of motivation, tangible objects that served as a scaffolding tool for navigation in hand, built up young children's confidence and positive expectation that *TaLearns* virtual environment is easy to use, and thereby motivated them to further explore *TaLearns*. Furthermore, collaboration among subjects in *TaLearns* mode motivated the subjects to share the tangible objects in hand freely in the shared space of *TaLearns*. On the other hand, CMM mode that was merely structured with digital presentations left nothing for the subjects to grab and share. Add to this the complexity in navigation, which resulted in CMM reducing the subjects' motivation [23].

Realistic element within contextualised learning [24] materialised by the tangible objects also serves as a viable explanation. The "relevant" component of Keller's ARCS motivation theory states that learners shown with items in real setting that are highly relevant and useful to them in learning is a way to motivate them [25]. Under this postulation, tangible objects in *TaLearns* that provided authenticity and relevancy of real world in learning to subjects was thus capable of kindling their motivation for learning [26]. According to Chen [11], a learner remembers what have been learned is by having similar experiences in an instruction that trigger the learner's memories. For this reason, the motivation for CMM subjects declined due to difficulty in triggering their memories in non-concretised environment in CMM.

Fig. 10 Gestural movement kindled subjects' motivation

Fig. 11 Digital presentation left nothing for subjects to grab and share

B. Interaction between Gender and Learning Mode

There was no significant interaction effect between gender and learning mode in terms of motivational experience. Such a situation indicates the gender of a subject did not moderate or affect the relationship between learning mode and motivation score. In other words, the motivation after treatment using *TaLearns* was not dependent on gender.

Cross comparison of learning modes by gender in motivation reports a significant difference between male subjects in *TaLearns* and CMM and between female subjects in *TaLearns* and CMM. Male subjects in *TaLearns* motivated significantly better than male subjects in CMM. Similarly, female subjects in *TaLearns* motivated significantly better than female subjects in CMM. This evidences that *TaLearns* brings motivation advantages for both male and female subjects simultaneously.

The ability of *TaLearns* to deliver information in multiple concrete and digital forms was the reason accounted for kindling the motivation of both male and female subjects. Although males and females have different approaches and preferences with computers [27], *TaLearns* had parts that were custom-designed to their character traits. Generally, males are inclined to work individually, whereas females prefer to seek assistance [28]. However, with the actual collaborative sharing of tangible objects in *TaLearns*, the male subjects had been encouraged to learn beyond their behavioural characteristics.

Meanwhile, the actual manifestation of constructivist and cognitivist's nature of learning in *TaLearns* had influenced female subjects to be as explorative as the male subjects. The negative condition of where a computer requires special spatial schema and is often portrayed as linked to males such that father and brother use computers the most [29], had deteriorated the females' motivation to use a computer. With the deployment of tangible objects in the multimedia context, the kind of paternal and mechanical role of using a computer in the view of female subjects was decreased.

One reason that accounted for low motivation in CMM mode is that the male and female subjects might have felt bored with the mere graphics or animations in the CMM. Children nowadays have been surrounded by vast exposure to digital media [6], such as high-end computer games and realistic animated movies. Because of this, typical virtual environment in CMM mode was no longer that much fun in their mind. *TaLearns* was different; its new form of novelty stimulated their curiosity and inquisitive nature.

C. Implications of the Research

As *TaLearns* has motivational advantages over the CMM system, kindergartens in Malaysia may be encouraged to consider using *TaLearns* for self-directed learning among preschoolers. In fact, motivation advantage alone is sufficient to convince teachers to consider using it, particularly when teachers are very busy with their routine duties in their classrooms [30]. This is because when motivation is increased, an attitude of inquiry can be stimulated [31], thereby interest and goals arouse for self-exploration. As a country striving towards the status of developed nation by 2020, where the pursuit of knowledge are considered as one of the economic driving forces, "arming" preschoolers with such motivation will promote their learning development as independent and self-directed learners that is able to support their own learning needs and quest for knowledge.

XV. Conclusion

A relevant research on the search for consistent evidence of tangible multimedia in motivating a preschooler was conducted. Statistical comparison analyses reveal that male and female subjects were equally motivated with the *TaLearns* treatment. With this, it can be concluded that tangible multimedia capable of becoming a universally effective multimedia that conveys motivation benefits to preschoolers of different gender.

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