



The Eye Speaks! Decoding user Experience Through Eye Tracking of Syntactical Properties Analysis for Cultural Artefact

^{1,5}Siti Mastura M.I., ²Sivaji, A., ²Soo S.T., ³Rahmah B., ⁴Hazreena H., ⁵Rahinah I.

¹Institute of Graduate Studies, University of Malaya, Kuala Lumpur, Malaysia,

²Software Testing Laboratory, MIMOS Berhad, Technology Park Malaysia, Kuala Lumpur, Malaysia.

⁴Faculty of Built Environment, University of Malaya, Kuala Lumpur, Malaysia.

³Academy of Malay Studies (Profesor Emeritus), University of Malaya, Kuala Lumpur, Malaysia.

⁵Faculty of Design and Architecture, University Putra Malaysia, Malaysia.

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ABSTRACT

Background: An artefact usage experience is able to provide a tremendous input on behavioural research. This paper presents about a computational methodology of eye tracking to lead designers and behavioural researchers to construct an effective procedure ensuring the excavation of user knowledge. **Objectives:** Our research highlights the potential for designers and behavioural researchers on using eye tracking test on for capturing user's knowledge of functional aesthetic as cognitive and behavioural ergonomic data for the said artefacts. The eye tracking instrument was introduced to capture the aesthetic experience knowledge of Malay cultural artefact for defining artefact behavioural experience (usage) based on the user's eye movements. **Results:** Results from a qualitative case study was performed demonstrated the use of eye tracking on studying the traditional Malay curvy weapon known as *Lawi Ayam* through the identification of the syntactical properties. Results from the eye tracking data (fixation data, heat map visualization, gaze plot and RTE feedbacks) on AOI (area of interest) was used to discover the interrelationship between user and artefact (stimuli). A dynamic observation during the identification process by the users in the eye tracking could reveal behavioural responses and eye movement information including the proprioceptive feedback from artefact usage experience. **Conclusion:** This study finds that the eye tracking method can be integrated in cultural artefact research to sustain tacit knowledge for new designing purposes.

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INTRODUCTION

Technologies such as computational approach provide opportunities to develop a new paradigm to understand the interrelationship between a user and an artefact. A combination of many physical artefact data and informational user data could provide a persuasive explanation from more diverse perspectives of product use. This notion could enhance understanding, acceptance, positioning, and use of an artefact by addressing cultural aspects of human-artefact interaction. This discussion applies not only to physical products but also to other forms of artefact interaction in user's mind. The user's mind in culture environment is able to produce different cognitive feedback in artefact interaction. Thus, the eye movement towards a cultural object could support the investigation of aesthetic interaction between the person and the stimulus of traditional artefacts.

In this study, the quality of interactive experience with artefacts is gained in a particular cultural context and only determined or evaluated in the context of use. Next to analytic study on an artefact and participant observation, the employment of new approach in computational testing could provide more meaningful understanding of user's preference associated with a still image of the chosen artefact. The following review will shed some light and open opportunities to establish the appropriate guideline to plan a proper procedure in user and computer interaction study.

The study amalgamated the knowledge between physical information of traditional artefact and the knowledge of psychomotor user skills (ability to learn and demonstrate manual dexterity; skilfulness in the use of hands or body) to investigate the user's aesthetic experience and cognition towards artefact design in eye

tracking technology. In order to identify the interrelationship between the design and the user, a set of artefact images (stimuli) are used to obtain the participants' responses based on their pre-existent experience or cultural memory. Also, participants' verbal descriptions regarding these images are vital to validate the findings. Moreover, the recorded data using eye fixation, fixation duration and entry time analyses on the images were derived from eye-tracking test data.

This study aims to investigate whether eye movement pattern could provide information on dynamic interrelationship between user and artefact to obtain behavioural understanding towards the development of new paradigm in cultural artefact. Therefore, this study considers finding a new applicable approach to validate the tacit information obtained during the ethnography or other method.

To obtain successful data retrieval, rigorous discussion on expert user factor contributed to data validation [1,2]. The researcher sees that physical interaction of cultural product design with the specific viewer could support the understanding of users' actual behaviour through computational interaction method (perception by eye behaviour) to improve the Malay cultural design based on behavioural ergonomic data. Therefore, there is a need to apply computational methodology on Malay cultural artefact research converged with human science to guide designers and behavioural researchers to establish product knowledge development in newer environment in Malaysia.

In this paper, we present the motivating background problem and discuss on aesthetic interaction theory to explain the relation of user aspect in aesthetic experience. This paper describes the potential of computational eye tracking approach to enable dynamic observation of users for capturing relevant data on specific elements of an artefact. In turn, we present the analysis and result, and conclude with the recommendations for establishing design-user system.

Methodology:

This study is an extension of earlier studies by the first author Siti Mastura *et. al* [3,4] whereby, it presents the relation of user involvement in obtaining behavioural responses and syntactical observation with a selected artefact using eye tracking technology. The study makes simultaneous inferences from literature review to assist the user perception and preference on cultural artefact to gain the research variables. This paper presents the feasibility of using the eye tracking method in Malaysian cultural artefact research.

Literature Review:

This section describes our motivating background problem and discusses what diagnostic Aesthetic interaction theory says about the need in bridging two components of person context and artefact context.

The relations of User characteristic in Aesthetic Interaction Ameliorates User Perception and preference:

The notion of interaction design has become an indispensable aspect of any development of product design, especially for those artefacts with embedded practical concept. The embedded practical concept in traditional cultural design focuses more on the understanding of intangible knowledge such as philosophy and pragmatic information. Hence, it requires different perspectives and approaches to increase the complex yet useful information for Malay artefact analytical research.

In Malay artefact context, the lack of pragmatic data provides the opportunity for this study to fill the gap in a new cultural setting. Although many literatures present a vast discussion on the relationship between design and the context of use, most of them have placed the user characteristic context in the general discussion. Fortunately, Margolin [5] and Locher *et al.* [6] emphasize that understanding the user characteristic remains crucial to value the user experience.

Margolin [5] suggests four dimensions of relationship that will help designer to elevate the essential point user context that includes: 1) the social dimension (understand the product contribution to social and environment impact, either positive or negative), 2) the inventive dimension (the inventor, refers to his ability to conceive new functional artefact that will be valued by the user on the perception of what people need or find useful), 3) the operational dimension (the design of the product has to be labelled), 4) the aesthetic dimension (the social perception is changing from emphasizing the form to focus on the use).

Meanwhile, Locher *et al.* [6] supports that along with the behavioural level of processing, central executive corresponded in reflective level too, which, is very sensitive to experience, training, culture, and education. In this respect, the researchers agree that these four factors are the closest characteristics to evaluate the cognitive and behavioural response of a particular traditional artefact. Also, these variables will be used to provide sufficient information worthy to understand the relation in the cognitive ability within its user eligibility.

In the Aesthetic Interaction framework, Locher *et al* [6] integrated an information-processing model of the nature of an aesthetic experience with a Wensveen's framework that describes the coupling of a user's actions (i.e., handling an artefact) and a product's function. The integration formed a general theoretical framework for understanding the nature of a user's aesthetic interaction with design products. The framework elaborates how both artefacts driven and cognitively driven processes referred to as bottom-up and top-down processes underlie

user-product interaction and the resulting aesthetic experience respectively. The scholars highlight the processes in the first stage as follows; 1) the continuous and dynamic bottom-up/top-down interaction between the properties (form) and functionality of the artefact involving the user's sensory-motor-perceptual, 2) direct voluntary attention to the artefact in a cognitively driven way, the "central executive" is monitored and direct the user-product interaction, which in the present account is conceptualized as consisting of limited-capacity, effortful, control processes. In the second stage of processing is to understand the focused attention to its form and functionality and followed by directed by the central executive, the intertwining interaction of perceptual-motor, cognitive, and emotional elements leads to an aesthetic experience.

Meanwhile, to result in affect emerge, the two driving forces of the system (artefact and person context) that reflects the user's cognitive structures and the top-down/bottom-up interaction underlying thought and action create both meaning and aesthetic quality for the artefact from which the aesthetic experience with the artefact. Throughout the interaction process, Locher *et. al* [6] also highlight four categories of human skills; cognitive, perceptual-motor, emotional and social skill. They propose that these human skills dynamically interrelate during interaction between person context and artefact context, which is called information-processing in aesthetic experience. Meanwhile, human skills were to be infused during the interaction between design and user context [6,9,10]. By the same token, the user participation in product interaction could provide insight on design-user relations and their aesthetic experience [5,7]. The literature highlights that there is a need for a new theoretical model that can help designer to use the power of the collective user experience to create a product milieu [5,6,8]. However, the lack of studies on preserving cultural artefacts highlights the need for further studies on the development of behavioural data in new cultural environment by bringing back the aspect of action into relationship with cultural experience. Therefore, the study agrees with these scholars that the constructed information-processing in Aesthetic Interaction framework highlights the importance of human skills and their aesthetic experience on artefact to understand what is happening when user perceived an artefact.

In the second quarter of the early 20th century, researchers began to explore eye-tracking movement associated with still images and interactive motion designs [11,8]. Many studies indicate that fixation times in eye movement test can be used to predict selection in large arrays on design and they might also be employed to estimate preferences for whole stimuli as well as their constituent features such as painting [11,12], graphic and photography [13,14], and landscape design [8,15]. Most of these studies deal with gaze pattern and fixation pattern in visual eye reading and picture perception through interactive computer interaction. They evoked the point that visual perception could provide valuable information that actively involves user's cognition. The number, location and duration of fixations used to scrutinize visually the artefact constitute the spatial-temporal aspects of encoding [6]. Recent studies support that fixation data, gaze plot (scan path) data and RTA are successful to analyse the content dimensions, the spatial organization of the content and the participant verbal description to show strong associations with dynamic depictions on stimuli [8]. From the above studies, none integrates the observer behaviour and feedback nor syntactical features of a 3D object as most of the studies particularly evaluates 2D artefacts. Therefore, this paper proposes to study the capability of eye tracking method from the users' perspectives in capturing their eye movements over an artefact.

In a recent studies in Malaysia, fixation and heat maps generated from eye tracker had found that Malaysian are highly attracted to the prominent design elements with good affordance in determining the user perception and preference to speed up decision-making process [16,17]. By comparison, there is a high tendency for Malaysian users to hold back their feedback during the usability testing that could impact the results [18]. However, the study on Malaysian users seldom involves specific users who dealt with a cultural artefact. The study foresees the salient map model could closely work with the top-down process in information processing theory. This finding encourages this study to determine the feasibility of evaluating the dynamic interaction between user and artefact to support the understanding of the cultural behavioural cognition..

The study posits that the association between behaviour and preference could be significant in bridging the knowledge of a user to an artefact. Hence, it may be possible to establish future design guidelines based on design-user interaction that converges analytical understanding of the artefact's physical and pragmatic assessment of its user's behaviour. The convergence may depend on the success of the Malay artefact comprehension through the perceiving process on design features and intangible knowledge. In this study, the researchers posit that tacit comprehension of the user's knowledge would relate to the design features derived from the artefact's material, colour, form, texture, surface pattern, decoration, and other details thus enabling potential display of its symbolic meaning [19,20].

As the paper noted earlier, there is a dearth of data on eye behaviour investigation on cultural artefact design since much is focused on other psychological-related discussion about the product design's qualitative emotion. Therefore, the purpose of this study is to find a means to add new empirical data on cognitive results when studying the aesthetic of a 3D artefact. Two stages of study have been identified: firstly, capturing and documenting the first fixation and heat map along with verbal feedbacks from the users to obtain the descriptive

judgment based on their pre-experience and secondly, documenting how and where eye fixations occurred while evaluating the artefact images.

Furthermore, by ranking features based on fixation times, we were able to predict successfully participants' preferences for novel feature combinations in particular. Particularly, it is to understand the eye gaze behaviour that could provide a certain quality of aesthetic judgment and interrelated communication between user and LA artefact. Therefore, the researchers posit that eye behaviour could reveal vital cultural design information in a form of feed-forward feedback while perceiving the artefact design using eye tracking method. Also the researchers posit that the user cognitive behaviour is influenced by the factor of perception and preference in computational approach such as eye movement analysis to reveal vital information from the stimuli.

Eye behaviour in perceiving Artefact design Stimuli to enhance the design Information:

In perceiving the artefact design, the eye behaviour of a user could reveal vital cultural design information in a form of feed forward feedback during perceiving the artefact design using eye tracking method [6,8,11,12,13,14,21,22]. The researchers believed that analytical observation on syntactical design feature could encode the information of artefact effectiveness, usage efficiency and user movement. In line with user-artefact design encoding, Massaro [12] highlighted one of the most well-known models of attentional integrated processing [23] in several computational features (for example, colours, intensities, and orientations of image gradients) so-called 'saliency map'. The saliency mapping predicts salient regions in an image, regions that are likely to draw attention to them based on their low-level properties. The model has been shown to account for a significant proportion of fixations participants made while free-viewing different images [24]. Thus, saliency mapping is a proposed way to construct the eye movement test.

Meanwhile, in Wallvaren *et al.* [11] eye tracking test conducted to compare the behavioural results and computational measures of complexity and information content, they concluded that low-level saliency measures based on the 'simple method of pixel counting' were effective in capturing vital part of the human aesthetic experience. The test showed the ignorance of high-level important node in the discussion of artistic style. However, the study showed a significant preference for certain artistic styles and were based on both low-level and high-level criteria in eye movement time course during interpreting and understanding the work of art. Therefore, the salient map model that closely work with top-down process in information processing, encourages this research to evaluate the dynamic interaction between user and the artefact towards understanding of the behavioural information cognitively.

Syntactical features of artefact to assist the user preference in Computational approach:

As integration of analytical observation method on syntactical features of artefact design stimuli could enhance the information processing in perceiving artefact design, this study finds that the features also assist the user to provide influence factor for user perception and preference in computational eye-movement analysis to reveal dynamic visual interaction. Therefore, the researchers posit that the usage of computational eye-tracking test approach could analyse the users' perception and preference through saliency mapping of the artefact's tangible features. These features would help provide further understanding about user cognitive responses, design features performance and behavioural ergonomic design.

Based on the above selected literature review, the study finds that the computational experiment method using the eye tracking instrument could test the quality of the information to understand more the part an informant plays in the social setting, and ultimately to put the whole understanding into perspective [25]. The paper finds the technique could enable dynamic observation and capture of relevant data on the users. These data could help reveal evidence of behavioural responses and eye gaze information for providing the proprioceptive feedback from artefact usage experience during the identification process. Additionally, the method is recommended for analysing specific elements of an artefact which would attract the user's attention for establishing the information for triangulation validation purpose.

Eye-Tracking Procedure La Artefact Case Study:

This section will now describe a case study in utilizing the ET technique. In this test, three kinds of data were obtained. The artefact-user interaction was evaluated to measure users' actual behaviour and design perception. Specifically, the test is to determine:-

- Behavioural responses based on design ranking based on three tasks,
- Syntactical preference based on heat map images, fixation on AOI (area of interest), first time of fixation and retrospective think aloud with eye tracking (RTE), and
- User eye behaviour on artefact design using eye tracking data; gaze-plot/scan path, fixation count, fixation duration & retrospective think aloud with eye tracking (RTE).

Instrument:

In this study, the eye movements were recorded with a Tobii T60 Eye Tracker, Tobii Studio and Mi-UXLab, (formerly known as URANUS, [26] in Lab Based Usability Testing (MIMOS Berhad, Malaysia).

Participants:

In this study eight users (qualified users) were recruited from various Malay *Silat* martial art schools in several states of Peninsula Malaysia (Kelantan, Penang and Selangor). The total number of participants meets the minimum requirement of 6 participants when conducting a qualitative eye tracking study [26] for heat map generation. The mean age was 50. All users have experience of more than 10 years in *Silat* practice and more than 5 years in artefact usage such as LA, *kerambit*, *tongkat* (wooden stick), *golok* (cleaver), *lembing* (javelin) and *keris*. They are familiar with context of use in terms of artefact typology and body movement (the user, the ring of training place (*gelanggang*) and LA artefact used in training session. All of the participants had normal or corrected-to-normal vision.

Stimuli:

The stimuli of this study consist of 6 designs of LA artefact that were superimposed with white background in 6 different frames. The artefact design was selected after the terminology and the physical criteria were redefined through ethnographic study [4]. In every image, the LA was positioned in basic gripping angle. The artefact without sheath (exposing the blade) is arranged side by side with artefact in sheath. The three main syntactic components were the independent variables predicted to be observed; hilt, blade and sheath (Figure 1). There are two types of series of images prepared in this test; 1) 1 set of printed version for warm-up (Figure 1a) 2) 1 set of Jpeg file images with 300 dpi for eye tracking test for Task 1 (Figure 1b) and Task 2 (Figure 1c). Every image is accompanied by 50 cent coin (Diameter = 32mm) to show the consistent scale of every artefact.

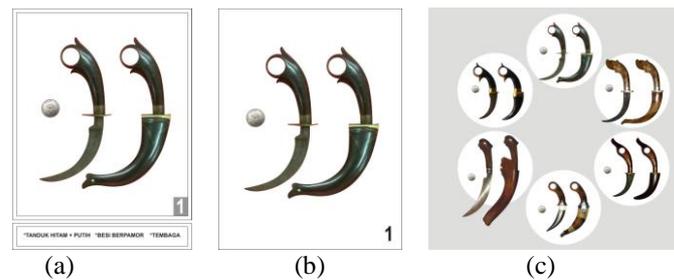


Fig. 1: (a) Printed image of artefact for warm-up test, (b) The same image with 300 dpi without material indication for eye tracking test, (c) All LA images arranged randomly for eye-gaze test.

Procedure:

The test was conducted in two different rooms. Before that, participants completed the background tests. In room 1, the experimental session started with warm-up questions. Participants were asked by the moderator to identify and rank the artefact design based on printed version of the stimuli (6 design of LA). The users answer by filling up the data in Mi-UXLab based on 6-point Likert scale (1 (strongly preferred), 2 (preferred), 3 (somewhat preferred), 4 (somewhat less preferred), 5 (less preferred), 6 (strongly less preferred)). The 6-point scale was chosen to have an even number of ratings in the scale to obtain participants' preference either positive or negative response to the stimuli. To note, neutral rating (forced response) may not be necessary as compared to a situation where a participant is very familiar with the subject, where it could be argued that in the latter case the participant could truly have a neutral attitude towards the subject at hand. The verbal feedbacks were recorded using audio recorder. The warm-up session ended within 10 minutes.

Next, in the second room, the users seated in front of computer screen of Tobii T60 Eye Tracker equipped with Tobii Studio. The eye tracking procedures occurred in two stages; the calibration procedures and the experimental procedures. During the calibration process, participants were required to fixate at various points on the screen. After calibration, the test began with a slide that informed them to view the artefact shown to evaluate their syntactical preference. The participants were allowed to view the image for 10 seconds. Then, the moderator extracted the heat map from the eye tracker and displayed it to the users and requested the users to think aloud and explain his action based on the Retrospective Think Aloud after task with eye movement (RTE), which is similar to study by [27] and [28] and gaze plot (scan path). The participants were also requested to justify their sequence of visual cues based on gaze plot. The procedure was repeated for the rest of 5 images. The equipment was recalibrated throughout the experiment when necessary.

RESULTS AND ANALYSES

Procedure of Analysis and Result in Eye-Tracking on LA:

In eye tracking study, the qualitative result can be used to see the discrepancies of users' feedback in RTE, frequency of agreement or even interrelationship of cognitive evaluation between eye behaviour (fixation on heat map and gaze plot) and empirical data using standard deviation (mean score and percentage). This study presents the descriptive analyses of behavioural data of LA cultural artefact.

Also, the result from the eye tracking is also used to validate some of the earlier findings (from previous method) to increase the reliability in the data analysis. Towards the end, the matched pattern increases the result validity of the first and second section result in triangulation process. In this study, the content analyses conducted for this section are threefold to answers the identified theoretical propositions.

Analysis in Warm-Up Session: Behavioural Response Data:

First, the behavioural responses data recorded in the MI-UXLab use the mean score analysis to understand the viewer's eye preference to rank the artefact in the printed images presented, which provides a frequency score. Responses to the ranking task were collected and the design that received the most responses was chosen as the winning category based on the frequency analysis and percentage analysis. The participant responses are analysed in descriptive manner. Meanwhile, the ranking result based on three tasks; effective artefact, movement efficiency and material preference are presented using standard deviation (mean score and percentage).

Analysis of eye tracking data:

Studies by [29] and [30] indicate significant finding that a larger amount of fixations in the same observation time will increase the observer's capacity to identify, recognise and memorise what is represented on the image. In this study, two sub-objectives were analysed:-

Syntactical Analysis for a Time to First Fixation Score, RTE and Heat Maps:

The syntactical analysis of the LA artefact involved the component, the design structure and the material. Table 1 shows the empirical result of time of first fixation anticipated to provide informative design evaluation of particular section on the artefact through the area of interest (AOI) identification (Figure 1). The fastest and slowest time of fixation result lead the researcher to capture the participants' attention on the artefact. For instance, the user has fastest fixation on Image 5 ($m=0.176$) compared to the Image 3 which is the slowest ($m=2.900$). At the same time, the RTE feedbacks must be transcribed to obtain the information from the participant that explained the empirical finding. Meanwhile, the heat map visualization is the interesting evidence used to justify the finding in both the results of time of fixation and RTE.

Table 1: Mean analysis of time to first fixation on every main syntactical component.

Main syntactic component	Mean (m) Time to First Fixation						Average score %
	Image 1	Image 2	Image 3	Image 4	Image 5	Image 6	
Hilt	0.301	0.609	0.629	1.786	1.519	0.254	92%
Blade	0.634	1.026	2.900	0.643	0.176	1.671	88%
Sheath	3.62	1.778	2.596	0.743	1.289	5.526	62%
Fastest time of first fixation							
Slowest time of first fixation							



Fig. 1: Three main syntactic components were the independent variables predicted to be observed; hilt, blade and sheath.

The heat map visualization analysis (hotspot) represents the viewer's visual attention to understand the eye preference and behaviour on design properties of LA artefact images (stimuli) (Figure 2). For instance, localized hotspot in Image 4 shows that the participants fixated longer on specific design element while they had a continuous cognitive activity during the design evaluation. The heat map result supports the time of first

fixation data and RTE feedbacks. However, if there is an error in generating some of the data of time of first fixation from the participant, the rest of the complete data is sufficient for analysis as long as the total data of participants is more than five. This is due to several factors such as habit and physical attitude of the particular user during the test or the eye is rather small.



Fig. 2: Heat Map Depicting Most Preferred Areas in Artefact from 8 Users.

Analysis for Scan Path (Gaze Plot), Fixation Duration and Fixation Count on Most Preferred Design Analysis:

Next, the scan path (gaze plot) pattern, fixation duration (FD), fixation counts (FC) are used to find the most preferred LA artefact design according to the user technique usage and movement efficiency. Table 2 and 3 presents the number of all recording in FD and FC which received significant differences when all 6 images are compared. The highest and lowest score in FD and FC is useful to identify the most and least preferred design. The fixation duration of each individual fixation is obtained within an area of interest. Meanwhile, the scan path and RTE analysis was conducted using eye tracking replays for every off-site participant on most preferred design to identify significant viewing patterns that could be associated with participants' image preference (Figure 3). For instance, other than the highest and the least images, the vast amount of gaze plot on specific images presented in the scan path pattern also helps to understand the eye behaviour influenced by the cognitive information processing of the pre-existent experience in current time. The process anticipated to help in understanding the underlying reasons for participants' responses. Eye gaze pattern of every participant is anticipated to produce a result of dynamic eye movement and reveal his reason of preference. Interestingly, the eye-gaze data of all 8 participants in this test was successfully retrieved compared to the time of first fixation data.

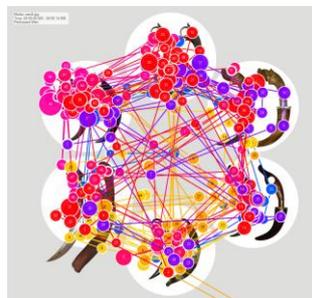


Fig. 3: Analysis of Eye Gaze Behaviour depicted from 8 participants.

Table 2: Fixation duration of each individual fixation within an area of interest.

Participant	Image 1	Image 2	Image 3	Image 4	Image 5	Image 6
E1	8.02	1.65	0.9	0.8	1.62	1.2
E2	1.7	0.37	0.77	0.93	0.73	10.05
E3	3	2.86	1.73	1.8	3.5	1.17
E4	1.85	1.24	1.05	2.67	1.33	6.2
E5	1.37	1.25	0.75	4.81	3.35	0.63
E6	0.77	0.18	0.97	4.31	0.57	0.6
E7	4.11	2.98	2.09	1.08	0.98	3.04
E8	6.85	1.57	0.92	0.25	0.6	1.82
All Recordings	27.66	12.1	9.17	16.66	12.68	24.72
	Highest FD		Lowest FD			

Validating Eye Tracking Results:

The result of eye tracking are made through inferences and comparing the result within syntactical analysis, eye-gaze analysis and behavioural response analysis. Through the inference process, descriptive explanation is used to determine the significant finding on the artefact effectiveness and user movement efficiency and eventually to increase the eye tracking result validity qualitatively [26]. As the eye tracking method is important to understand the person context and the artefact context in HCI, any related agreement or approval of

data (pattern matching) with the participants to link with the theoretical proposition increases the internal validity.

Table 3: Fixation Count - number of times the user fixate on an Area of Interest.

Participant	Image 1	Image 2	Image 3	Image 4	Image 5	Image 6
E1	18	5	4	3	6	3
E2	7	2	4	3	3	26
E3	10	4	4	5	10	4
E4	6	6	4	9	6	17
E5	4	7	3	16	13	2
E6	3	1	4	15	1	2
E7	8	10	8	4	2	9
E8	22	6	3	1	2	8
All Recordings	78	41	34	56	43	71
	Highest FC		Lowest FC			

As there is four test of validity suggested by Yin [31] to support emerging context of case study, in this eye tracking test, the construct validity was tested through the literature finding and expert qualitative judgement. Meanwhile, external validation established using full participant by the expert users (participants) of LA application in several different stages of eye movement test (warm-up session, syntactical evaluation and preference evaluation). Any agreement or approval of data (pattern matching) to link with the theoretical proposition increases the internal validity.

At the same time, this research eye tracking method to validate some of the findings increases the reliability in the data analysis. Therefore, as the objective is to find the significant finding for the third component to support the triangulation process, the result of cognitive data from eye tracking test is used to complete the cycle of data mining. Then, the identified data from previous domains of constructs and method (artefact context and person context) are brought in to complete the final triangulation process and also to increase the research LA artefact validity as showed in Figure 4. Finally, the finalized data anticipated to achieve the theoretical propositions.

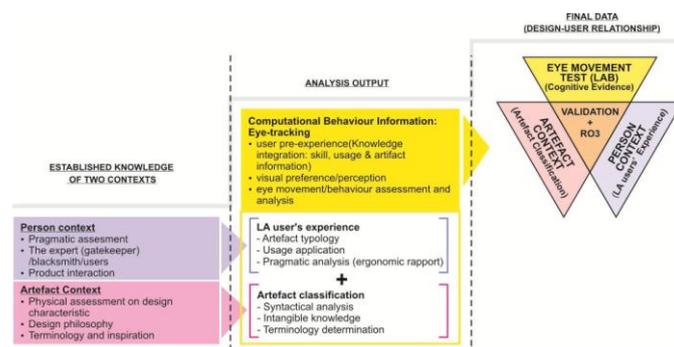


Fig. 4: Process of Validation to Achieve Data Pattern Matching For Theoretical Propositions to Attain the Research Objectives.

Discussions:

Prior studies have showed mixed results concerning the interaction between visualizing the memory and eye fixation analysis using various types of stimuli. The paper has so far demonstrated the use of the eye-tracking test to help the process of design evaluation of several sources of Malay traditional artefact design to understand user experience and object identification. To comply with task scenario given, the study found that expected fixated area in design (the gaze plot/scan path analysis showed that artefact in Image 1 received the highest FD (27.66) and FC (78)) has revealed the crucial factor in the effectiveness of artefact usage and its design preference.

As fixation pattern is a popular metrics employed by prior researchers, our novel finding on the time of first fixation and pattern has a dynamic interaction when the participants' cultural memory and usage experience is recalled and manipulated in an implicit manner. Concurrently, in this case study, the eye tracking research did evaluate experienced users and found very interesting eye behaviour. Their eye gaze plots keep alternating between specific locations on the stimuli which shows how their minds keep recalling the information from pre-existent experience of the artefact. Interestingly, we found the fixation on the heat map visualization (for instance, localisation hotspot on specific element of 'guard' on Image 1, 2, 3, 4 and 6) demonstrated a vital source in obtaining feedbacks about how some component could affect aesthetic judgement positively and negatively. The participant (trained user of the artefact) presented interesting feedbacks in both negative and

positive way to justify their preference which will be reported in a separate paper. On the other hand, as the participants in this study are new to eye tracking technology and less familiar with UI conventions, the case study assumed participants would sometimes simply fixate more or longer. Neilsen and Pernice [26] remind researchers that senior participants aged over 65 are not an ideal group for eye tracking studies due to purely logistical reasons such as regression lenses in glasses, bifocals, and various eye diseases that come with age conflict with the eye tracker and impact calibration needed to capture the user's gaze. The study notes this concern.

This study focused on the accumulative pre-existent experience that supports the eye tracking extensively in defining the syntactical criteria of specific object component. The findings support a study by [29] that interpretation and perception through the eye behaviour of the viewer towards the stimuli could be associated with current experience. More interestingly, our case study reveals several answers concerning the debated issue of LA artefact classification related to provide evidence to support that, in fact, the LA artefact in Malay traditional weaponry identification could be classified accordingly using the syntactic analysis. By syntactic analysis on the LA components, the case study had confirmed the specific yet vital physical requirement in the design to ensure its effective and efficient usage (See separate study by Siti Mastura et. al [3]) for explicating and establishing design characteristic of the LA artefact. Their study found that the eye tracking technology is beneficial for further exploration in artefacts study and has potential for application in future design studies.

Conclusion:

This paper has presented the eye tracking methodology for use in artefacts study. It provides detailed guideline about planning the test to be used on appropriate participant to reveal cognitive evidence through eye tracking method for knowledge preservation in Malaysian cultural industry. It has demonstrated its utility and worth. We suggest that the method be used as a starting point to get a general idea about which design elements of functional cultural artefact attracted the participants' attention and which items were not fixated at all. Therefore, the result can guide the next researcher to understand the artefact design context and the person context more. The paper posits that the syntactical component evaluation has potential to give specific perspectives on how artefacts were originally designed according to their relevant usage and user movement. Hence, this resulted in their respective high effectiveness and efficient product performance.

This study would like to recommend future studies to utilise the eye tracking method on other socio-cultural artefacts for the purpose of capturing and documenting their respective tacit design aesthetical values. The paper posits that these tacit aesthetical values when well documented are actually the essence of the cultural civilization. Hence, this study is in line with the need to uphold the socio-cultural aspects in any sustainable development agenda for a nation. The idea for sustaining traditional experience and intangible knowledge through the computational approach could then lead towards preserving and sustaining these intangible cultural values by appropriate integration into contemporary product designs. The authors believe these new product designs would be more acceptable to the local consumers while giving appreciative excitement to non-local consumers alike. Most importantly, the intangible product value represents the identity of the culture they originated from thus giving Malaysian design products their Malaysian identity.

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