Evaluating Computer Interactions and Infographics Usability: Analyzing Individual's Performance through Viewing Patterns

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Abstract
Computer interactions and infographics are important to represent and communicate complex information. The impact of visualization and its effect on learning the results of interaction with multimedia instruction reveals a great deal. Eye tracking is the method used to examine the graphical processing. Therefore, the present study aims to examine computer interactions and infographic usability by conducting verbal and visual performances test on undergraduates. The 62 undergraduate females were recruited as the study sample and presented the video of Napoleon's march to Moscow. This study identifies how long, where, and in what order or when accompanied with text and what's the participant's pattern on Minard maps. The performance test scores and the verbal visual learning style rating included the visual and verbal variables. The tools that are used to enhance the results are heat maps, cluster and scan paths. The 62 undergraduate females results shows that there is a fundamental difference in verbal and visual learning participants in viewing pattern on the heat map. The heat maps, clusters, and scan paths were combined for the distinct groups to provide a more complete picture of viewing patterns using Tobii Studio Software. The study results indicate that visual content was remembered by most of the participants and also indicated that the visual effects in multimedia learning environments and can be utilized to improve the multimedia design. Therefore, the study concluded that infographic and computer interactions are an effective approach for enhancing the understanding and usability of students.

Keywords: Infographic, verbal and visual learning style, eye tracking, Minard's map, viewing patterns.

1. Introduction

Information design has become substantial to process the unprocessed stack of data and information unbridled by Information and Communication Technology (ICT). That is why the modern education system should develop skills and knowledge in students to use information more efficiently and effectively. ICT should provide a more active role to explore, comprehend and interpret the use of information rather than just acquiring the knowledge. In line with this, one of the methods to improve the ability of students to understand and interpret information is through infographics [1]. Infographic is an abbreviation for 'Information Graphics' that is aimed to disseminate data in a way that connects the reader to the information. The interactive infographic has become an important tool in demonstrating or presenting complex data in the simplest form. It is mainly a combination of elements of data visualization and has become an easy way of disseminating data throughout the world. It helps to demonstrate large data to a heterogenous audience. It constructs a pictorial view of the data. Due to the large aesthetical

contribution to the data visualization, the researchers seem to be interested in studying this particular relationship [2]. The objective of infographics is to develop the ability of students to see connections and events between them in new and different ways and to uncover other invisible patterns [3].

Nowadays, infographics have become one of the trends in context with learning approaches to the visualization of knowledge by showing its visual form [4]. Infographics include several forms of interactive media, such as; charts, images, sketches, and text. In line with this, a study by Kordaki and Gousiou reflected the idea through digital card games that it is highly popular in various regions [5]. The games serve as a combination of audio and visual images providing relevant instructions that are highly impactful for students acquiring primary education. The technical perspectives are now a realm of users, who configure systems, rather than the realm of software engineers [6]. Similarly, Wuang et al [7]. further illustrated that graphical learning is highly effective in various training programs due to the increased effectiveness of knowledge that is transferred through visual images. This; however, reduced the possibility of missing information, since knowledge is transferred through concept-based maps [8]. Another study was carried out by Hernández-Sellés et al [9]. highlighted that student feel less interactive and often get frustrated due to unattractive teaching patterns. One approach for enhancing student performance and motivation is to adapt teaching ways for fulfilling the varied learning style preferences of undergraduates. Learning style preferences are the approach in which learners perceive, process, store, and recall efficiently and effectively attempt to learn. Eye tracking is the most efficient way of learning large content. The whole procedure is less time-consuming. Human memory prefers more realistic content than abstract content. Integration of text and pictorial sources with the help of their similarities is optimum for effective learning [10].

Despite the literature defining the advantages of the aesthetics related to the infographic, it is still widely unknown how aesthetic impressions are formulated, and how can these impressions be made appealing [2]. Apart from it, little is known regarding the advantages associated with the design portfolios of infographics [7]. Infographics are influencing almost every aspect of life, from journalism to education, all the fields of life are being subjected to the rapid growth of information graphics [11]. In addition, concept maps are largely used as a valuable form of infographics to provide a clear picture of the information. The concept maps help the participant to understand the test and to elaborate on the results. Moreover, there is less literature present as to how to take advantage of these design portfolios [7]. Despite all the prevailing literature about the use of new technologies in the field of education, very little research has been carried out on the design and implementation of infographics.

There is a need to analyze eye-movement measures (patterns of viewing and map/text fixation, and participants' performance on verbal and visual tests) that facilitate the examination of the multimedia theory and cognitive processing to assert the map's dominant effectiveness toward learning. The interest of the present study is on subjects' fixation on Minard's map and the corresponding text in terms of count and du-

ration within a multimedia framework by considering human responses on the Visual Verbal Learning Style Rating (VVLSR) to understand the undercurrents of visual literacy. Fixation time is determined by an individual's viewing habits, which also determines how difficult it is to interpret the context. However, in most cases of visual performance longer durations indicated a high level of understanding of users. The present study aims to evaluate computer interactions and the usability of infographics by analyzing individual performance through viewing patterns. A cohort of literature present on the following topic will be evaluated to gain insight into the following topic. As discussed earlier, an infographic is emerging as a strong tool for disseminating information among a large group of people for better understanding. Moreover, the graphical touch enables the reader to remember the information for a long time. The study signifies the identification of eye movement in terms of observing patterns of visualizing the map and text, the enhanced interest of the learner, and the subject's participation in verbal and visual aspects. It explains the pattern of how the participants sought to examine Minard's map along with the text. In this study, verbal and visual has been conducted on 62 participants. A video was demonstrated to each participant based on that video a multiple-choice test was given to each participant and concept maps were used to help the participant for a better understanding of the test and to achieve an explained result. The research questions addressed in this study are as follows;

Q1. Do participants who classify themselves as verbal or visual learners differ in terms of relative patterns of fixation on the map versus the text?

2. Literature Review

Infographics can be described as a tool for the spread of information through several platforms, such as; broadcasting or social media [12]. Several studies indicate that a combination of pictures and text encourages learning and deepens comprehension and problem-solving procedures. For instance, a combination of pictures and text help in achieving effective learning consequences rather than alone [13-14]. On the contrary, learning outcomes cannot be simply improved by just combining pictures and text. The efficiency of this combination is majorly reliant on attributes such as the visualization form, the number of referential connections, and the type of learning task between pictures and text, as well as the personal attributes of the learner [15]. Therefore, learning accomplishments vary in terms of individual differences including spatial ability, cognitive style, and previous knowledge. Verbal for verbal or auditory representations and visual for visual or pictorial representations are the channels used for multimedia learning individual's process information [16].

The structure of working memory is further reflected through verbal and visual processing. The abilities of visual and verbal constituents of working memory are confined, varying majorly based on individual differences including intelligence, and are majorly associated with cognitive load linked by an individual [17]. Some studies have indicated that cognitive style and working memory capacity are majorly associated. The effect on

the learning process might be because of the visualizer-verbalizer cognitive style. Visualizers accomplish effectively when learning from pictures and text and gain assistance from pictorial information whereas verbalizers depend additionally on text. Furthermore, text-picture combinations are advantageous to visualizers, while circumstances offer merely textual information resulting in better outcomes for verbalizers [18]. These outcomes can stimulate the assumptions proposed and also recommend that visualizers might be effective to implement information represented in both platforms demonstrated in the cognitive theory of multimedia learning [18].

3. Materials and Methods

3.1. Research Design

This study used eye tracking technology and visual/verbal learning style to support the results we used heat maps. clusters and scan plots. Tobii X120 were used to gather the data and Tobii Studio was used for the collection of data. This software facilitated the researcher's recording of tests, the visualization of eye-tracking data, the creation and management of AOI, and the calculation of eye-tracking metrics. Automated visualization of the data has been examined in the form of scan paths and heat maps or clusters.

3.2. Participants

A total of 62 female undergraduate participants were selected for the study. The native language of the participants was Arabic; therefore, the information was given in Arabic to the subjects. No compensation was given to the subjects as a reward for participating in the study. The selection of female students was based on cultural restrictions imposed within the country and; thus, was allowed to survey female undergraduate students only.

3.3. Instructional Materials

A video based on fourteen slides regarding Napoleon's march to Moscow was shown to the participants in Arabic translations. The text consisted of the main historical events that took place at that time, especially, the name of cities, the number of men, the name of rivers, dates, and temperatures. A modified text was given on a portion of every slide of Minard's map of Napoleon's march to Moscow. The first slide was welcome, the second slide demonstrated some background information and the remaining 11 slides displayed similar portions of the text beneath Minard's map. The slides were converted to JPEG format.

3.4. Verbal and Visual Performance Tests

3.4.1. Verbal Test

After viewing all the slides, the participants passed a verbal test. The test was aimed to investigate the recall of information in the text portion of the materials. 20 multiple-

choice questions were involved in the verbal test. To check the consistency of the test internal reliability method is used. The internal reliability assesses the reliability of the stigma mechanism scales and stigma source subscales [19]. The internal reliability of the verbal test was 0.42.

3.4.2. Visual Test

A total of 19 items were included in the visual test to recall participants' information regarding four rivers and 10 cities on the map. The test also aimed to investigate the ability of the participants to effectively select the correct graph. Moreover, they were asked to choose the best shape corresponding to several geographical elements. The internal reliability of the visual test was 0.53.

3.4.3. Verbal and Visual Learning Style

The Participants classified their visual or verbal skills with the Verbal-Visual Learning Style Rating. The style rating includes 1 question with 7, Likert-scale, options. The 7 options were: moderately more verbal than visual, strongly more verbal than visual, equally verbal and visual, slightly more verbal than visual, moderately more visual than verbal, slightly more visual than verbal, and strongly more visual than verbal.

3.5. Procedure

Tobii X120 Eye Tracker was used to determine and count the eye movements of the participants. Tobii Studio software was used to analyze and collect the data gathered from X120 Eye Trackers. Two usability labs were used to carry out the study, one lab consisted of the eye tracker and the other lab consisted of the verbal and visual performance tests. Demographic information was obtained from the participants and informed consent was also signed by the participants. The participants were made to sit at a fixed distance between themselves and the monitor, on separate chairs. The distance was approximately 70 cm and eye calibration were also carried out. The participants were restricted to make any movements. Eye-tracking calibration was established and saved before individual participants' exposure to instruction with the software configuration tool. Measurements for the monitor and eye tracker were entered concerning the surface. After completing 11 slides, the participants were moved to the second room where the verbal and visual tests were carried out.

3.6. Data Analysis

Further, data analysis was carried out with Statistical Package of Social Sciences version 23.0 (SPSS), and descriptive statistical analysis using standard deviation, mean averages, etc. were carried out to test the effect of eye trackers on the verbal-visual learning of participants. Pearson's r was used to determine the direction and strength of the relationship between the fixation and performance test.

4. Results

The participants were divided into 4 categories; pre-dominant verbal learning, pre-dominant visual learning, only visual and only verbal. All participants were tested on

both verbal-visual learning conditions. Most of the participants were placed in a visual group based on their answers. The verbal group consisted of participants who rated themselves as moderately or slightly verbal. Lastly, the most visual group consisted of participants who rated themselves as strongly visual. The test scores by learning style group are demonstrated in Tab. 1, predicting the descriptive analysis.

Tab. 1. Descriptive Statistics for Verbal Performance Test Scores and Verbal-Visual Learning Style Rating Survey

Style Group	N	Mean	Standard Deviation
Pre-Dominant Verbal Learning	11	8.18	2.09
Only Visual	27	9.26	2.89
Pre-Dominant Visual Learning	24	8.36	2.70
Only Verbal	0	0	0
Total	62	8.73	2.69

The visual performance test scores of the participants by learning style group have been suggested in Tab. 2, predicting the descriptive statistics. Pre-dominant verbal learning scored 4.91 ±2.30, visually scored 6.63 ±2.83 and pre-dominant visual learning scored 4.38 ±4.64 with a total of 5.45 ±2.53.

Tab. 2. Descriptive Statistics for Visual Performance Test Scores and Verbal-Visual Learning Style Rating Survey

VVLSR	N	Mean	Standard Deviation
Pre-Dominant Verbal learning	11	4.91	2.30
Only Visual	27	6.63	2.83
Per-Dominant Visual Learning	24	4.38	1.64
Only Verbal	0	0	0
Total	62	5.45	2.53

To compare the performance scores on the verbal test of participants among the three groups, one-way ANOVA was conducted. The value of alpha was set at 0.05 to meet the assumptions for both ANOVA tests. For both verbal tests, the homogeneity of variance assumption was confirmed with *a p*-value of 0.420. For visual ANOVA, the *p*-value was found to be 0.745 through Levene's test.

Each participant was individually tested; therefore, the independence of the sample was a reasonable assumption. On the other hand, a positive but insignificant impact of learning style was found concerning the verbal test $F_{(2.59)} = 0.957$ (*p*-value = 0.390). Moreover, the differences between the three groups were also tested through one-way ANOVA which also addressed the visual scores. Thus, results suggested a significant impact of learning style on the visual test $F_{(2.59)} = 6.26$ (*p*-value = 0.003). Due to the significance of the results, the Tukey hoc test was also computed. The results suggested that the performance of the group in the visual test was better compared to its counter-

parts (*p*-value = 0.003). However, none of the other pairings was found to be statistically significant.

A Bonferroni adjustment was made to maintain an overall alpha of 0.05 for the eight tests. Each test was conducted with an alpha of 0.006. Tab. 3 shows the strongest relationship between text duration and verbal score (r = 0.543). In general, the verbal score had slightly stronger correlations than the visual for all the fixation measurements.

Tab. 3. Correlations Between Fixation Measures and Verbal/Visual Performance Scores

|	n	Performance	
Map Fixations	62	0.480*	0.347*
Map Duration	62	0.454*	0.414*
Text Fixations	62	0.543*	0.422*
Text Fixation	62	.389*	.358*

Note. * Correlation is significant at the adjusted .006 level (2-tailed)

The preference of participants regarding the style of learning was asked. The results showed that 51 participants favoured the visual learning style, 6 preferred the verbal-visual learning style, and 5 preferred the verbal learning style. The heat maps of five visual participants were compared to five verbal participants to achieve some degree of parity. The total number of heat maps was 51; thus, the selection of heat maps was carried out by choosing one out of each 10 maps. Moreover, a combination of five visual and five verbal heat maps was prepared respectively. Furthermore, the viewing patterns and differences in the data sets were examined. Different colours were set in the heat maps to demonstrate the information regarding the number of fixations and the time a participant spent in an area of the image. The Color red illustrated the highest number of fixations and green least number of fixations. Fig. 1 shows the heat maps which involve the combination of 11 slides for the participants who rated their learning ability as verbal. On the other hand, Fig. 2 shows the combination of 11 slides of the participants who rated their learning ability as visual.

There were variances in the viewing trends between the visual learning style and verbal learning style participants. For verbal style learners, the heat maps describe their use of the map on the first slide, followed by a reduction in the use of the remaining slides. The use of maps was shown by the visual-style learners in all 11 slides. The variation between the two groups was very clear in slide 5. The use of maps was shown by both groups on slide 11. On the contrary, the heat maps showed much greater use of the map in slide 11. Greater use of the text was revealed in both visual and verbal groups in all slides.
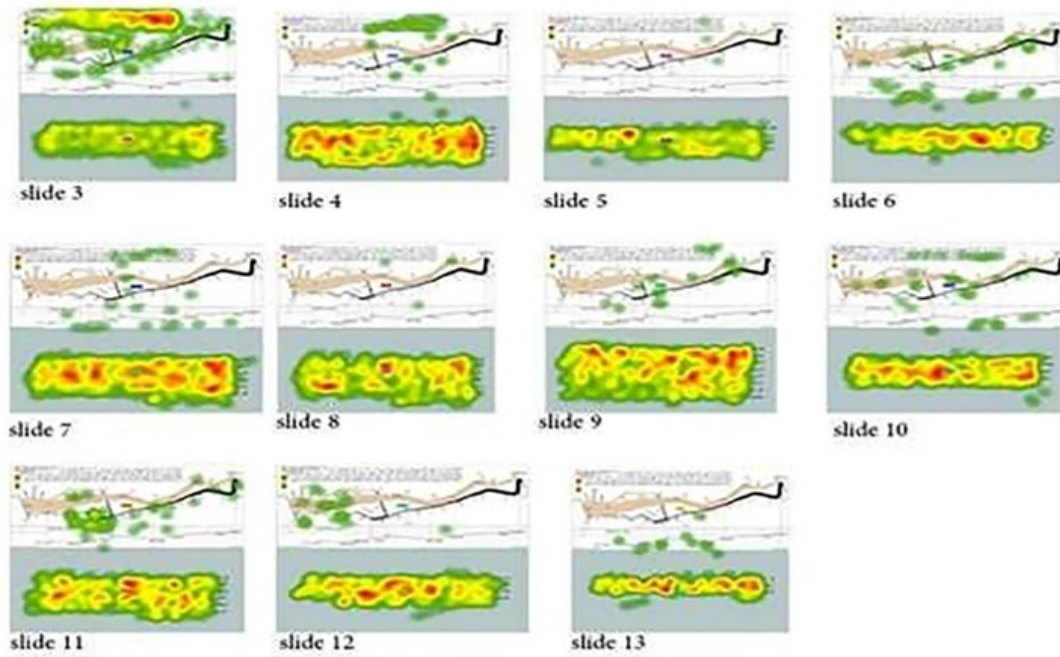
Fig. 1. Heat maps to represent the learning ability of the verbal learner
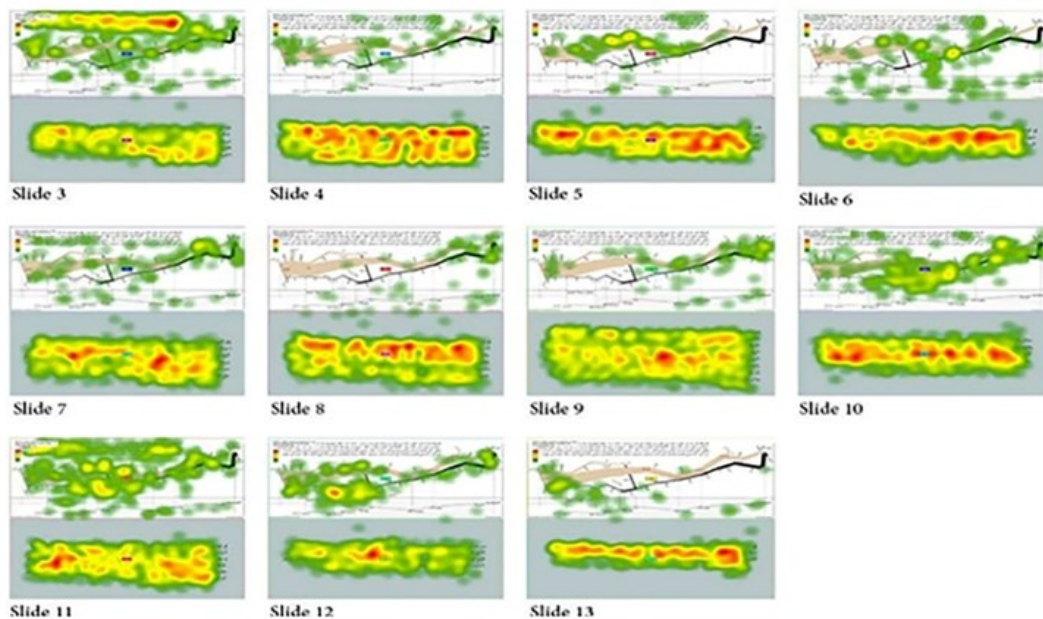
Fig. 2. Heat maps of participants who rate their learning ability as a visual learner

From Tobii Studio, visual heat maps offered a promising visual representation of the variations between the test scores of participants on the visual and verbal tests. All participants, as per the heat maps explain that they read the text, irrespective of scoring lower or higher on the visual or verbal tests. On the contrary, the use of the map was demonstrated majorly with more intense heat on the map areas indicating that the subjects used the map more in linkage with the text, and; thus, scored high on both the visual and verbal tests. Thereby, the visual elements of the map assisted the understanding

the lesson. The heat maps indicated assertion to demonstrate verbal and visual representations. The cognitive rationale was provided to explain this outcome by determining that the learner creates meaning by choosing, implementing, and organizing visual and verbal representations in multimedia instruction.

Participants self-reported learning preferences were used to identify significant differences in performance on the verbal and visual tasks. The individual's ratings of their visual abilities varied significantly. On the other hand, there was no statistically significant difference. The continued use of the map was another difference between the heat maps for reported visual and verbal learners over the 11 slides within the multimedia instruction. The heat map of verbal learners indicates merely a strong fixation on slide 3 in Minard's map. Fixation in both groups resulted in a similarly hot heat map on slide 11. It was assumed that they were likely connected to the patterns associated with the Berezina River in both the text and the map. Therefore, they all spent greater time reading and comprehending the event. Nonetheless, the heat map shows additional fixation for visual learners. The number of fixations on a specific display aspect must emphasize the significance of that element. Thereby, it is valuable to compare and contrast slide 11 with different heat maps, scan paths, and clusters for the two learning style groups.

Visual heat maps from Tobii Studio provided a striking visual representation of the differences between participants' performance test scores on the verbal and visual tests that were taken upon completion of the instruction. Fig. 3 and 4 are heat maps that show participants' scores on the verbal and visual tests. Fig. 3 displays the low scores for the verbal test on the left and the high scores on the right. Similarly, in Fig. 4, the low scores are on the left, and the high score on the right for the visual test. Their viewing behavior from slide 11 differed for the verbal-visual style learning group (Fig. 5 and 6). The text utilized by both groups was almost the same. The participants who scored low and high in both verbal and visual tests these qualitative displays show the differences.
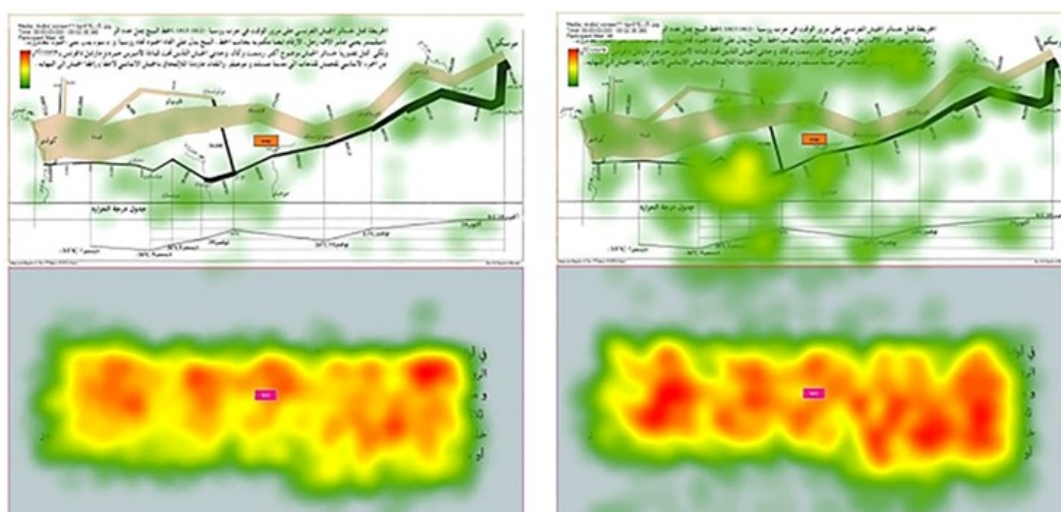
Fig. 3. Lower scores (left) and higher scores (right) on the verbal test
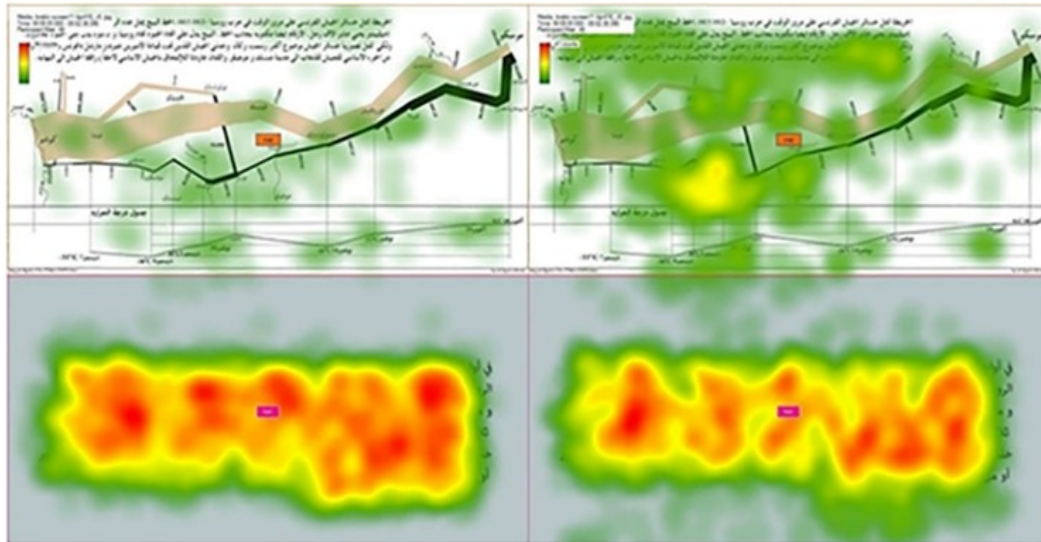
Fig. 4. Lower scores (left) and higher scores (right) on the visual test

The heat maps demonstrate that all participants read the text, regardless of scoring high or low on the verbal and visual tests. However, the more intense "heat" on the map areas, demonstrating greater use of the map, clearly shows that the participants who used the map more in conjunction with the text scored high on both the verbal and visual tests. Thus, when the visual element (Minard's graph) of the multimedia instruction was used, it aided participants' understanding of the lesson (Napoleon's March on Moscow). The heat maps reveal Mayer's assertion on integrating visual and verbal representations. Mayer provided the cognitive rationale for explaining this result; he determined that the learner constructs meaning by selecting, organizing, and integrating verbal and visual representations in multimedia instruction.

Participants who rated their learning style as verbal did not look at the map concerning the events related to the text underneath. The map has almost no red spots and some random green dots that show less use of the map. Participants who rated their learning style as visual seemed to follow the events on the map while they were reading the story. The smaller corresponding red and yellow colours on the map show how they looked at the area on the map throughout their reading of the text. The reported visual learners examine the map and text in such a corresponding way, it is possible to see almost one red area on the map for every reference of it in the text.

The learning style was used to discern by self-reported participants, more deeply, the verbal and visual tests on performance scores concerning significant differences. The visual performance test scores have significance differences that rated themselves as Only Visual (n = 27) and Pre-Dominant Visual Learning (n=24). While the statistical difference was not significant, the most visual group also performed more poorly than the Pre-Dominant Verbal Learning (n=11) groups.

Fig. 5. Verbal learners cluster for Slide 11

Fig. 6. Visual learners cluster for Slide 11

The heat maps that reported verbal and visual learners are another difference over slide 11 the use of the continued by the assumed visual learners throughout the instruction from multimedia. The heat maps of verbal learners show strong fixation on the map of Minard's on slide 3, the materials of the first slide. The heat map on slide 11 resulted in a similar "Hot" by both groups' fixation. The events related to the Berezina River in both the map and the text were similarly attractive to them. Thus, they spent more time reading and understanding the event. Still, visual learners show a more intense fixation on the heat map. Therefore, it is important to compare and contrast slide 11 with distinct heat maps, clusters, and scan paths for the two learning style groups.

Based on the scan paths (Fig. 7, 8), The scan paths clearly show which element of the slide is noticed and in what order, the relative length she viewed the various element of the screen that attracted her eye and effectively revealing the order that the participants viewed. Some participants still make multiple visits to the map to support their understanding.
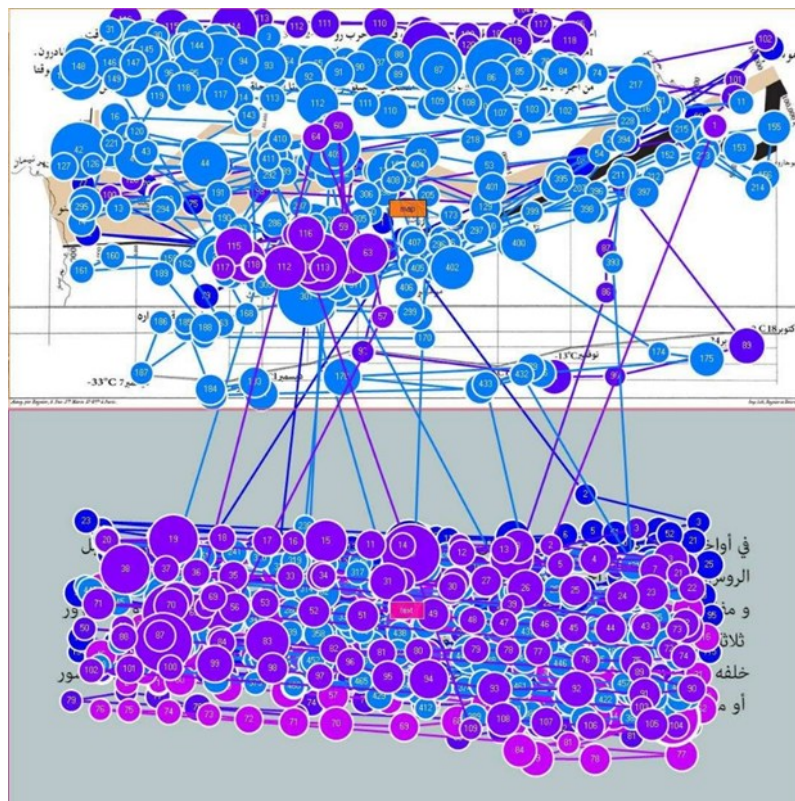
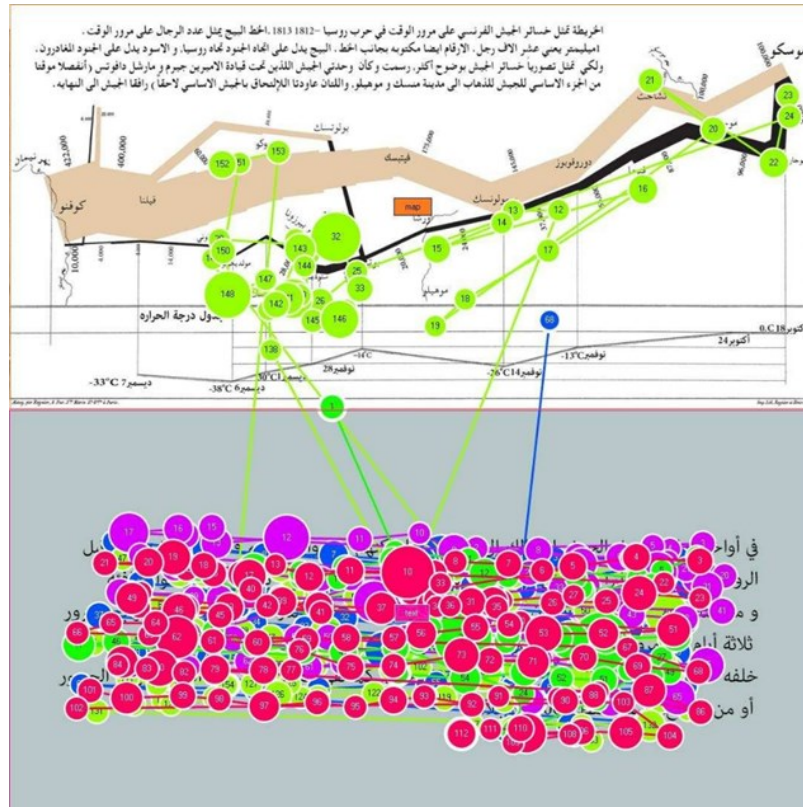**Fig. 7.** Verbal learner scan path for slide 11.

**Fig. 8.** Visual learner scan path for slide 11

5. Discussion

The study found that visual content is more engaging compared to listening or another form of content. These findings have been consistent with the findings of previous studies. For instance, Lazard and Atkinson reported that visual content holds significance; thus, visual content is important for persuasive message processing [20]. Moreover, an infographic can be considered an important tool for carrying out information related to environmental issues. Therefore, the study provided significant results which can be used effectively by practitioners to utilize the opportunities associated with visual content and infographic.

The findings are also in line with a study conducted by Bhandari [21], stating that visual interpretation in mobile phone devices assists in reducing task completion, and also it improves the efficiency of performance tasks. In addition to this a study conducted by Baglama et al. [22] also reported results that were consistent with the findings of the current study.

The current study results also demonstrated the importance of using infographics in the field of education. The results showed that infographics can effectively increase the efficiency and effectiveness of the learning process. Moreover, the use of infographics can significantly overcome the issues related to mathematical learning. The above finding is in line with the findings of Murray et al. [23] as they reported the effectiveness of the infographic. The results showed that the use of infographics enhances the under-

standing of students and highlight the importance of infographics as it can be noticed that more participants were preferring visualization over verbalization. This also presented key points that must be noted before the creation of an infographic. The study conducted by Naparin and Saad also depicted that infographic can be effectively used in classrooms with a good design aspect [24]. Moreover, the research predicted that the information presented on the topic of infographics in the literature review can be effectively utilized to understand the implementation of infographics in education. It also concluded that the results can also be utilized for the formulation of the infographic as instructional media. However, the infographic was found to improve the effectiveness of lectures through the visual representation of the video which in turn enhanced the understandability of students. It also concludes that the adaption of infographics in the academic environment should be considered.

Participants used the map in less time than they used the text. Additionally, visualization tools all of eye-tracking, including clusters, heat maps, and scan paths noted the use of participant on the map. The scan paths cartoon strip-like series presents participants' dependence on the map for concepts of the text and vexing vocabulary Fig. 9.
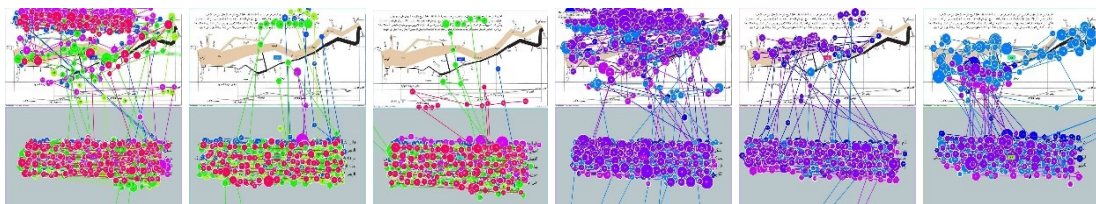
Fig. 9. Sampling of scan plots demonstrating participants' dependence upon the map.

The sampling of scan plots reveals participants several visit to the map throughout their reading of the text to support their understanding. They refer to tended to the map, frequently, when faced with challenging text or particularly unfamiliar. Therefore, they not only depend upon the map as an aid in comprehending the text there is good evidence, but the duration, shorter and fewer fixation count also suggest that they prepared the visual information, more precisely. According to Goldberg higher fixation count does not correlate in abroad sense, with learner's efficiency in viewing/searching, positively [25]. But alternating eye fixations of participant on the map and the text declare the tendency to combine the information in a multimedia learning environment when the graphic(s) are detailed, not decorative Liu & Chuang [26].

Therefore, Tufte was correct in identifying Minard's map as exemplary as a complicated graphic narrative that's the evidence and that it was a good selection for incorporation into the multimedia instruction for this study. The scan path visualization shows clear signs of which elements of the slide were spotted and in what order, effectively revealing the relative length she viewed various elements of the screen that attracted her eye and the order in that participants viewed. The longer fixation duration is the larger circle. The map indicates the rivers of Studenska and Berezina likely new terms and unfamiliar vocabulary for participants have the two largest circles. This participant, as well

as common participants, to identify the location of the rivers looked on the map upon encountering the names in the text, by that making awaited use of the map. The lines were revealed and noticed the direction of her connection and fixations in her search for connections to the material in understanding. The scan path shows the order and direction of her eyes and corresponding cognition, the cognitive processing behaviors that learners experience when faced with new knowledge were consistent with other previously mentioned. The concept of integration is also reinforced by the scan path, the visual to comprehend complex narrative or information with which they are not already acquainted are a cognitive function of the learners' dependence. The participant's integration was demonstrated by slide 11. The text to the map upon encountering the initial mention of the city of "Studentska." The scan path shows consistent visitations.

The fundamental differences are shown by the heat maps in viewing patterns. The colors of heat vary in severity from the hottest red to orange, yellow, and coolest green. The longer viewing time has a hot color; the less viewing time has a cool color. Participants who rated their style of learning as verbal and the events related in the text underneath did not look to the map in relation. The map has some green dots showing less use of the map and has no red spots. The events on the map, while they were reading the story, are the participants who rated their learning style as visual. The map shows how they looked at the area on the map throughout their reading of the text the smaller corresponding red and yellow colors. These phenomena have one explanation that is "Fixation that is connected in a small area indicates focused and efficient searching" Cowen, Ball, & Delin [27]. The map and text examine by the reported visual learners in such a corresponding way, one red area on the map for every reference of it in the text is possible to see. Rayner states that movements of the eye occur when "information at the center of vision has been processed, and a new fixation location has been chosen" [28].

Self-reported learning style participants were used to discern, more deeply, the verbal and visual test's performance scores concerning significant differences in relation. The visual performance test score is the only significant difference that occurred between the participants that rated themselves as moderate and slightly more visual (n =27) and strongly more visual (n = 24). While the statistical difference also performs more poorly than the more equally verbal visual and verbal all levels (n = 11) group. The findings are unusual, to researchers one may defer, such as Kollöffel, Massa & Mayer, who concluded that preferences and learning styles did not relate to equating learning to lower or higher performance. [29,30].

The heat maps for reported visual learners and reported verbal learners over the 11-slide continued use of the map by the supposed visual learners throughout the multimedia instruction is another difference between them. Fixation on Minard's map in slide 3 shows a strong verbal learner heat map, the materials of the first slide. The "hot" heat map on Slide 11 both groups resulted similarly. The events related to the Berezina River in both the map and the text seem that they were similarly attractive. Thus, they all spent more time reading and understanding the event. Still, visual learners show a more intense fixation on the heat map. Jacob and Karn specified that "the number of

fixations on a particular display element (of interest to the design team) should reflect the importance of that element" [31]. Therefore, it is important to compare and contrast slide 11 with distinct clusters, scan paths, and heatmaps.

The slide 11 viewing behavior differed by verbal a visual learning style group. The text area seemed almost the same for both groups. But, in the understanding of the text, there was a big difference in their use of maps. The visual group make as much use of the map as the verbal group did. The visual group spent more time relating other events with what was described in the text, as evidenced by the relatively hotter spots on their heat map. It seemed the visual learners made a more concentrated effort to connect the instruction from previous slides with this newer information.

The slide 11 clusters (Fig. 5, 6) show very distinct areas of participants for fixation of either visual or verbal learning styles. The Tobii Studio software clustering is another type of visualization. The distance between the two points is calculated by the software in the records and then assigned to the same cluster. "The clustering algorithm tries to find spatial patterns in the distribution of the gaze data" Tobii.com [32]. Same as the heat maps, the text was read by the all-participants clusters presents that. Thus, the participants with a verbal learning style did not use the map more than the visual learning style. When the event was mentioned in the text only 20% of the participants in the verbal learning style group looked at the related on the map (Fig. 5). But when the related event was mentioned in the text only 80% of the participants in the visual learning style group looked at the area on the map (Fig. 6). These results present the participants who express the preference for learning with the visual look to the map to understand the text consistently [32].

The cluster shows all the participants read the text, similar to the heat maps. Yet, the participants with the verbal learning style did not use the map more than the visual learner's style. When the event was mentioned in the text only 20% of the participants in the verbal learning style group looked at the related on the map. But when the related event was mentioned in the text only 80% of the participants in the visual learning style group looked at the relation on the map. These results present the participants who express the preference for learning with the visual look to the map to understand the text consistently.

Some participants still make multiple visits to the map to support their understanding based on the scan paths. Kalyuga, Chandler, and Sweller indicated that when learning from text and diagrams, it is good to have the available for the learners to reduce unnecessary search and graphics both physically [33]. An efficient search reduces cognitive load and supports working memory, "disparate information requires working memory resources that consequently are unavailable for schema acquisition, inhibiting learning" Kalyuga et al [33].

The research has some limitations such as the study participants only included females, along with restriction of age and education; therefore, the results cannot be generalized for a definite population. The research only used video with slides, which fails

to claim that the research is on computer interactions. The study results do not contain verbal participants due to the small sample size.

6. Study Implications and Recommendations

The findings of this study can be implied at various phases. Firstly, the results of this paper can be implied in educational institutions where they can use it as a useful teaching strategy. Besides this, various advertising agencies can also benefit from this paper as infographics are widely considered in the given field. Similarly, the results of this paper are useful in designing effective multimedia presentations for both teachers and students, as poster presentations are highly common among students and thus provide maximum student engagement. Visual and verbal measurements in the given paper are useful for instructors to identify students' needs during the learning process.

Other than this, the present study can also be implied to various technical and scientific information to deliver the content appropriately. For future researchers, it is recommended to involve different formats such as; (PDFs, videos etc.) to understand the change in behaviour and understanding patterns of individuals.

Besides this, there is a need to investigate the topic in different settings such as educational institutions, and marketing agencies, along with its popular usage on social media. As infographics are now used in various fields, this provides an open ground for the researcher to investigate the topic to provide additional information. Working in this regard may be carried out using a large sample to increase the reliability of the research. The above-given suggestions are important to decode the viewing patterns of different individuals under different settings while analyzing their impact on user performance.

7. Conclusions

The study has evaluated computer interactions and infographic usability. The study included both visual, verbal and viewing patterns performance tests to understand the usability of the infographic. Thus, the results of the study concluded that visual content and infographic were found to significantly influence the usability and understanding of students. Therefore, it can be concluded that infographics have a large impact on enhancing the understanding of users. Moreover, infographics have implications in all the respective fields, including medicine, education, and newspaper etc. To this end, the use of an infographic is justified and can be used as an effective method, especially in the field of education to increase the understanding of students.

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APPENDIX C

VERBAL TEST

1. Napoleon Bonaparte was the leader of which country?
a. England
b. France
c. Poland
d. Russia

2. Who was the Tsar (leader) of Russia?
a. Federov
b. Napoleon
c. Alexander
d. Nicholas

3. What was the first river crossed by Napoleon's army?
a. The Nieman River
b. The Rhine River
c. The Berezina River
d. The Loire River

4. What was the approximate size of Napoleon's army at the beginning of the invasion?
a. 52,000 Men
b. 122,000 Men
c. 422,000 Men
d. 1,000,000 Men

5. In what month did Napoleon's invasion of Russia begin?
a. June
b. July
c. August
d. September

6. According to the materials, what was the first city captured by Napoleon?
a. Maloyaroslavets
b. Moscow
c. Vitebsk
d. Vilna

7. Who was Kutuzov?
a. The Head of the Russian Army
b. One of Napoleon's Marshals
c. The Mayor of Moscow
d. The English Ambassador

8. How did the Russians prevent Napoleon from getting supplies?
a. By blocking the supply lines to France.
b. By refusing to accept French currency.
c. By burning crops and towns.
d. By destroying the English supply ships.

9. According to the materials, why did Napoleon split his army?
a. To prevent Russian units from joining together.
b. To look for food and supplies.
c. To make it easier to cross the various rivers.
d. To hide the size of his army.

10. What direction is Vitebsk from Vilna?
a. North
b. Northeast
c. East
d. Southeast

11. The largest battle of the invasion occurred near what town?
a. Vilna
b. Smolensk
c. Mozhaysk
d. Moscow

12. At the largest battle of the invasion, what was the size of the French army compared to the size of the Russian army?
    a. About half
    b. About the same size
    c. About double
    d. About triple

13. In what city did the French army plan to spend the winter?
    a. Paris
    b. Moscow
    c. Smolensk
    d. Vilna

14. Why did Napoleon's army leave Moscow?
    a. As a condition of a truce with the Russians
    b. Because of the arrival of the English reinforcements
    c. Constant attacks from the Russian Army and people
    d. A lack of food and supplies.

15. When Napoleon's army left Moscow what size was it (compared to the original invading force)?
    a. 1/2
    b. 1/3
    c. 1/4
    d. 1/5

16. What did the Russian army's arrival at Maloyaroslavets force the French to do?
    a. Return to Moscow
    b. Retreat along their original invasion route
    c. Take a longer route south back to France
    d. Abandon their cannons and supply wagons

17. On the way to Studentska, why did Napoleon's force double in size?
    a. Stragglers that didn't make it to Moscow rejoined the force.
    b. Reinforcements from France met Napoleon.
    c. Russians wishing to leave the country joined his army.
    d. The Italian Guard arrived from the south.

18. Difficulties in crossing the Berezina River reduced Napoleon's army by how much?
    a. 1/2
    b. 1/3

c. 1/4

d. 1/5

19. At the end of the campaign, approximately how many survivors were left in Napoleon's army?

a.   4,000 Men

b.   b. 10,000 Men

c.   c. 50,000 Men

d.   d. 100,000 Men

20. Where was Napoleon's army on the coldest day?

a.   Moscow

b.   Molodechno

c.   Studienska

d.   Malyaroslavets

APPENDIX D

VISUAL TESTS

Rivers:
Berezina
Moskva
niemen
orcka

Cities and Towns:

Botr   Smolennsk   Maloyaroslavets
Kovno   Studienska   Mojaisk
Polotsk Vilna   Moscow
         Vitebsk

Niémen R. | 422.000 | 22.000 | 6.000 | Kowno | Wilna | 10.000 | 4.000 | 8.000

Niémen R. | 6.000 | 22.000 | 422.000 | 400.000 | Kowno | Wilna | 10.000 | 4.000 | 8.000

55.000 | 60.000 | Polotzk | Glouboköe | 30.000 | na

55.000 | 60.000 | Polotzk | Glouboköe | na

MOSCOU | 100.000 | 127.000 | R. | 100.000 | Chjat

MOSCOU | 100.000 | 127.000 | R. | 100.000 | Chjat

Mojaisk | Tarentino | Malo-jarosewli | Wizma | 87.000 | 96.000 | 55.000

Mojaisk | Tarentino | Malo-jarosewli | Wizma | 87.000 | 96.000 | 55.000

30.000 | Bérésina R. | Botr | Studienska | 50.000 | Minsk | no

30.000 | Bérésina R. | Botr | Studienska | 50.000 | Minsk | no