

RECOMMENDED ELEMENTS OF INFOGRAPHICS IN EDUCATION (PROGRAMMING FOCUSED)

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ABSTRACT

This study focused on investigating the elements of infographics in the field of education especially in Programming. It was done by reviewing related literature reviews, interviewing experts in design, content, and the current infographics in programming. The findings showed that based on literature review a good infographic should consist of a good title, suitable graphs/charts/pictures/images, readable text/font, a clear story, reliable data, have an excellent use of color and an appropriate design format. Based on six design experts stated that the position, location, and identification of each element in infographics design to make it clear to the audience. Furthermore, content expert explained some important points of data structure and algorithms. The last one is taken from 6 current infographics which contained 7 elements. This is important to enhance the reader's understanding of the content of the infographic because it should present information in a clear, concise, and effective manner.

KEYWORDS

Infographics, Infographics Elements, Education

1. INTRODUCTION

There are a lot of infographics that have been used in different areas such as business, health, industry, advertisements, e-commerce and education. The design of an infographic needs to be suitable with its aim. For example, in business, an infographic is used to promote a service or a product or as a marketing strategy. On the other hand, in the field of education, an infographic can be used as a kind of instructional media and is aimed to increase students' understanding of the subject's content. Therefore, the design of infographic for educational purposes is very important to be investigated. There are several elements that have been identified. This study aimed to choose the appropriate elements for educational infographics particularly in the subject of programming.

This research is really urged to do because there are several difficulties arise during the learning process of basic programming concepts such as program construction [1], loops manipulation [2], structures control and algorithms [3]. In addition, [4] stated that computer programming learning is a difficult process. They demonstrated that many students find difficult to use programming languages to write programs to solve problems and do not know how to create algorithms. Many novice students even show difficulties to use basic concepts like control structures to create algorithms that solve concrete problems. Data structure and algorithms are very important elements in computer science and education field because they influence memory faults and make the speed of memory slower if students do not understand the implementation of those algorithms in operating computer programming, These materials are very useful to make the program running well [5].

2. METHODOLOGY

The methodology of this study involved 4 phases which were: reviewing literature, interviewing six experts of infographics design about their opinion of infographics elements for programming and also an expert about the content of data structure and algorithms, and then searching for current infographics related to programming whose design were in line with the literature review and the experts' statements. Table 1 shows the 4 phases of this study.

Table 1. Description of methodology

Sources of Data	Techniques of data collection	Data Analysis	Objectives
Literature review	Searching for reliable sources from 18 articles from various journals	summarizing and synthesizing the elements of infographics and writing them become reliable information	To make justification and judgement about 7 infographics elements in education
Experts of Design	Interviewing six experts about their opinions on infographic elements	Considering their opinions, experiences and expertise in making the conclusion of infographic elements for education.	To ensure that experts have already known and used those elements in their designs
Expert of Content	Interviewing the expert of data structure and algorithm	Analyzing the content of the materials for inclusion in the infographics	To know the best way to teach data structure and algorithm
Current infographics	Selecting 6 infographics focused on programming	Collecting the information of the position, location, and identification of each element in these existing infographics	To examine these current infographics in light of the literature review and experts opinions

3. RECOMENDED ELEMENTS FOR INFOGRAPHICS IN EDUCATION

3.1 INFOGRAPHICS DESIGN AND ELEMENTS BASED ON A REVIEW OF THE LITERATURE

This literature review was based on technical relevancy that highlights the overall description of the research area related to the infographics design in education especially in programming. The guidelines found here have been categorized into seven elements of infographics.

3.1.1 TITLE

A title is the most important aspect in any material such as a book, blog, etc which reflects the content being presented. The same applies to titles in infographics. [6] reported that a title should grab a reader in seconds to read infographics and should have a persuasive headline which is responsible for 90% of people viewing (or not viewing) an infographics.

3.1.2 GRAPHS/CHARTS/PICTURE/IMAGES

There are different kinds of graphics that can be found in infographic content such as graphs, charts, pictures, and images. According to [7] different types of diagrams such as tree diagrams, network diagrams, statistical diagrams, schematic diagrams, or concept diagrams can be used. In

addition to this, [8] stated that in infographic design, the icons, statistics, references and facts can also be found. For the meaningful representation of data there can be maps (flow maps, mind maps), charts (pie charts or line charts) that are often used for displaying data values, and graphs (a bar graph or a stacked bar graph) to give a maximum effect of the infographic and it is called the Picture Superiority Effect [9]. On the other hand, line strokes are used with various widths and colors to help encode information and picture symbols should be consistent and so familiar [10].

3.1.3 TEXT/FONT

Text often takes the form of labels and can give short explanations to make the data more useful. [11] affirms that linear text can be used where ideas, concepts and connections are visibly highlighted by graphic devices such as diagrams, charts and maps. In addition, [12] asserts that simple text messages combined with a relevant image, simple graphic configuration, or chart can make a lasting, memorable, impression on the audience to be more actively involved and engaged in higher message elaboration and to support the comparison of relative levels of information.

3.1.4 STORY

The story of an infographic usually includes a mark, a symbol or visual element typically stands for quantitative information to effectively and efficiency present information, while color, size and shape usually describes the qualitative aspect by [13]. According to [14] the story should elucidate complex concepts in a user-friendly manner to a desired audience.

In the research of [15] the infographic story is designed to communicate a specific set of information to a certain audience by turning complex and abstract concepts into intuitive knowledge, illustrate data and textual information using icons, images, colors and elements of graphic design. Furthermore, [16] states that the information flow/process which infographics contain shows some sort of flow or process in which the individual data points fit into an overall context. Another opinion from [17] states that design can be divided into several elements of space provided as the regulation of story.

3.1.5 DATA

[18] professes that to communicate clearly, the context needs to be provided for an infographic. According to [19] in making the data for an infographic, one needs to do research and limit sources and avoid using contradictory materials. Preferably, one should not use data older than a year and up to a maximum of two years (one should always list the timeframe of data relating to the graphic). Besides, [20] states collecting and processing data include the raw data and a series of actions makes a good visualization for infographics.

3.1.6 COLOUR

According to [21], colorfulness is the integration of specific colors with saturation and a number of image areas in a given image. Colorfulness is also used for perceptual models and complexity as an estimate for visual appeal in determining the colors. In addition, [22] thought that color schemes are better if there has been some consideration for people who are color blind. Furthermore, getting the color balance and relevance right is not an easy task but is very important for infographic design as stated by [23]. Based on [24] study that a choropleth map can

be used as the dominant visual representation for color design and it has been recommended that a spectral color sequence from yellow to red be followed with the lighter more luminous yellow indicating less and the darker less luminous red indicating “more”, and a neutral grey be used for which data is missing.

3.1.7 DESIGN (FORMAT, QUALITY, PERFORMANCE AND AESTHETICS)

Research by [25] reports that illustration is a unique and impactful visualization can be applied to individual visual elements in infographics as a part of design. [26] explains the use of elements like spacing and dividing lines to distinguish the content sections from one another. According to [27] vertical infographics are also easier to view on most browsers and mobile devices, and tend to get much more social media shares compared to horizontal infographics. Then there is the issue of the size, the height and width, the height/width ratio and the black pixel density of each connected component constructed for an infographic. The connected components are classified into three types: graphical components, textual components and noise.

There are four categories of infographic design (bullet list equivalents, snapshots with graphic needs, flat information with graphic needs, and the information flow process [28]. The concept of design can be adapted into several criteria including visual aspects, verbal messages, and media specifications for infographics [29]. Hyperlinks are also commonly used in infographics as a means to engage news readers in news acquisition [30]. Table 2 is highlighting description of each infographics element and the importance of elements combination from different literature review for standardization infographics elements in education.

Table 2. The Importance of infographics elements based on literature review

NO	INFOGRAPHICS ELEMENTS	LITERATURE REVIEW	IMPORTANCE OF INFOGRAPHICS ELEMENTS
1	Title	Dalton (2014)	Responsible for 90% of people viewing (or not viewing) an infographics.
2	Graphs/Charts/ Picture/Images	Marabella (2014)	To represent meaningful data and to display data values
		Zhao (2015)	Give a maximum effect of the infographic
		Handaru, et al., (2015)	Help encode information to be consistent and familiar
3	Text/Font	Yani, et al., (2015)	Give short explanations to make data more useful
		Krum (2014)	Make a lasting, memorable, impression on the audience to be more actively involved and engaged in higher message elaboration and to support the comparison of relative levels of information.
4	Story	Smiciklas (2012)	Elucidate complex concepts in a user-friendly manner to a desired audience
		Lyra, et al., (2016)	To communicate a specific set of information to a certain audience by turning complex and abstract concepts into intuitive knowledge, illustrate data and textual information
5	Data	Krum (2014)	To communicate clearly
		Dalton (2014)	To limit sources and to avoid contradictory materials
		Yani, et al., (2015)	To give and proof data in reality as the main

			information will be delivered
6	Colour	Harrison, et al., (2015)	For perceptual models and complexity as an estimate for visual appeal
		Zhao (2015)	For making consideration of color blind people
		Dalton (2014)	For getting the color balance and relevance right
7	Design (Format, Quality, Performance and Aesthetics)	Marabella (2014)	To distinguish the content sections from one another
		Lee & Kim (2016)	As a means to engage news readers in news acquisition

3.2 INFOGRAPHICS DESIGN AND ELEMENTS ACCORDING TO DESIGN EXPERTS

In designing a good infographics, 7 elements should be included based on this literature review and six (6) experts in design discuss these elements below. Expert 1, 2, 3 are from Indonesia. While expert 4, 5, 6 are from Malaysia. The experts from Indonesia are online course facilitators which use infographics as their media and having experience in designing infographics for years. In addition, the experts from Malaysia are infographics designers in university for more than five years and their masters focused on design.

The title element should be in the top-centre; font size is bigger and depends on the information be delivered [31], [32], [33], and [34]. The position should be on the top and depends on the size of paper for example A4 and uses formal font [35]. On the other hand, the font should be different from the font used for the content [36]. Alternatively, the title should be short and did not recommend long title [37]. Add spaces and should be read easily, interesting results and appropriate with a new era of design [38]. The last is title position should be easily seen, readable, clear, eye-catching, and use an appropriate color[39].

Graphs/charts/pictures/images according to experts have various judgements. For instance, adding diagrams, pie charts, or icons, with a data proportion of 50%, making a mind map and adding pictures/ images [40]. On the other hand, it depends on the formality of presenting the information [41] while focused on the layout starting from the top and with the diagram's position on the side/centre[42]. In addition, related to the title / topic, contents describe as soon simple [43] and[44]. The last thing, related to creativity and a creator can use an illustration, tracing, or vector. The position also can be on the right or the left and might use an effect from Photoshop [45].

Text/font should use informal but readable fonts and depends on the topic[46] and [47].One should use simple text and not be too long [48], one should simply use points, create icons by using creative and interesting vectors [49]. On the other hand, using two types of fonts, neither small nor too big and should be tidy [50]. Similarly, one should use important points with a maximum of two sentences[51]. While, using types of any formal texts, clear content, and make it as simple as possible [52]. San Serif fonts (plain text) are the mostly used font for infographics. In the same way, write concisely to make the graphic flow and easy to read for the readers [53]. Fonts should be clear and contrast, not many sentences should be used, with suitable space and appropriate margins and paper space left or top for explanations [54].

Data should make use of diagrams, pie charts, or icons to help the visualization of the data so that readers can easily grab information [55]. Another way to make data clear by writing certain points on a piece of paper, to get a better idea of what to put in infographic, and consider how many points to present ([56]. On the other hand, made an infographic about teaching and learning

includes general explanation about topic, subtopic, and decide for mapping location of data in the infographic [57]. Data is an essential part of an infographic because without data there are only 'graphics' and no 'info', the presentation of texts, the need for pictures to be clearly understandable, user friendly and for the location be in the centre, with a logo placed in the top centre, left, or right [58]. Additionally, content, text, and an explanation can be used to present data in an infographic [59]. Creativity, thinking that vector or tracing objects, composition and location should be set creatively in the graphics layout [60].

Story: different elements should relate to one another by adding pictures/ images to strengthen the information[61] and[62]. One needs to understand students' level and characteristics to make a suitable design for their audience based on a certain topic[63]. On the other hand, a designer highlight a topic, then present other information [64]. Text and images to be displayed are related to each other, tracing and illustration should be suitable with topics and patterns by combining title of a new era of design[65]. Designers should pay attention to topic first, related concepts, suitable images, and make their audience interested [66].

Clarifying about colours, it is good to use soft colours for the background, brighter colours for text, so that the topic can be read easily. Typically, size is connected with space, shape is related to colours and texts have a close relationship with colours and the choice of suitable fonts [67]. The best color is a combination of white and black [68], uses basic colours such as red, yellow, green, and blue [69].Use bright colors and that the background should be contrasted with the fonts used for the content [70] and [71]. Data or highlight should have brighter colours but the rests should not be too dark, the colours should be appropriate with topics and include the newest trends of a new era of design [72]. Similarly, there should be a match if there is a combination of two colours[73].

The last is design, both landscape and portait could be usedas long as the elements were connected each other. To make an infographic clear, the title should be in the form of a circle placed in the centre and information should be well-summarized and arranged visually[74]. While have lining, mapping based on creativity, informative data and experience to compare with others to enrich the ability of designing [75].Further, everything should be integrated into one topic or theme appropriate for students 'level and characteristics, the designer should highlight the topic, then present other information by giving a simple explanation (catchy) and it should be easy to understand [76]. Designers should add meaningful images, decorate with visual objects by giving some sparks and put together a few design elements to form a visual interesting story [77]. Alternatively, zigzags, left to right, or top to bottom and continuing to the right, left to right and continue to right to left in the form of circle [78].On the other hand, picture size larger consider about space, colors should allow for clear shape and text, including all important elements for the sake of creativity, design interest and sense based on a new era of design [79].

3.3 CONTENT EXPERT FOR INFOGRAPHICS MATERIALS

The third step for this research project was analyzing content about programming. Data structure and algorithm topics were chosen to explain principles of basic programming and explain each subtopic about data structure and algorithm. An expert in teaching data structure and algorithms are from Malaysia. She explained some important points to deliver in the content of a potential infographic.

Data structure is the way to arrange data which is used in every application or data institution or data structure including stacks, trees, arrays, queues, linked lists, and graphs. Algorithms consist of pseudo code and a flowchart. The problem that needs to be solved is the challenges in teaching data structure and algorithm because it is difficult to know how to select appropriate data structure in every case. Moreover, in teaching data structure and algorithms, lecturers have to include real world application analogies in every subtopic in order for students to understand. An analogy is the best technique for explaining every subtopic and to understand the main concepts of data structure and algorithms are based on the types needed. The most important topic is arrays and linked lists, because those topics are indispensable, because they connected with other subtopics while the most difficult topic is linked list and graph. The first subtopics that must be explained is arrays and linked lists because they are related with basic concepts in programming. The last instruction is creating full operations of each data structure for example insert, remove, search, etc[80]

3.4 INFOGRAPHICS DESIGN AND ITS ELEMENTS FROM CURRENT INFOGRAPHICS

The last phase of this study was choosing infographics based on the criteria uncovered in the literature review, design experts and programming expert. 6 current infographics are analysed in light of the literature review and experts' statement. Table 3 is a summary and explanation of the 6 infographics which fulfilled the requirements to be considered in the category of good infographics in the field of education because they contained the important elements of infographics design: title, graphs/charts/pictures/images, text/font, story, data, color, and design (format, quality, performance, and aesthetics).

Table 3. The Description of Elements of 6 Current Infographics

Title	Title Position	Graphs, Charts, Pictures, and Images	Types of Texts/ Fonts	Introduction, definition, conclusion, Sources	Types of data used	Colours used	format, quality, performance, aesthetics (numbers, shapes, and symbols)
An overview of computer programming	Left	Pictures, charts	Linear text in the box	Introduction, sources	Definition and history of programming languages, and diagrams	White, black, orange, grey, and purple	use of symbols
Why JavaScript is the future of programming?	Centre	pictures, charts, tables	Linear text	Definition, conclusion, sources	The reasons why beginners prefer to use JavaScript	Black, blue, yellow, white, grey, and green	inclusion of numbers (percentage)
Modern language	Centre	chart, images	Separate Linear	-	Which languages are	Yellow, blue,	inclusion of

wars			text in the box		best for small business and job seeker, and diagrams	green, black, white, red, orange, and grey	numbers (percentage)
5 reasons to teach kids to code	Right	Images, charts	Linear text with image	Sources	Learning programming empowers kids, the need of programmers, and diagrams	White, grey, yellow, blue, light blue, red, brown, light brown and black.	inclusion of symbols
The history of programming languages	Right	Images, table, picture	Linear text in the border	Introduction	Early mechanical computer expert who wrote algorithm, and primary uses of programming languages	Black, white, blue, yellow, red, and grey.	inclusion of symbols and subtitle
Top 10 programming languages to know in 2014	Left	Images	Linear text and the number in circle	Source	The description of programming languages	White, yellow, blue, orange, black, red, grey, and brown	The inclusion of symbols and subtitle

Based on Table 3, all 6 programming infographics which were selected included every recommended element from the literature review and experts opinion on a good infographic design.

4. CONCLUSION

There were four different data sources to investigate the elements of infographics in education, which consisted of a literature review taken from 18 references books and journal articles, interview of six experts of design, a content expert's point of view, and the existing design of 6 infographics from the field of education, particularly in programming education. The findings revealed that essential elements include title, graphs/charts/pictures/images, text/font, story, data, color, and design, which should carefully consider the position, portion, types, and appropriateness of each element to make a good infographic design. It can be concluded that this literature review, experts design, and current infographics are all part of a design analysis technique for creating infographics in education. The most important aspect of an infographic

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besides design is content. Based on expert statements for data structure and algorithm content
future research could be conducted regarding to infographics about data structure and algorithms.

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