Instrument for evaluating digital educational comic

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Abstract
Digital educational comic allows learners' knowledge and ideas on various subjects to be synthesized in a form of digital comic. Digital educational comic not only contains informative and emotive elements, but also engages the learners emotionally. In order to know the digital educational comic is valuable to leaners, it is needed to be evaluated properly. In specific, it should be measured based on what level it is able to educate and entertain the leaners. However, to date the standard evaluation of digital educational comic is scarce. Therefore, this paper aims to present the design, development, and validation of an instrument for evaluating digital educational comic. The instrument focuses on evaluating two main aspects of the digital educational comic: learning (12 items) and entertainment (8 items) which were based on the literature of comic core elements. Content validity, face validity, and reliability tests were carried out and the instrument shows satisfactory properties and could be useful in the educational environment and research. The use of the instrument may contribute to a deeper understanding of digital educational comic properties, valuable for comic development and improvements of quality in comic educational content.

Keywords
Digital educational comic, Instrument development, Evaluation of comic, Learning and entertainment content.

1.Introduction
Unlike regular books, paintings, or movies, comics are collectively no better nor worse than other media, but simply different [1]. Hence, the terminology of "comic" itself is a widely debated point in comic scholarship. For example, in the book of critical essays on comics by Varnum and Gibbons [2], the definition of comics is compiled as "a narrative form consisting of pictures arranged in sequence," (p. xvi). Beforehand, comic book creator Eisner [3] (1985) specified comic as "sequential art" or "the arrangement of pictures or images and words to narrate a story or dramatize an idea," (p. 5). McCloud [4] later revised the term of comic as "juxtaposed pictorial and other images in a deliberate sequence, invented to convey information and/or to produce an aesthetic response in the viewer," (p. 5). In contrast, Cohn [5] was critical towards a definition of comic as a language. As a substitute, he stated that comics are social artefacts that communicated in visual language.

Despite the contradictions between the authors, there is a significant consistency in their writings where comic appears to retain several key features: narratives, pictures, images or arts; and sequences. Using these mutual characteristics, Tatalovic [6] categorized comics into single-frame cartoons, short comic strips, comic books, and graphic novels in terms of length and narrative complexity level. Additionally, it is important to clarify that picture books are not comics because their definition finds no adherence to the non-structural conception of comics [7] despite sharing substantial common ground [8].

With the arrival of digital technology and displays, the medium of comics is undergoing a transition, such as pacing of digital comic sequences is affected by replacements of page turn, panel spacing and layout influenced by canvas scrolls [9]. The advancement in the digital comic could be realized in the interaction styles. These interaction styles of digital comic involve eye-tracking, voice control, facial expression recognition, gesture recognition,

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key-board control, touch screen control, and handle control [10]. Spectacular reading experience is also offered in digital comics that incorporate rich multimedia elements of audio to animation [11], as well as accepting mouse click, drag, text, and touch input [12, 13]. Despite the technological progression, animated illustrations, music, and sound effects were found to be beneficial in multimedia stories while interactive elements such as hotspots and games are distracting in contrast [14].

As a further remark, hypercomics expands the feature of digital comic with non-linear story structure [15]. One of the various types of digital narratives are stories that meant to inform and instruct [16]. Instructional messages are integrated with learning activities to create more engaging and exciting learning environments [17] by allowing learners to self-reflect on their thinking in their digital story [18]. Similar to educational comic, it signifies a unique nexus of numerous visual storytelling techniques [19]. According to Jüngst [20], educational comic narrative may contain informative and emotive elements. Essentially, the value of digital educational comics not only relies on how successful they are in delivering instructive content, but also engages the audiences emotionally. While some learners saw significance in the technical aspects of educational comics, others enjoyed being both educated and entertained [21].

1.1The need of digital educational comic evaluation

In comic development, from idea generation until through completed comic, evaluation needs to be incorporated into the development process. Evaluation is needed to provide the educators and developers with more direction about what constitutes effective and high-quality educational comic. As stated by Guimarães [22], the comics that are used for the representation of scientific information must "be as accurate as the researchers who are producing Science. In other words, they should incorporate all the features of scientific behavior, such as objectivity, factualness, impartiality etc.". A problem facing many educators is how to evaluate comic for instructional content. This was apparent when many researchers found comic is one of the powerful tools that provide learning and entertainment at the same time. Recent years have witnessed a growing appreciation towards educational comics which are now capable to address almost any subject from fiction to non-fiction,

without age boundaries [23] and relevance of comic in classroom [24].

Therefore, the aim of this paper is to discuss the design, development, and validation of the instrument for evaluating digital educational comic; which focus on the learning (in-formative) and entertainment (emotive) aspects of the digital educational comics.

2.Methodology
Learner-generated comic instrument consists of structured questionnaire is constructed according to [25] instrument design method as shown in *Figure 1*. The instrument design does not employ reverse-worded statements based on the evidences that negatively-worded items do not prevent acquiescence response bias [26, 27].
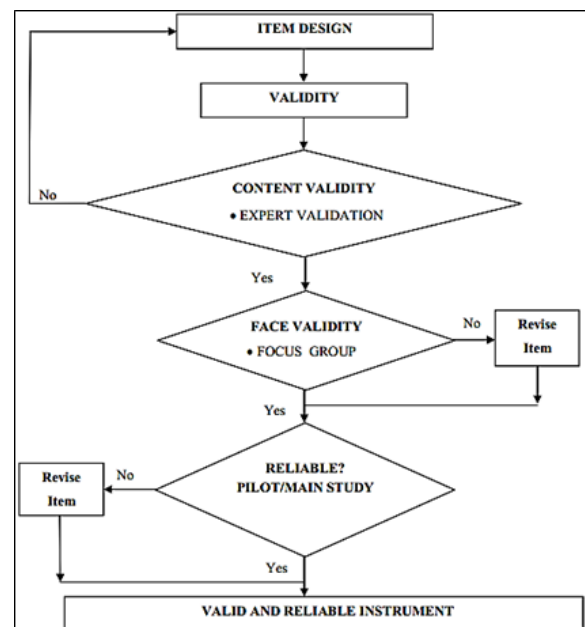

Figure 1 Questionnaire instrument design method [25]

2.1Item design
Based on the previous discussion of the digital educational comic characteristics, it should be measured based on what level it is able to educate and entertain the readers. Compiling the comic characteristics found in articles and books by various authors: an analysis was developed (*Table 1*). The digital educational comic evaluation instrument contains two major dimensions; namely learning and entertainment. Principally, naming the aspects within dimension is based on learning content quality criteria associated with content and format by [26]

and [27]'s coding scheme for learning objects assessment.

These item statements give attention on the comic core elements. Hence, an ordinal scale review form by Cooper [28] is adapted as it contains standards for the particular educational topic or subject and comic literary. Griffith [29]'s assessment criteria for school library graphic novel is also adapted into the questionnaire. Besides that, educational comic attributes in Cirigliano [21]'s experiment are also replicated in the instrument design. The analysis on evaluation criteria is exhibited in *Table 1*.

Table 1 Analysis on evaluation criteria for digital educational comic

	Aspects	Description	Source
(1) Learning: Intention			
L1	Learning Goal Alignment	At what level the comic's ideas/questions/facts/pieces of information are relevant to the topic?	[26, 28, and 29]
L2	Agility	To what degree the text element in the comic is presented in short, concise segments?	[26]
L3	Typography	To what extent the font shapes, colours and size facilitate and stimulate reading?	[26 and 29]
L4	Consistency	To what degree the comic makes use of certain pictorial consistency which adds significantly to the learning process?	[26]
L5	Recipient	To what degree does the comic promote a positive attitude toward the topic? To what degree does the comic respect the reader by presenting positive race/gender/ethical, and/or cultural values? To what extent do the comic's readability and interest level developmentally appropriate for universal audience?	[26 and 29]
L6	Reusability	To what degree do the digital comic's native files work efficiently for different users in different digital environments and in different educational contexts over time? At what level the native file self-contained, modular, traceable, modifiable, usable, standardized and properly grained, generic, and platform independent?	[30]
(2) Learning: Outcome			
L7	Accuracy	At what level the ideas/questions/facts/pieces of information in the comic is accurate, free of errors, and fact-checked?	[26 and 28]
L8	Reliability/ References	At what level the quoted materials are visibly cited?	[26]
L9	Argumentation/ Constructive Activity	At what level the ideas/questions/facts in the story are sufficient in number and scope to support the targeted educational outcomes? To what extent do the comic generate ideas/questions/facts/pieces of information about the topic?	[21, 27 and 29]
L10	Thoroughness	At what level the characters/personas interaction with the educational content are meaningful and permit the reader to have a much greater understanding of the concept/topic?	[21, 26 and 29]
L11	Emphasis of Key Concepts	To what extent the comic's pictorials facilitate the reader's involvement in, understanding of, and use/transfer of its educational content? At what level the ideas/questions/facts/pieces of information in the comic are easily balanced, distinguished or discernible from fiction or fantasy?	[27 and 28]
L12	Prospective	To what degree the story potentially open for sequel or continuation? To what extent the comic ending trigger further questions related to the educational topic?	[26 and 29]
(3) Entertainment: Aesthetics			
E1	Visual Appeal	At what level the comic's illustrations/photos/graphics are appealing? To what degree the colour palette (e.g., pastels, primary colours, sepia tones) aid the reader in understanding the tone and mood of the story? To what extent the comic contains a vivid and interesting writing style that actively involves the reader?	[21, 27 and 29]
E2	Layout	To what extent do the pictorials and words complement one another? At what level the contrast and effects are used effectively to aid focus?	[27 and 28]

	Aspects	Description	Source
E3	Clear Instructions	To what extent the story pace, shot, direction natural & make sense to the reader? To what degree the characters position are reasonably placed?	[27 and 28]
E4	Navigation	To what degree the comic panels, speech balloons and captions placement ease and flow of the story? At what level the white space between the text, frames, and illustrations help readers move through the comic, or are the pages too busy?	[27 and 29]
(4) Entertainment: Enjoyment			
E5	Organization	To what degree does the comic have a beginning, middle, and end? To what degree does the comic have a well-described setting?	[21, 26 and 29]
E6	Plot	To what extent the plot exhibit good development, imagination, and continuity? To what extent does the resolution bring the conflict to a satisfying end?	[28 and 29]
E7	Characters	To what extent the characters are believable and well developed? To what degree the characters' pose, gesture & expression make sense in the story?	[28 and 29]
E8	Feedback	At what level the comic provides enough context and action to keep the reader moving through the story? At what level the plot necessarily gives user adequate direction and information for progressing to?	[27 and 29]

3. Content and face validity

Content validity refers to the ability of the instrument adequate and represent the overall aspects of digital educational comics while face validity is tested in order to know whether the instrument apparently linguistically and analytically look like what is supposed to be measured [31]. To perform both content and face validity of the instrument items, five experts comprising academicians in digital educational media design and development are officially appointed to review the instruments. Based on their knowledge, expertise, skills, and experiences in the above-mentioned field, they are required to rate the relevance of each item in the questionnaire: Essential, Useful but not essential, or Not necessary. *Figure 2* shows example of content and face validity form which was provided to the experts.

The experts also indicate whether the items and keywords meet the appropriate standards of media production, accurately reflect the dimension category,

capture the entire scope of the digital storytelling domain, and other required details or additional suggestion to improve the instrument [32]. Their critiques were reflected where several associated items are rephrased and improved.

Contiguously, face validity was also performed involving a focus group of ten students as the potential users in understanding the questionnaire. The questionnaire items are modified according to their feedback and agreement during the discussion. The criteria of face validity assessment of this study are based on [33] namely:

- Appropriateness of grammar
- The clarity and unambiguity of items
- The correct spelling of words
- The correct structuring the sentences
- Appropriateness of font size
- Consistency of style and formatting

Figure 2 Example of content and face valid form

4.Pilot study

In order to test the reliability, consistency, and stability of the instrument, a pilot study involving 98 undergraduate students of a single university was conducted. The 98 respondents completed the questionnaire, and this number is adequate to obtain reliable results in response to [34, 35] who suggest employing at least 30 datasets for obtaining reliable results in statistical tests. During the data collection, the researcher detects and records any content of the questionnaire that failed to be recognized or understand by the respondents.

After the pilot study, statistical test was conducted where factor analysis and Cronbach alpha test are executed to measure the reliability of the instrument. Firstly, the value of Kaiser-Meyer-Olkin (KMO) and Bartlett 's test of sphericity is calculated. The results are depicted in *Table 2*. According to [36] the condition of factor analysis is KMO value must be

greater than 0.50 while Bartlett 's test must have significant value of p less than 0.0. It is required that the instrument must be greater than 0.5 factor loading rule [37]. Therefore, results from *Table 2* demonstrate that the stated conditions are significantly fulfilled.

Next, the factor loading value conditions were also accomplished where all 20 items obtained greater than 0.5 scores (see *Table 3*). Four principle components were also successfully extracted that explained 66.289% of the total variance.

Finally, Cronbach 's Alpha test was run to remove items which do not concur to the minimum value of 0.7 [38] or above 0.6 [31]. Plus, to test instrument consistency, value of Cronbach's alpha coefficient indicates that α > 0.7 to be accepted as reliable [38]. Accordingly, Cronbach 's Alpha test for learner-

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generated comic instrument discloses significant results as presented in *Table 4*.

These findings exhibited that the instrument design is consistent. From the content validity, face validity, and reliability tests which were carried out, the instrument shows satisfactory properties and could be useful in developing and evaluating digital educational comic. The use of the instrument may contribute to a deeper understanding of digital educational comic properties, valuable for comic development and evaluation, and improvements of

quality in comic educational content. Thus, the finalized instrument is presented in *Table 5*. It was apparent that *Table 5* shows the final version of the instrument for evaluating digital educational comic, which caters for both learning and entertainment aspects. Apart from that, verbal discussion with the respondents was simultaneously carried out to gather additional review towards the instrument. The respondents were asked to provide general comments on the instrument based on learning and entertainment aspects of comics.

Table 2 KMO and Bartlett's test results

Kaiser-meyer-olkin measure of sampling adequacy.		.873
Bartlett's Test of Sphericity	Approx. Chi-Square	857.613
	df	190
	Sig.	.000

Table 3 Factor loadings results

Items	Loadings	Items	Loadings
L1	.660	E1	.673
L2	.770	E2	.562
L3	.694	E3	.652
L4	.692	E4	.708
L5	.578	E5	.736
L6	.708	E6	.715
L7	.694	E7	.756
L8	.611	E8	.649
L9	.545		
L10	.534		
L11	.632		
L12	.687		

Table 4 Reliability test results

Dimensions	Cronbach's Alpha	N of Items
Learning	.901	12
Entertainment	.879	8

Table 5 Instrument for evaluating digital educational comic

Aspects		Description
Learning		
L1	Learning Goal Alignment	At what level the comic's ideas/questions/facts/pieces of information are relevant to the topic?
L2	Agility	To what degree the text element in the comic is presented in short, concise segments?
L3	Typography	To what extent the font shapes, colours and size facilitate and stimulate reading?
L4	Consistency	To what degree the comic makes use of certain pictorial consistency which adds significantly to the learning process?
L5	Recipient	To what degree does the comic promote a positive attitude toward the topic?
L6	Reusability	To what degree do the comic's native / digital / source files are file self-contained, modular, traceable, modifiable, usable, standardized and properly grained, generic, and platform independent?
L7	Accuracy	At what level the ideas/questions/facts/pieces of information in the comic is accurate & free of errors?
L8	Reliability	At what level the quoted materials are visibly cited?
L9	Argumentation	To what extent do the comic generate ideas/questions/facts/pieces of information about the topic?

Aspects		Description
Learning		
L10	Thoroughness	At what level the characters/personas interaction with the educational content are meaningful and permit the reader to have a much greater understanding of the concept/topic?
L11	Emphasis of Key Concepts	Do the contents in the comic are easily balanced, distinguished or discernable from fiction or fantasy? At what level the comic emphasis on key concepts?
L12	Prospective	To what degree the story potentially open for sequel or continuation? Does it trigger further questions related to the educational topic?
Entertainment		
E1	Visual Appeal	At what level the comic's illustrations/photos/graphics are appealing and aid the reader in understanding the tone and mood of the story?
E2	Layout	To what extent do the pictorials and words complement one another? At what level the contrast and effects are used effectively to aid focus?
E3	Clear Instructions	To what extent the story pace, shot, direction natural & make sense to the reader? Do the characters position are reasonably placed?
E4	Navigation	To what degree the comic panels, speech balloons and captions placement ease and flow of the story? Are the white space between the text, frames, and illustrations help readers move through the comic, or are the pages too busy?
E5	Organization	To what degree does the comic have a well-described setting with a clear beginning, middle, and end?
E6	Plot	To what extent the plot exhibit good development, imagination, and continuity? Does the resolution bring the conflict to a satisfying end?
E7	Characters	To what extent the characters are believable and well developed? Do the characters' pose, gesture & expression make sense in the story?
E8	Feedback	At what level the plot and action necessarily give user adequate direction and information for progressing to?

For instance, in the aspect of learning, the information on comic should be presented correctly and shortly, and concise segments. In addition, the character's interaction with the educational content should also meaningful as the dialog is aligned with the displayed information. Aside from that, the pictorials would be helpful to facilitate the reader's understanding towards the learning content; where in comic scene, the props (correct and incorrect signs) provide comparison and highlight important facts to the reader.

In the aspect of entertainment, the characters' pose, gesture, expression, and position is suggested to be reasonably placed. Other aspects, the speech balloons and caption placement in the comic also will ease the flow of the comic story and the pictorials complement with the plot. Finally, the comic should also provide enough context and action to keep the reader moving through the story. All these suggestions were taken into consideration for further improvement of the instrument.

5.Conclusion
This article sought to present the new instrument for evaluating digital educational comics. It has reported the development and validation of the instrument for its validity and reliability. The instrument focuses on the learning and entertainment aspects of digital educational comic. In specific, the instrument offers for measuring at what level the digital educational comic is able to educate and entertain the reader. Essentially, this study has provided adaptive criterion of educational and entertaining comic. Results from this study support the implementation of digital educational comic as a technology integrated classroom practice.

In this study, it was concluded that developing any kinds of instructional material is difficult to accomplish and needs meticulous considerations in the design and development process. It is because, both entertainment and learning are mainly relative to the age, gender, and socioeconomic background of learners [38]. Nevertheless, it seems highly recommended to utilize digital comic that may contribute to learning atmosphere inside or outside the classroom.

Conflicts of interest

The authors have no conflicts of interest to declare.

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