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Infographics as a Reflective Assignment Method in Requirements Engineering e-Course?

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Abstract—**Our Work in Progress Paper in Innovative Practice Category focuses on how learners' experience use of infographics in advanced level e-course on requirements engineering (RE). Infographics are visual representations of information in such a way that information can be easily understood at a glance. Most of the previous infographics studies have been conducted in the context of inquiry learning. To complement this research, we studied how learners experience use of infographics as a method for reflective assignment and hence if the usage of infographics supported conceptualization about RE. We adopted a qualitative content analysis approach, applying thematic network analysis to the data received from five case learners. This approach proposes graphical networks as an aid for analyzing and synthesizing qualitative data into basic, organizing, and global themes. The thematic network analysis produced two global, seven organizational, and 53 basic themes. The global themes were named "Visual literacy" and "Conceptualization". In addition, the e-course supervisor evaluated learners' infographics according to assessment criteria. Based on these analyses, learners can, using infographics, concentrate on essential topics, distill information, and develop their skills for visual literacy and conceptualization. The results suggest that infographics can be successfully utilized in reflective courses assignments that are typically produced as linear texts.**

Keywords—**Infographics, higher education, e-course, visual literacy, conceptualization, requirements engineering, RE, thematic network analysis, learner's experiences.**

I. Introduction

According to Lankow *et al.* [1], an infographic (or information graphic) provides visual cues to communicate information. Lankow *et al.* [1] explained that an infographic can be a simple or complex representation, meaning that there is no threshold for something to be termed an infographic. They also noted that an infographic is often seen as a specific ``format" for depicting information. Drawing on Roman architecture Vitruvius, Lankow *et al*. [1] referred to the attributes of appeal, comprehension, and retention as a means to analyze the design of infographics for different purposes. For instance, Lankow *et al.* [1] noted that authors in scientific contexts have placed little emphasis on appeal.

The main types of infographics include statistical, time-series, process, narrative, metaphor, comparison, hierarchical, and networks [2, 3]. Another taxonomy differentiates between static, interactive, and video infographics [4]. A usual definition is that an infographic communicates complex information in a succinct manner [5, p. 3].

Infographics have been used as learning materials (e.g. [6]) and as assignments in which learners create them (e.g. [7]). In the latter case, subject knowledge needs to be integrated with technology skills such as representational skills (see, [8]). Learners' opinions indicate that they value infographics due to enjoyment and reinforcement in learning [6, 9].

Regardless that the skills involved in creating infographics are arguably relevant in higher engineering and computing education, there seems to be little systematic research on infographics in these fields, particularly regarding learner-made infographics in e-course context in the field of requirements engineering (RE). This study complements previous research by focusing on the experiences of requirements engineering e-course learners who were allowed to create infographics for a reflective assignment. A qualitative survey was issued to learners who selected to create infographics. The research goal was to gain insights into what benefits or obstacles learners attributed to this form of studying. A thematic analysis was applied to the data and the analysis was complemented by e-course supervisor observations of the resultant infographics. This work-in-progress study maps different learner perspectives and seeks to identify specific research questions.

We begin by summarizing infographics research in education as our theoretical framework in Section II. Our study context and research method are introduced in Section III. Preliminary findings are presented in Section IV. We conclude and discuss our future work in Section V.

II. Infographics in Education

A common feature in the pedagogic literature is that infographics are related to the pervasive use of visual information in the current information age and relatedly to visual literacy and its development.

Lyra *et al.* [6] used infographics as learning materials for environmental engineering learners. The study compared the situations in which the learning materials were presented either as infographics or disassembled into graphics and text. The main observations were that those who were provided with infographics held the information for longer time and showed a positive correlation between correct answers and enjoyment with the assignment. The two groups did not differ as for learning overall. Similarly, the study by Ozdamli & Ozdal [9] used infographics as learning materials, and both teachers and learners found infographics to vitalize coursework and allow repetition and reinforcement in learning. These perceptions

showed a change from neutral to positive after teacher training on infographics was provided. Ott, Robins, and Shephard [10] developed an infographic to support self-regulated learning. Learners were shown information about the key course concepts, their current course progress, and previous course learners' perceptions of task difficulty. Learners appreciated this infographic as motivational and supportive, while the final results of the course remained unaffected.

When learners have developed infographics (similar to our research interest), pedagogical settings have resembled inquiry learning. Alabdulqader [7] asked learners to prepare infographics as a method to report outcomes of their studies on ethical issues in computing in their local community. Shanks *et al.* [11] asked small learner groups to study a selected health issue and prepare an infographic as the outcome of their group inquiry. These learners reported that infographics taught them how to communicate science topics to non-experts and appreciated infographics as a way to deepen their learning.

Gebre and Polman [8] used infographics in secondary level science education, asking learners to prepare infographics about science news. The main challenge was that learners tended to focus on depictive, iconic representations; the authors concluded that education is needed to develop learners' skills toward more abstract representations. Moreover, Gebre and Polman [8] observed that learners were able to give meaningful peer feedback of infographics although emphasizing completeness and information sources less than appeal. In another study, Polman and Gebre [12] studied expert opinions about infographics with the aim of informing STEM fields education of the key attributes in science communication. The experts focused on purpose, content, and representation in the infographics they were asked to evaluate. These studies [8, 12] serve as useful references for the present study in which RE learners' perceptions about creating infographics and e-course supervisor's observations about the resultant infographics are reported; they motivate research on learners' conceptualization processes with infographics.

III. STUDY CONTEXT

The case course was an advanced level e-course in RE. A requirement in the software development context is defined as a condition or capability that must be met or possessed by a system or system component to satisfy a contract, standard, specification or other formally imposed document [13].

The RE e-course is implemented in Moodle e-Education environment. Learners submit their assignments to Moodle according to the pedagogical manuscript of the course. The course supervisor monitors learners' progress and evaluates assignments. The e-course consists of three phases. These phases form a cumulative learning process. After each phase, learners submit an assignment and the supervisor evaluates it and gives feedback on how to proceed.

To complete the course successfully, an accepted learning diary or infographics were required and given as equal options for learners. For both options, guidelines were given. However, as learning diaries are more familiar for learners, infographics were described more deeply with a text and a video in Moodle. Learners were guided to use text, figures, images, and tables in their infographics. Video, animation or sound was not preferred. This was due to keep primary focus on the course content, requirements engineering, not on technical issues. Learners could create their infographics individually or in pairs.

The aim was to explore the applicability of infographics for a reflective assignment and offer an alternative new way to complete the course; learners' reactions and experiences were studied in a small sample group. Infographics were chosen by 10 learners out of 35 (29 %). In each course phase, learners answered two questions: (a) What did you learn? and (b) How can you apply your learning? During the course, each learner who chose to use infographics produced 13 A4 infographics. In each phase, infographics were submitted as one pdf file to Moodle. The e-course language was English. The study was carried out during the autumn 2018.

Using a semi structured questionnaire approach, (summarized in Table 1), the experiences of five learners (participants P1, P2, P3, P4 and P5) were collected, transcribed, and analyzed. All participants were learners in engineering and computing education with at least three years academic study experience. Participants P1, P3 and P5 had not used infographics before. Participants P2 and P4 were familiar with the concept of infographics while had no experience in preparing them. As learners studying IT courses, all participants can be judged to possess sufficient technical abilities to learn to use infographics tools.

TABLE I. SEMI-STRUCTURED QUESTIONNAIRE

• Why did you choose infographics as a tool for doing course assignments instead of a learning diary?
• How would you describe your overall experiences with using infographics in the course assignments? • What resources and/or tools were helpful to you when you created your infographics? • What challenges did you face when you were creating your infographics? How did you overcome these challenges?
• Did infographics help you to increase your knowledge and understanding of requirements engineering more than doing learning diary -type report? • If yes, think also which aspects of using infographics were useful for you and helped you to understand the course material?
• Do you think that you learned also other skills when you created your infographics? Please, describe your feelings and experiences.
• Do you think that infographics supported your learning process? Please, describe how. • Did infographics support you to focus on the subject itself? Please, describe how.
• Would you recommend using infographics for future learners in this course? Why or why not? • What guidelines would you like to give for future learners when they create infographics for this course? • What else would you like to share about your experiences in using infographics as study outcome? • How would you like to develop using infographics in this course? Please give some practical examples.

Thematic networks analysis [14, 15] was used for analyzing and synthesizing qualitative data. The analysis was data-driven, meaning that theory did not inform the themes. The method collects textual data and organizes the perspectives in the data into a network diagram. Thematic networks analysis has three

classes of themes. (1) Basic Themes (small rectangles inside dotted lines in Figures 1 and 2) are simple premises, lowest-order themes, of the collected data. Basic Themes say very little on their own. As they are clustered together, they start to complement each other and form organizing themes. (2) Organizing Themes (ellipses in Figures 1 and 2), as middle-order themes, assemble basic themes into clusters forming an argument or position about the situation. (3) Global Themes (rectangles in the middle of Figures 1 and 2) filter organizing themes into one insight that summarizes a comprehensive issue. Global Themes tell us what the texts as a whole are about within the context of a given analysis.

The analysis process proceeded as follows. Ten learners who had chosen to use infographics were called to participate in this study. Five learners volunteered. They were told that they can record or write down their answers to the semi-structured questionnaire. The data received were transcribed and analyzed by the first author. A total of 93 samples from the transcribed data were filtered out and basic themes derived from these samples. The basic themes were grouped into clusters forming organizing themes, which were further summarized into two global themes. Thus, the analysis produced two thematic networks through a data-driven analysis. These thematizations were reviewed in a shared session by the two authors, which resulted in a few modifications on how themes were named. In addition, the supervisor of the course evaluated all 130 infographics created by ten learners. A brief summary is provided.

IV. FINDINGS

The thematic networks analysis produced two global, seven organizing, and 53 basic themes (emphasized in italic font below). The two global themes were named "*Visual literacy*" and "*Conceptualization*". Visual literacy refers to versatile information visualization aspects of infographics reported by the participants. Conceptualization concerns topics related to information distillation and identifying essential themes due to use of infographics, as reported by the participants.

A. Visual literacy

A thematic network titled *Visual literacy* is illustrated in Figure 1. The network shows the different organizational and basic themes of visual literacy in the participants' views.

All participants reported experiences of *knowledge visualization*. They felt that *visual perspective* to course assignments was something new and challenging. This *motivated* them. Participants P1, P3, P4, and P5 reported that their *graphic design* skills improved during the course phases, which they felt *rewarding*. The participant P2 was more experienced in *graphic design* and felt that the assignments gave an excellent opportunity to practice more. All participants felt that working with infographics was *compelling* and *efficient*. The *utilization* of the created infographics *in the future* as a manual was especially pointed out by the participant P1. *Conveyance* of *complex ideas* by means of infographics seemed to challenge all participants, as infographics require one to convey the meaning or essence more effectively than a

textual description does. The participant P1 summarized: "A picture is worth a thousand words."

All participants shared the feeling that they were actually learning also *visual communication* during processing their infographics assignments. They said that they *combined information* and *presented information forward*. This was seen as an interesting difference compared to a traditional learning diary assignment. They further contemplated that learning diaries are written for supervisors and/or oneself, while infographics are more communicative to a wider audience.

The participant P1 said that infographics create a *visual memory trace* that makes studied materials easier to absorb and remember. P1 also told that more difficult parts of the course materials could be presented as *layered* illustrations. Layered approach concerned presenting formal methods of RE, which was the most difficult part of the course. Preparing infographics seemed to ease the understanding of formal methods. The participants P3, P4 and P5 reported more *in-depth learning experience* with infographics than with just writing linear essays. Use of time with creating infographics divided participants: P1 reported that it was *more time-consuming*; P2, P3 and P4 reported that it was *less time-consuming*, and P5 was neutral.
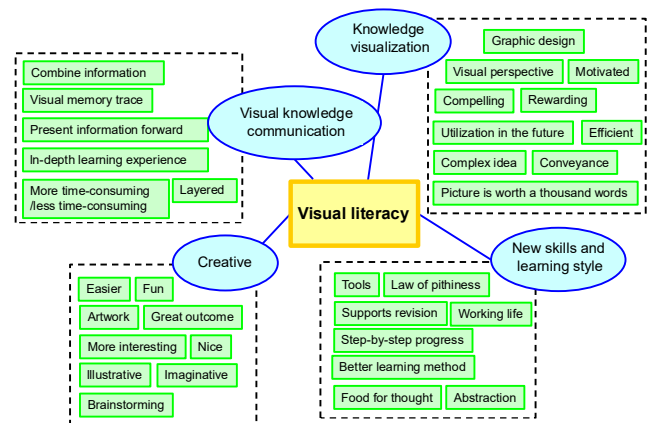

Fig. 1.   Thematic network for global theme "Visual literacy".

All participants shared the same feeling of *creative* when they processed their infographics assignments. They said it was *easier*, *nice* and *more interesting* to work with infographics than with learning diaries. They also reported that it was *fun* to do *artwork* and create *illustrative* presentations. They told that they enjoyed *brainstorming* and *great outcome*. They felt that they really can be *imaginative* when doing their assignments compared to writing learning diaries.

Topics related to *new skills and learning style* were reported by all participants. *Tools* for creating infographics were said to require extra technical training. P1 specifically said that in conjunction with studying and understanding *law of pithiness* infographics provided new skills as a "by-product". P1 highlighted that these skills were likely to be useful in *working life*. Participants also stated that 3-phased pedagogical manuscript of the course and infographics as an assignment reporting method *supported revision* because the earlier phase infographics needed to be revised before doing the next one, to

keep up the logic of the story. Also, they highlighted that infographics supported *step-by-step progress* and the development of *abstraction* skills. Altogether, participants felt that infographics was *better learning method* for them and gave *food for thought*.

B. Conceptualization

The second global theme related to *conceptualization,* in other words, it concerned topics related to information distillation, identifying essential themes, and relations between the themes due to use of infographics in the context of RE e-course material. The thematic network is shown in Figure 2. The network illustrates the different organizational and basic themes related to conceptualization.

Related to *ease of understanding and remembering*, the participants P1 and P5 highlighted that with a *story like* infographics it is possible to *clarify complex subjects*. They said that preparing infographics is like creating a story with a storyline, and felt that it was important to keep the storyline consistent in each study phase. P2 said that with infographics it is possible to create a *versatile picture* of an issue which takes into consideration several aspects, for example different stakeholders in case of RE. P3 reported that with infographics there is *no cram*. P4 pointed out that *visual hints* in infographics made it easier to remember larger unities. All participants agreed that infographics were *better than linear essays*.

All participants reported that creating infographics supported their *concentration and focusing*. They said that it was easier to *see the forest for the trees* related to each *chapter content* in the e-course book. They felt that infographics as a format for reporting assignments assisted them to identify and concentrate on the essentials. Information *distillation* and *clarification* were adopted as a working method among all participants. Especially P3 reported that *no (mind) roaming* was experienced.
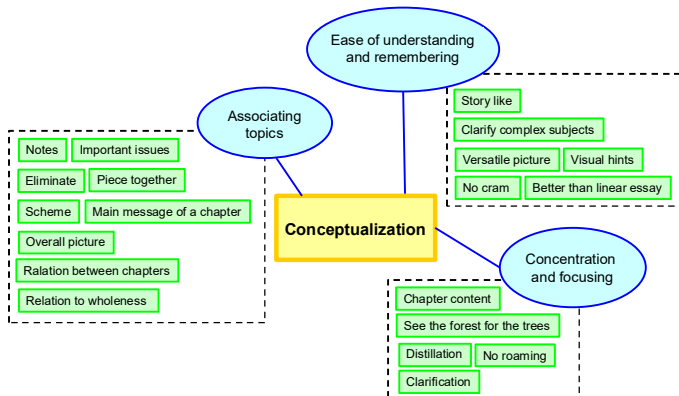

Fig. 2. Thematic network for global theme "Conceptualization".

All participants reported themes related to *associating topics* while creating infographics. P1 and P5 highlighted that with each e-book chapter they made first *notes*, highlighted *important issues*, and *eliminated* less important topics. With this process they were able to identify the *main scheme of a chapter* and finally see the *overall picture* and *relations*

between different chapters. The participant P1, who had several years of experience in working life, also told that infographics helped to see requirements engineering's *relation to wholeness*, which in this case is software development in general.

C. Supervisor's evaluation

The evaluation by the course supervisor concerned all 130 infographics created by ten learners. The assessment criteria focused on identifying (a) essential definitions, activities, roles, stakeholders, processes, methodologies, tools, and management value engineering in RE context, (b) logical progress in each phase, (c) consistent storyline, (d) graphic design style, and (e) coherent whole. According to supervisor's observations, the learners were able to recognize more effectively the essentials than with writing linear essays. Conclusively, the infographics assignment reporting mode and related guidelines supported them to prepare compact presentations. Although some learners thought that infographics were more time consuming, no submission delays occurred among the learners who were working with infographics. All infographics were surprisingly well done. The storylines were logical and consistent in all three phases. Graphic designs were creative and in some cases certain graphical elements were systematically used to indicate certain pieces of knowledge, for example, RE activities, roles, stakeholders, processes, methodologies, and tools. This interestingly appeared as a kind of a personal iconic language. In addition, the atmosphere of enthusiasm came across from the infographics created by the learners.

V. CONCLUSIONS

This study reported learners' experiences of using infographics as an assignment reporting method in a requirements engineering course. The attitude of the case participants (5 learners) towards infographics was positive and enthusiastic. Participants reported that it was challenging - food for thought - but fun to create infographics. Altogether, they wished that more courses would use infographics as an assignment method in place of essays. They also highlighted that they learned new technical and cognitive skills that will be useful in their study and working life. Examples of these skills are usage of infographics tools, graphic design, visual literacy and conceptualization. The supervision's observations of using infographics as an assignment method in RE e-course definitely supports the extension of using infographics to replace and complement linear texts. Because only few learners chose to "try out" infographics in our study, we conclude that the benefits documented here should be communicated to future learner populations. This way we can encourage and potentially lower barriers to versatile modes of studying.

This work-in-progress study reported viewpoints of volunteered learners and therefore does not intend to generalize. Future research should study the applicability of infographics as a reflective assignment in larger populations. This study revealed interesting detailed experiences, such as "no cramping" and "no roaming," which exemplify aspects that should be studied further in the present-day information-rich study surroundings imposed on the learners.

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