Typesetting DSL Teaching Method based on the Paradigm WYSWYM

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Abstract: In Brazil, the parameters that determine the standardization of academic texts are defined through technical norms produced by an organization called ABNT. The majority of students in higher education courses opt for Microsoft Word as the main reference to edit their academic productions. However, few students are able to question themselves about the tools and the methods they use to comply with these rules and a very large part of them do not know the so-called paradigm WYSWYM. In this paper, we present a methodology to acquire knowledge about word processing through the presentation and practice of the typesetting DSL LaTeX for non-exact science students. A survey was conducted to gather the feedbacks of our students demonstrating a fair acquisition of the method and a high confidence concerning the future return on their learning investment.

1 INTRODUCTION

Donald E. Knuth viewed computer programming as an art form just like the creation of poetry or music (Knuth, 1997). In 1977, outraged by the poor quality of the typography of the word processors in the market, he influenced a revolution founding on a new edition paradigm called WYSWYM (What You See is What You Mean) as opposed to the classical WYSWYG (What You See is What You Get) (Scales and Ecke, 2002). Therefore, TeX was released as a free software document composition system, independent of the hardware used for viewing or printing (Knuth and Bibby, 1984). The TeX system was designed to be ergonomic (the authors can use it directly with little computer knowledge background) and free (as the fruit of an academic research). The direct use of plain TeX format being quite tough, it has been extended to LaTeX in 1984. LaTeX was originally written by Leslie Lamport (Lamport, 1994), and constitutes actually a set of TeX-based macro commands. The Brazilian Association of Technical Standards (ABNT) is a non-profit organization promoting technological developments and responsible for technical standardizations in Brazil. It is a founding member of the International Organization for Standardization (ISO) and the exclusive representative of Brazil in the International Electrotechnical Commission (IEC). ABNT has been active in product certification since 1950 establishing marks of conformity with standards applied in product certification schemes. ABNT also certifies quality systems, environmental management systems and several other products. ABNT is organized in committees (called CBs standing for Brazilian Committees) which are designed to support the development of technology and the participation in international standardization. The documentation standards, which serve as guidelines in the edition of academic works are established by ABNT/CB-14 (Brazilian Committee for Information and Documentation). With these rules, Brazil owns a unique standard for transmitting the academic knowledge in a clean and organized manner, properly understandable by any researcher, scientist or professor. The majority of students in higher education courses opt for Microsoft Word as the main reference to edit their academic productions. However, Microsoft Word is concerned by many issues such as a lack of features, incompatibilities between versions and operating systems, potential expensive licenses, etc. An alternative would be to use a free Software as a Service like Google Docs or Word Online. Nevertheless, the main issue of these solutions stands in the adequation of the academic work

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with the ABNT standards. As a consequence, during school life, many students have contact with ABNT rules. However, it is in higher education that relations with such norms become closer. This is due to the fact that most Brazilian universities opt to use them as guidelines for editing the scholar productions. Following the ABNT rules is extremely important for the clarity of information and thus facilitates the identification and understanding of contents. It is well known that many students have a certain fear of the ABNT rules thinking that these rules are too much complicated. However, few students are able to question themselves about the tool and the methods they use to comply with these rules and a very large part of them do not know the paradigm WYSWYM. In this paper, we present a methodology implemented during the second semester of 2020 in a discipline called *Introduction to Computer Information Systems* from the course of Bachelor in Accounting, Economics and Marketing at the Vila Velha University in Brazil. Most of the classes took place in a hybrid schoolroom (virtual and physical) in reason of the COVID-19 pandemic. The objective of this discipline is to provide for the students general knowledge about 5Cs for managing information in organizations for operation, management and decision-making. The 5Cs represent well established processes to change data into information. They consist of capturing information, conveying, creating, cradling and communicating. In other words, the discipline tackles the procedures that convert data into required information by recording, classifying, organizing and interpreting them. Technically, these procedures are fast done by a computer (both hardware and software) using artefacts like spreadsheet, database management system or word processing. With regard to the latter, the paradigm WYSWYM was taught through the presentation and practice of the language LaTeX with an emphasis on some fundamental notions such as *Installation*, *Simple Commands*, *Report creation*, *Figures*, *Tables*, *Formulas* and *Bibliography*. The students were evaluated across two projects along the semester. At the end of the semester a survey was conducted to gather the feedbacks of the students demonstrating a fair acquisition of the method and a high confidence concerning the future return on their learning investments.

The remainder of the paper is as follows: in Section 2 we will describe our methodology to teach the paradigm WYSWYM with LaTeX; in Section 3 we will present the results of our survey conducted at the end of the teaching-learning process; in Section 4 we will present some related works; and finally in Section 5 we will conclude and draw some perspectives.

2 LEARNING PATHWAY

In the Figure 1, we describe the different blocks of the learning pathway to acquire knowledge about the main topic *Word Processing* of the discipline *Information Systems*. As explained in the introduction, our strategy is to introduce the paradigm WYSWYM through an hands-on learning of the language LaTeX (Scales and Ecke, 2002).

In the first block, we epistemologically represent LaTeX as an historical rich keystone in Computer Science. First, this language is special since it comes from an asynchronous co-creation of two Turing Award laureates: Knuth and Lamport. LaTeX is basically a set of macros to facilitate the usage of TeX. LaTeX is a typesetting Domain Specific Language (DSL) created to support a particular set of tasks performed in the specific domain of the digital edition. It provides macros with an easy-to-understand grammar supporting semantic markups (Hufflen, 2006). The markups concern the logical meaning of a document rather than its appearance as advocated by the paradigm WYSWYM. Behind the scenes, TeX handles the procedures. As a consequence, the foundational language TeX is considered a procedural descriptive markup language for edition. This part of our learning pathway represents an opportunity to recall the wide variety of classical DSLs created in the history of Computer Science, such as HTML or SQL for example.

In the second block, our strategy is to present two alternatives for the installation of the proper technical framework: (i) by setting up a local solution and/or (ii) by using a Software as a Service (SaS). For the first alternative, different options are presented to fulfill the students needs in terms of conformities with the different operating systems architectures. For the second alternative, a collaborative cloud-based LaTeX editor is presented as the simplest solution for the students who would not invest so much time in setting up a local solution. This block is the opportunity to describe the modern usage of the cloud computing, particularly in relation with the last SaS generation.

In the third block, the classical syntax of the LaTeX command is presented (a given word usually preceded by a backslash determining a special behaviour and potentially taking some parameters). The native document classes in LaTeX are presented (i.e. `article`, `letter`, `report` and `book`). The distinction between content and form is an essential feature of the paradigm WYSWYM.

Thereafter, we present the command to declare a style in the preambule of a document. Subsequently, other commands (inside the body of the document)

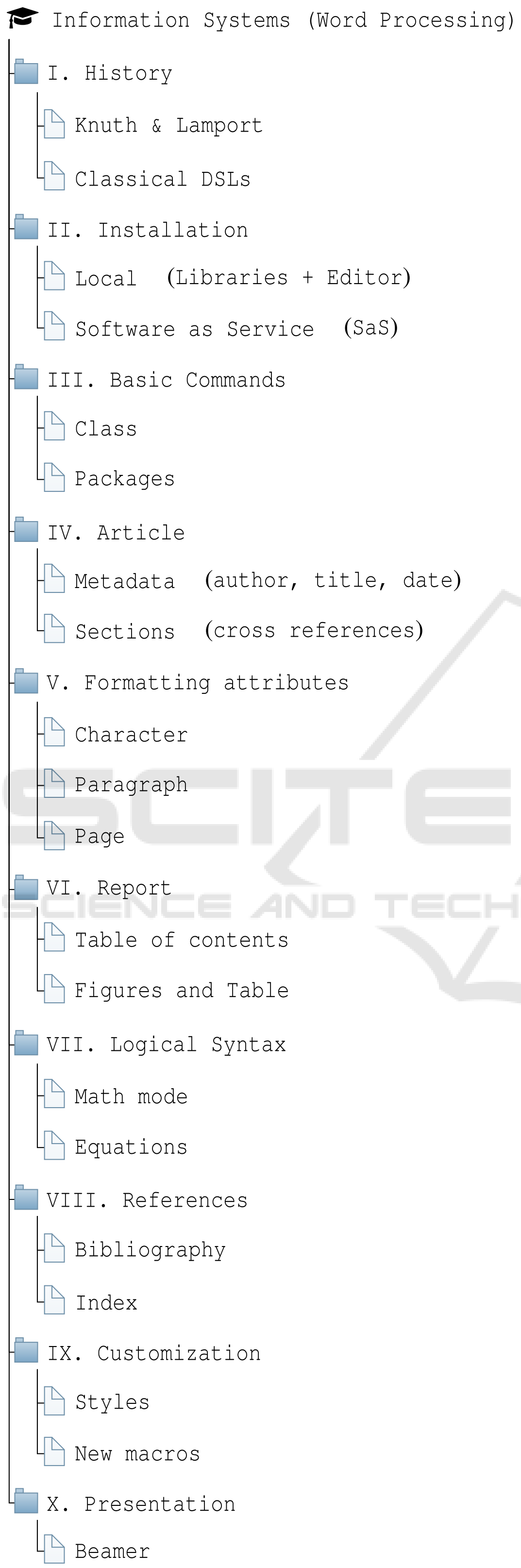

Figure 1: This caption has one line so it is centered.

are illustrated through the addition of a diacritic to a letter. This is also an opportunity to introduce the packages (declared by using commands in the head of the document) and particularly the package `inputenc` together with its parameter `utf8`. Character encoding is re-contextualized as a major artefact to store and transfer data in Computer Science.

In the fourth block, we select `article` as the class of a new document. Thereafter, we present the commands to declare the metadata of a document (i.e. author, title, date and abstract) and to set its language (e.g. French, Portuguese, ...) through the package `babel` with the appropriate option. At this stage, a first draft of an article is built by introducing the different levels of a document (`part` (only for the class `book`), `chapter`, `section`, `subsection`, `subsubsection` and `paragraph`). The mechanism of cross references is presented by promoting the scalability of such an architecture for the document.

In the fifth block, we present a collection of formatting attributes applicable to a text in a single native step. Therefore, we introduce the commands aiming to set different font families, font sizes, font styles and font colors. Structured and structuring elements such as list and floating, footnote, line break, indent, vertical and horizontal spacing and page break are introduced. The commands to define a page style are presented and particularly the ones to deal with page numbering, headers and footers. Finally, a list of special characters in TeX is presented and the way to escape them is also explained.

In the sixth block, the proposal is to switch the class of the document from `article` to `report`. The intention is to reveal a large part of the LaTeX potential through the edition of a report that can be potentially turned into a course conclusion monography. The content produced in the other blocks can be reused. First, we introduce the command to automatically generate a table of contents. Thereafter, some images are included in the document by using different options. The distinction between fixed and relative dimensions is explained by investigating different ways to dimension the images. The macro `figure` is presented with the command `caption`. A list of figures is automatically generated in the same way as the table of contents (by using a different command). The same operation is conducted with the macro `tables` and consequently a list of tables is generated.

In the seventh block, a focus is given on one of the strongest benefits of using LaTeX: the edition of some mathematical typesetting. This is achieved by the use of the operating mode called math mode. Nevertheless, it constitutes a large topic due to the existence of a lot of notations. The most commonly used notations of the plain LaTeX are introduced and the edition of some more complex formulas is described through the use of the `amsmath` package. The three different ways to write in math mode are described: inline, equations and numbered equations.

In the eighth block, a new important feature of academic works is explored through the incorporation of the references. First, the package `makeidx` is introduced to support the creation of indices (alphabetical list of expressions with the pages upon which they can be found). After that, we explain why LaTeX owns a great support for citing references thanks to the auxiliary tool BibTeX. We describe the two alternatives to deal with the list of references: by flat-file database or by embedding them at the end of the document. The relevance to deal with a centralized bibliography source linkable to many documents is highlighted (write once, read many). We present the most commonly used entry types (e.g. article, book, or conference). We present the BibTeX style files that describe how bibliography items will be formatted. An ABNT-based BibTeX style for listing is introduced to convince the students about the simplicity of such an approach. Different citing styles are introduced through the package `natbib`.

In the nineth block, we take advantage of the past block to generalize the ABNT-based styles from the biliography list to the whole document. The distinction between the files `.cls` (describing the classes) and the files `.sty` (describing the packages) is explained. A selection of interesting classes (e.g. `lncs.cls`, `elsarticle.cls`, `acmart.cls`, etc.) and packages (e.g. `tikz`, `algorithm2e`, `listings`, `supertabular`, etc.) is presented. `AbnTeX2`, a suite with a class, citation packages and bibliographic style formatting that meet the requirements of ABNT standards is introduced. Finally, we focus on Plain TeX to explain advanced techniques for creating commands or environments that match specific needs.

In the tenth block, the `beamer` class for creating presentation slides is introduced. A set of templates is presented, and some elements structuring the presentations are described (e.g. title page, headers/footers, highlighting, table of contents, effects, etc.).

3 SURVEY

An online questionnaire was carried out in December 2020. The survey was targeting students that participated in the discipline called *Introduction to Computer Information Systems* from the course of Bachelor in Accounting Sciences, Economics and Marketing at the Vila Velha University in Brazil. They followed the learning pathway presented in Section 3 to acquire knowledge about Word Processing. In order to address the research questions, this study relied on qualitative and quantitative data collected by the questionnaire summarized in Appendix. The instrumentation to conduct our study consists of a form, divided into eight blocks and including a consent form for the study to guarantee the participants' rights (regarding anonymity and strictly academic use of the data), some questions to profile the participants (knowledge and experience in word processing) and the remaining questions to obtain their feedbacks and perceptions about the learning pathway. The questionnaire was created at https://www.questionpro.com/. After gathering the data, some subsequent analysis was performed through spreadsheets analysis.

3.1 Procedure

The procedure for applying the survey was to send the students an online questionnaire[1] at the end of the semester just a few days after the final evaluation. Thereafter, the participants would have 48 hours to respond. The participation was optional, nevertheless in order to encourage the engagement it was offered one additional point for the averages in case of contribution.

3.2 Participants

The survey was viewed 91 times and 59 non-exact science students started responding. From them, 49 students completed the questionnaire out of a total of 115 students in this discipline. Figure 2, through its external ring, describes the partitioning of the undergraduate courses in the class. The internal ring represents the percentage of students from each course who completed the questionnaire. In relation with the participants, 21 men and 28 women aged between 16 and 49 years completed the questionnaire. Three participants did not inform their age, however, their answers were considered and replacements by median were performed.

Most participants informed that before taking the discipline, they had no experience in using any programming language (91.8%). Only four participants (8.2%) have had such an experience (2 in C, 1 in Python and 1 in Microsoft Office Automation). No student knew LaTeX before taking this course.

[1] https://www.questionpro.com/a/TakeSurvey?tt=N9drEjTsgvY\%3D

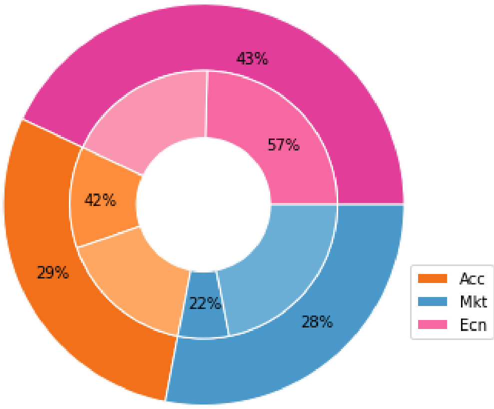

Figure 2: Participation of the students.

3.3 Perceptions

As described in Figure 3, from the 49 students who completed the questionnaire, 77% of the participants (38 students) intend to use LaTeX in the future (by answering yes or maybe), and among them, we highlighted two groups: students over and under the age of 30 years.

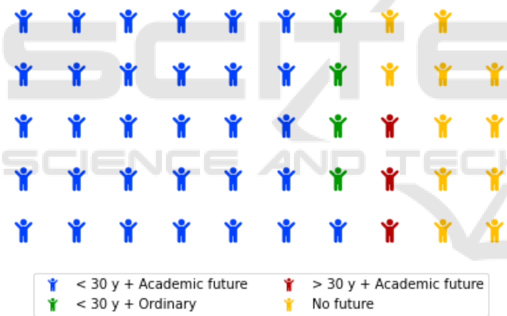

Figure 3: Intentions of the students.

A small number of participants are over 30 years old and among them, 75% mentioned that they intend to use Latex for academic purposes and did not have any difficulty with learning the language, demonstrating that age is not impacting for learning LaTeX. Concerning the participants under the age of 30 years, 35 students (71.4% with an average of 20.5 years) answered that they intend to continue using LaTeX in the future (yes or maybe), and among them, 31 students (88.6%) mentioned that they would use it for academic purposes. Even if they are beginners attending the second semester of their undergraduate course at the university, the students became interested and conceptualized the potential needs in using LaTeX for future works (e.g. final year project reports).

We observed a large part of the students glimpsing a potential benefit of LaTeX for academic purposes (e.g. scientific works). Among the participants, 45 students notified using Microsoft Word and only 2 students mentioned using LibreOffice Writer which corroborates the observations stated in the introduction about the mainstream usage of Microsoft Word in Brazil.

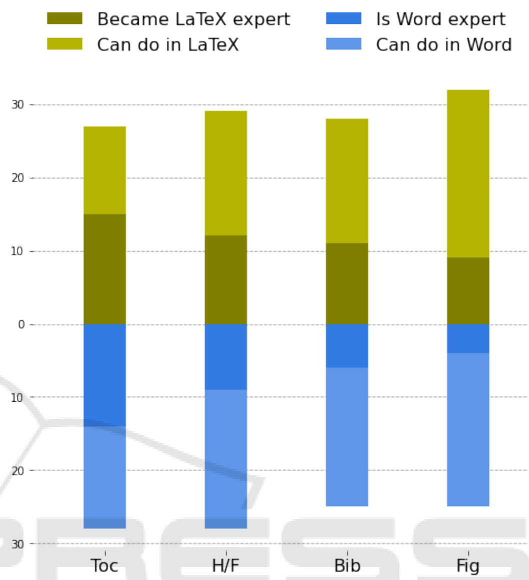

Figure 4: Fluency of the students.

We observed that few students are used to learning how to practice word processing (28.57%). Fourteen participants declared having already taken a course to learn how to use a word processor (in other words 35 participants had never taken such a course). Nobody replied that they had few knowledge about word processing, 12 students thought they could improve, 15 students thought they had a normal background and 21 students thought that they already knew a lot of features concerning word processors.

In Figure 4, the perceptions of the students in relation with some staples (ToC: Table of Contents generation, H/F: Headers and Footers configuration, Bib: Bibliographic references insertion, Fig: Figures managing) of the word processing are detailed either for Word or LaTeX. Concerning Word, 28 students can generate a table of contents while 14 students are experts on that; 28 students can configure headers and footers while 19 students are experts on that; 25 students can insert bibliographic references while 19 students are experts on that; and finally, 25 students can manage figures while 21 students are experts on that. Concerning LaTeX, 27 students can generate a table of contents while 15 students became experts on that;

29 students can configure headers and footers while 12 students became experts on that; 28 students can insert bibliographic references while 11 students became experts on that; and finally, 32 students can manage figures while 9 students became experts on that.

3.4 Inferences

First, we can infer that the percentage of students who can work with Word is very close to the percentage of students who can work with LaTeX (w.r.t. the same features). Despite the students having few contacts with the language, their consolidated skills in LaTeX are close to the ones reported in Word. The students who declare to have no idea about how to use the suggested functionalities are generally similar between Word and LaTeX. In other words, the difficulties encountered by the students confronted to the two word processing paradigms are very similar. The learning period on LaTeX was short, though, the results of the survey showed similar students perceptions about the consolidated skills between Word and LaTeX.

We notice that LaTeX learning does not require any background in programming languages since only 8.2% (4 students on a total of 49 students) possessed such knowledge. Thus, there are obvious benefits for who is not fluent in a given programming language. Finally, 25 students conceptualized LaTeX as a normal or quite easy language, 22 students found difficult while two students found it extremely difficult. Half of the students who thought it was easy did not have any difficulty in learning LaTeX. Ten students declare their intentions to continue using LaTeX, 28 students are dubious and 11 intend to not continue. Although a large part of the students demonstrate to have learned the staple, they are still in doubt whether to continue using LaTeX or not. Nevertheless, when asked if they would like to add any comments, 11 students (a quarter of the participants) voluntarily made very positive comments regarding the learning and the use of LaTeX.

4 RELATED WORKS

In Breitenbucher (2007), the authors are literally shocked by the poor typesetting quality of the independent study theses. They notice that most of their math and science students begin college or university study with no idea of how to use Word or other tools to write a technical paper. On the other hand, Neuwirth (1991) thinks that TeX has nothing to do in schools and encourage to keep it only in the academic and commercial world.

It already exists a substantial set of approaches that deal with LaTeX teaching and particularly to introduce LaTeX for beginners (Lamport, 1994; Grätzer, 1999, 2013). There exist handbooks (see for example Higham, 2020) or LaTeX companion (see for example Mittelbach et al., 2004) that advice on how to write and publish a paper by covering the entire publication process. There also exist brief introductions to the LaTeX system for typesetting documents (see for example Griffiths and Higham, 1997; Oetiker et al., 2014). Such introductions to LaTeX generally begin with typing a small text and enriching it (see for example Bitouzé and Charpentier, 2006).

While mathematics remains the main domain for teaching LaTeX in universities (Aebischer et al., 2009; Sullivan and Melvin, 2016; Heavner and Devers, 2020), it also exist some approaches dealing with students in engineering science and mechanics (Gray and Costanza, 2003; Abdullah et al., 2013) or in liberal arts (Breitenbucher, 2007). Hufflen (2006) introduces LaTeX in the context of semantic markups-based languages (related to semantic notions, rather than layouts).

Generally, the approaches focus on preparing the students for some long conclusion works or final year project report (see for example Aebischer et al., 2009; Abdullah et al., 2013) as to our purpose. In (Abdullah et al., 2013), the authors point out writing as one of the skills necessary for engineering students to master.

Naturally, the related works address the materials, tools, logistics, syllabus and topics covered in class or workshops as well as the assignments given to the students (see for example Gray and Costanza, 2003; Blaga, 2007; Abdullah et al., 2013; Sullivan and Melvin, 2016). For example in Moudgalya (2011), the authors created the following list of tutorials: what is compilation?, letter writing, report writing, mathematical typesetting, equations, tables and figures, bibliographies, inside story of bibliographies, LaTeX on Windows, updating MiKTeX on Windows and Beamer.

Some approaches (see for example Heavner and Devers, 2020) also promote LaTeX as a method to support students learning and understanding mathematical compositions while also developing their communication. Finally, a large part of the related works also present the students perceptions and the pros and cons feedbacks and suggestions (see for example Breitenbucher, 2007; Aebischer et al., 2009; Abdullah et al., 2013). Some authors also discuss the lessons learned both pedagogical and LaTeX-related (Gray and Costanza, 2003) or the problems related to the process of LaTeX learning (Blaga, 2007).

5 CONCLUSIONS

Scientific writing is central to the popularization of science. Nevertheless, technical writing, and mathematical writing in particular, is a complex and difficult task. Generally, the paradigm WYSWYM supports the creation of documents which are beautiful in form as well as content. LaTeX is a powerful typesetting tool which can be used creatively or detrimentally to fulfill the exigences of such a paradigm Hwang (1995). Therefore, in the context of teaching, LaTeX allows the students to be more concerned with the contents and consequently reduce the weight of the formatting tasks increasing the quality of their works. LaTeX being extensible in reason of its numerous packages, it is impossible for an initiation course to give all the functionalities that already exist (Aebischer et al., 2009).

In this paper, we present a methodology to acquire knowledge about Word Processing through the presentation and practice of the language LaTeX and a learning pathway comprising ten blocks with an emphasis on some fundamental notions such as Installation, Simple Commands, Report creation, Figures, Tables, Formulas and Bibliography. A survey was conducted to gather the non-exact science students feedbacks demonstrating a fair acquisition of the method and a high confidence concerning the future return on learning investment. It seems that students were highly motivated to participate in such a discipline, since each block requires some resources and personal time. Many students who took this course showed interests in continuing to use LaTeX for academic or scientific purposes.

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APPENDIX

Questionnaire

The process of developing the questionnaire was done in cooperation with some past students who already have experienced the method. The instrument for assessing the students opinions was 30 items mostly multiple-choice questions (MCQ) and open-ended questionnaire (OEQ). The questionnaire is structured around 8 main sections (Parts) and is divided into relevant sub-sections that briefly details the questions:

Part A. Demographic/Background Information

(a) class (Accounting Sc., Economics, Marketing)
(b) age, gender
(c) programming skills background

Part B. Previous Knowledge

(a) previous skills in LaTeX
(b) previously used text editor/word processor
(c) previously taken course (word processing)

Part C. Self-evaluation Word/LibreOffice

(a) general
(b) generating table of contents
(c) headers/footers
(d) figure with caption and numbering
(e) citations/bibliographic references

Part D. Self-evaluation LaTeX

(a) general
(b) generating table of contents
(c) headers/footers
(d) figure with caption and numbering
(e) citations/bibliographic references

Part E. Perceptions

(a) Perceptions on the opportunity to learn LaTeX
(b) Difficulty level about LaTeX

Part F. Intentions

(a) Intention to continue using LaTeX
(b) Possible future issues to apply LaTeX

Part G. Willingness to use LaTeX

(a) while confronting with the ABNT rules
(b) while writing an ordinary document

Part H. Preferences (End of the Semester)

(a) Microsoft Word/LibreOffice vs. LaTeX
(b) Additional comments