http://www.educacioneningenieria.org

Hidden information in a thesis evaluation rubric: A Civil Engineering case study

Yasmany D. García-Ramírez

Departamento de Ingeniería Civil, Universidad Técnica Particular de Loja, Loja, Ecuador
ydgarcia1@utpl.edu.ec

Abstract— The objective of the reported research was to analyze the information provided by the rubric for evaluating a thesis for a Civil Engineering degree. For this, it selected forty-one thesis reports from 2018-2022 on the Civil Engineering career at the Universidad Técnica Particular de Loja (Ecuador). Surprisingly, the hidden information in the rubric was a bias from the thesis committee and the student's sex. The academic tool also showed limitations in its evaluation criteria, so it must be restructured or recreated. Administrative situations must be modified because is affecting the principle of the rubric. The procedure used can serve as a reference to evaluate other rubrics in similar areas of knowledge. This study shows the biases that can occur in the thesis evaluation tools and are still in use today.

Keywords— thesis, rubric, Civil Engineering degree, bias, hidden information.

Recibido: 15 de noviembre de 2022. Revisado: 30 de enero de 2023. Aceptado: 3 de febrero de 2023.

Información escondida en una rúbrica de evaluación de tesis: Un estudio de caso en Ingeniería Civil

Resumen— El objetivo de este proyecto fue analizar la información que brinda la rúbrica para evaluar una tesis en la carrera de Ingeniería Civil. Para ello, fueron seleccionados 41 informes de tesis del 2018-2022 de la carrera de Ingeniería Civil de la Universidad Técnica Particular de Loja (Ecuador). Sorprendentemente, la información oculta de la rúbrica fue un sesgo para el Comité de Tesis, así como el sexo del estudiante. La herramienta académica también mostró limitaciones en sus criterios de evaluación, por lo que debe ser reestructurada o recreada. Las situaciones administrativas deben modificarse porque están afectando el principio de la rúbrica. El procedimiento utilizado puede servir de referencia para evaluar otras rúbricas en áreas de conocimiento similares. Este estudio muestra los sesgos que se pueden presentar en las herramientas de evaluación de tesis y que aún se encuentran en uso en la actualidad.

Palabras Clave— tesis, rúbrica, carrera de Ingeniería Civil, sesgo, información oculta.

1 Introduction

Universities must pay close attention to the graduation design [1]. This design measures the quality of professional education and the understanding capacity of students [2] under the guidance of experts in the field. The graduation design includes the end activity, such as the thesis or monograph, before students graduate as professionals. Their purpose is to increase their skills in creative thinking, research, development, and communication, among others [3]-[5]. Also, to cultivate their ability to apply the theoretical knowledge and professional skills they have learned to solve practical problems [6], which are necessary for professional practice. The graduation design is complex and requires the joint effort of teachers and students [7], must be improved [8], and must have adequate evaluation tools.

One of these tools is the thesis evaluation rubric. A rubric is an academic tool to make students aware of what is expected, get familiar with criteria, and interpret teacher and peer feedback [9]. There are two types of rubrics: holistic and analytical [10]. Holistic rubrics have a single criterion to assess a student's overall achievement on a specific activity. Analytic rubrics assess students' achievements based on multiple criteria organized in several levels of achievement as columns and assessment as rows. This rubric has the terms 'qualities/criteria' or 'criteria/standards' as headings [11]. Each cell typically contains descriptive text that spells out the characteristics of a particular level or 'standard' for that criterion.

Rubrics have been widely used in civil engineering subjects, but just a few have focused on theses. For example, Prins et al. [9] proposed six criteria based on the APA manual and three levels of achievement (sufficient, good, or points of excellent). The criteria included: a) introduction, b) methods, c) results, d) discussion, e) organization, thesis structure and writing style, and f) process of the thesis according to Hadwin et al. [12]. This rubric met both functions of learning (formative) and measurement (summative). Despite their importance, the academic rubrics have not had the expected boom or the extensive application that they should [13].

In Civil Engineering of the Universidad Técnica Particular de Loja (UTPL), a rubric is being used to assess the thesis document. This instrument is not holistic or analytical, as shown in Table 1. The rubric evaluates two aspects of the thesis: the theoretical/technical and methodological. Each aspect has five criteria with different weight values. The average of those two aspects is the thesis grade. The director of the career designates the thesis committee that assesses the written document and the oral presentation. The committee has three professors: a president, a member, and the thesis director.

The rubric of Table 1 is unclear about the score the committee should assign, for example, in the use of theories and concepts, when the professor should give 30% or 20%. Then the evaluation becomes subjective of the one who evaluates. These criteria do not allow the student to learn either because it is limited to grading the

thesis. Therefore, the objective of this article is to analyze the information provided by the rubric for evaluating a thesis for a Civil Engineering degree in UTPL. For this goal, reports of the thesis committees were randomly selected between 2018 and 2022. Forty-one reports were collected and analyzed.

Table 1
Rubric used to evaluate theses in Civil Engineering at UTPL

Aspects	Weigh (%)
The theoretical-technical aspect	
C1. Use of theories and concepts	30
C2. Abilities, skills expressed, and improvements obtained in techniques, processes, and applications	30
C3. Designs and models presented	20
C4. Use of updated technical references	10
C5. Relevance of the conclusions	10
The methodological aspect	
C6. Structure of the document (title, problem, objectives, theoretical framework, etc.)	20
C7. Methodology used (design, justification of the methodology, instruments, analysis, development, etc.)	25
C8. Bibliographic techniques (citations, notes, references, etc.)	10
C9. Results Obtained (importance of the contributions achieved, relevance, etc.)	25
C10. Presentation (style, clarity, spelling, layout, etc.)	20

Source: Adapted from UTPL [14]

In order to present that analysis, the rest of the document is organized as follows. Chapter 2, on materials and methods, describes the sample selection, the collection of data, and its processing. Then, the results section shows the findings of the thesis committee, the aspects of the rubric, and the influence of the sex student and professor on the thesis grade.

2 Materials and methods

This section presents the details of the experimental plan, from sample selection to data processing.

2.1 Sample selection

The sample selection consisted of a random sample of the theses that finished between 2018-2022 in the Civil Engineering career at UTPL. It chose forty-one documents, where 28 were men and 13 were women, as shown in Table 2. Generally, in this career, there is more man than women. Students generally graduate around 23 years of age. It is necessary to mention that no committee had three men or three women. Civil engineering at this university has 19 men professors and 9 woman professors.

Table 2
Detail of the collected sample in this study

Year	N°	N° men	N° women	N° of graduated students*
2018	12	6	6	66
2019	8	6	2	42
2020	8	6	2	55
2021	8	5	3	82
2022	5	5	0	18
Total	41	28	13	263

Source: García-Ramírez and Segarra [15]

2.2 Data collection

The director approved the thesis before submitting it to the secretariat of the career. This dependency sent the document to the thesis committee and gave them 15 days to write a report. This committee has a president, a member, and the director who directed the thesis. The president requests the thesis grades from the other professors through an online document. Generally, the president is the one who grades first, and after them, the rest of the committee. A report was drawn up with their average and signed by the professors. It delivered this document to the secretariat of the career; so the student could perform their oral presentation.

2.3 Data processing

A first analysis was performed between the scores of the two aspects of the rubric for each professor. It employed scatterplots and boxplots, and descriptive statistics. A second analysis was performed between the evaluated aspects and the final grade of the thesis. Stepwise linear regression analysis and linear regression were used in this evaluation. Finally, a third analysis compared the sex of the professors of the committee and the sex of the student. It estimated the averages of the grades by sex of the student. Then their value was compared with the sex of the professor. Minitab 14 [16] was used in all these calculations.

3 Results

This section presents the results organized into three sections: committee, criteria of the rubric, and by sex student/professor.

3.1 Committee grades

One of the first analyzes carried out was the matrix plot of the results of the theoretical-technical aspect among the committee, as seen in Fig. 1. A regression line was also placed in this matrix to analyze the data trends. The slope of that line is higher between the grades of the president and the member than between the president and the director. It is interesting to observe that the values between the president and the member are similar and distributed, unlike the director, who has higher values close to the maximum.

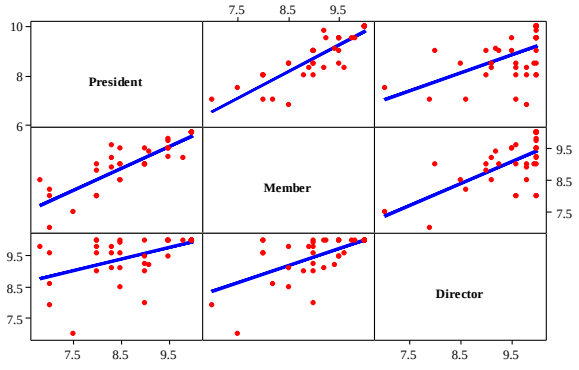

Figure 1. Matriz plot of the theoretical-technical aspect of the rubric under analysis

A similar analysis was developed for the methodological aspect (*See 2*). In Fig. 2 the trend found between the president and member

is the same; however, the director has a distribution much more similar to the rest of the committee and is not biased towards the maximum score. So, in this case, the principal source of variation in assessments among professors will be the theoretical-technical aspect. Considering this bias, it is necessary to reconsider all the dimensions of the evaluation rubric.

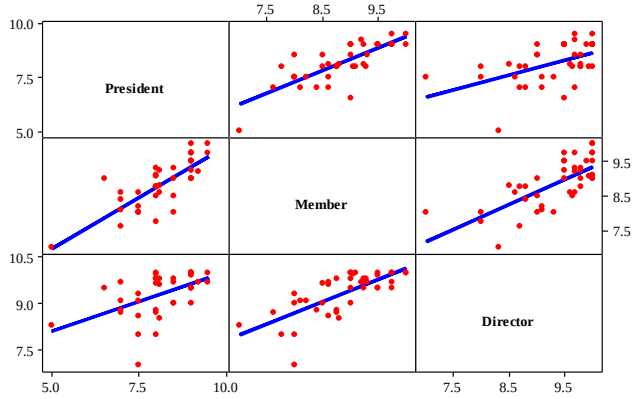

Figure 2. Matriz plot of the methodological aspect of the rubric under analysis

Due to this possible bias, it has drawn a boxplot (see Fig. 3) with the final grades for each professor on the committee. This figure shows that the director's scores are higher than the rest of the professors. Likewise, the president grades with lower scores, and the member gives intermediate values. Regarding scattering, the director has less dispersion than the rest, while the president has the highest dispersion; and the member, again, is in an intermediate zone.

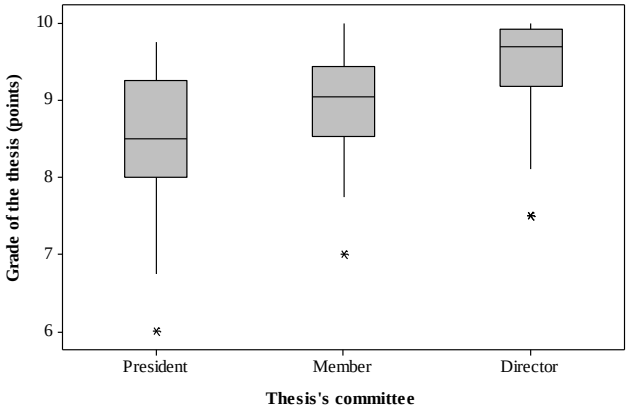

Figure 3. Boxplot of the thesis's grades of the committee using the rubric in analysis

Based on the results in Fig. 3, a Student's t-test was performed to check the differences statistically. The results can be seen in Table 3. The p-values are less than 0.05, which means there is a significant difference between the grades given by the professors of the committee. This lack of objectivity may be due to the rubric criteria, the role in the committee, local culture, or a combination of all these factors. The main result is that the director should not be part of the thesis delegation since their evaluation is not objective. The director systematically assigns higher grades than the rest of the professors.

On the other hand, the evaluations between the presidents and members are similar. This trend may be due to the way grades are shared in the committee. A professor initially assigns their grade. The second instructor can see this grade and assigns their own.

Table 3
Detail of the Student's t-test results comparing the data of the grades of the professors in the 41 data collected

Variable	Mean	StDev	SE Mean	95% CI	T	P
President versus director						
Director	0,944	0,066	0,010	(0,923, 0,965)	-8,80	0,000
Member versus director						
Member	0,900	0,066	0,010	(0,879, 0,921)	-4,23	0,000
Member versus president						
President	0,853	0,086	0,013	(0,825, 0,880)	-3,53	0,001

Watching other preview grades could impact the grades of the second evaluator. This bias is quite similar to the anchoring effect, which is highly documented and proven [17]. For example, the first evaluator can place 10 points on a certain criterion, and the second evaluator thinks that this criterion is not very well developed, so it deserves a score of 6 points. However, seeing a score of 10 gives a grade of 8 points. The second evaluator doubts their score and offers one that is closer to the given in the first order. This particular behavior should be evaluated and deepened in future works. Given this evidence, the procedure should change to a new one and be free of subjectivity.

3.2 Criteria of the rubric

It calculated the correlation matrix of the aspects that were evaluated in the rubric to analyze the criteria (C) (see Table 4). In this table, the relationships whose p-value were less than 0.01 have in bold. Almost all criteria in this matrix, except C3-C4, have a positive correlation. That is, when one criterion is high, the other one will be also high. This trend is consistent because a good thesis will receive good grades in most aspects and vice versa. However, the most significant correlations (P-value < 0,01), especially those with values greater than 0,5, could be merged, rewritten, or undergo further analysis. For example, C3 (the designs and models presented) may be similar to C7 (the used methodology used), whose correlation is statistically significant. It is as interesting that C10, regarding the written part of the document, is correlated with six criteria. Also, C7 and C9 have similar behavior.

Table 4
Correlation matrix between criteria of the rubric

C	C1	C2	C3	C4	C5	C6	C7	C8	C9
C2	**0,31**	1,00	*	*	*	*	*	*	*
C3	**0,41**	**0,41**	1,00	*	*	*	*	*	*
C4	0,10	0,12	-0,05	1,00	*	*	*	*	*
C5	0,20	0,16	0,12	**0,44**	1,00	*	*	*	*
C6	0,22	0,21	0,20	0,21	**0,52**	1,00	*	*	*
C7	**0,56**	**0,49**	**0,45**	0,07	**0,39**	**0,37**	1,00	*	*
C8	0,05	0,14	**0,25**	0,15	**0,24**	**0,29**	0,19	1,00	*
C9	**0,38**	**0,52**	**0,50**	0,04	0,12	0,16	**0,52**	0,12	1,00
C10	**0,34**	**0,30**	**0,36**	0,18	**0,26**	**0,39**	0,23	**0,37**	0,07

C: criterion of the rubric under study, P-value < 0,01 are in black, * Equal value than the lower triangle

Considering the previous found, a regression analysis was performed between the final result and the criteria. It calibrated the equation using the Minitab Stepwise option [16], so the result was the eq. 1. This equation is only for reference and is employed to check whether or not the rubric is reliable.

$$FS = 1{,}14 + 0{,}37\,C7 + 0{,}28\,C9 + 0{,}22\,C10 \quad (1)$$

Where: FS = Final thesis' grade, C7/9/10: score of criterion 7, 9, and 10, respectively. Eq. 1 had an adjusted R^2 of 0,84, which means that responding only to criteria 7, 9, and 10, would already have a value close to the final grade of the committee. The results of eq. 1 can be seen in Fig. 4. Based on these results, again the criteria of this rubric should be redone.

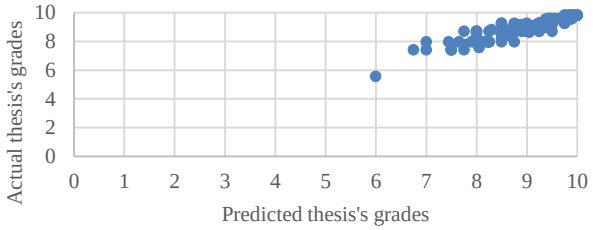

Figure 4. Comparison of actual final grades versus the use of eq. 1

3.3 Sex student/professor

Finally, an analysis was made between the sex of the students and the sex of the committee professors. Table 5 shows the assigned average grades. In this table, students have been split by sex. Also, it calculated the grades difference between the students. As a result, women receive a higher score, almost systematically, in all criteria. They got high scores not only from male evaluators but also from female professors. It is worth mentioning that male instructors assign higher scores than female teachers. For both students, females receive lower scores on criteria C4 and C9. C4 is related to the previous updated literature, and C9 is to the relevance of the results. The latter could be studied in depth in the future.

Table 5
Average grades thesis assigned to the students by the professors' committee

	Male professor			Female professor		
C	Male student	Female student	Dif. (points)	Male student	Female student	Dif. (points)
C1	8,5	9,1	0,6	9,4	9,7	0,2
C2	9,0	9,8	0,8	9,6	9,8	0,3
C3	8,5	9,3	0,8	9,0	9,8	0,8
C4	9,3	8,9	-0,4	9,7	9,3	-0,4
C5	8,6	9,3	0,7	9,1	9,9	0,8
C6	8,9	9,5	0,6	9,5	9,9	0,4
C7	6,3	7,0	0,7	7,8	8,6	0,8
C8	9,3	9,9	0,6	9,7	10,0	0,3
C9	7,1	7,0	-0,1	8,3	8,2	-0,1
C10	8,7	9,3	0,6	9,4	9,7	0,4
TTA	8,6	9,0	0,3	9,3	9,6	0,2
MA	8,3	8,7	0,4	9,1	9,4	0,3
Total	8,5	8,9	0,4	9,2	9,5	0,3

C: criterion of the rubric under study, TTA: Theoretical - technical aspect, MA: Methodological aspect, Total: Both aspects

On the other hand, in the final grades, female students receive 0,4 points more than male students for male professors and 0,3 points more for female professors. Based on these results, it is appropriate to mention that the criteria evaluated by this rubric are not impartial; therefore, a new rubric should be proposed.

4 Conclusions

The rubric analyzed must be modified to avoid the bias of the committee either by its designation or by the sex of the student. Likewise, the criteria must be recreated since it is enough three of them to assign the final grade with enough precision. The rubric should meet the standards of an analytical rubric to serve as a reference for student learning and allow for proper assessment by the committee.

On the other hand, from the regulations, the career director must exclude the director of the thesis from the committee since the director's bias causes the grade to increase. Also, it should find another alternative to request the thesis grades, to avoid the anchor effect of those who have placed the grades first.

This article has its scope. The study focused on a single university in the country. Also, there were not the same number of male students as females. Likewise, the number of data collected was few despite having several years recorded. Despite this scope, the study shows the biases that can occur in the thesis evaluation tools and are still in use today. Finally, the work showed some biases, hidden in the information of the rubric, that can be evaluated in technical careers.

References

[1] L. Suolan, L. Kong, and H. Juan, "Research on improving graduation design of engineering majors," in *3rd International Conference on Science and Social Research*, 2014. doi: https://doi.org/10.2991/icssr-14.2014.89.

[2] X. Liu, P. Du, S. Wu, and Y. Hao, "Teaching reform and exploration of graduation design for civil engineering," *IOP Conf Ser Earth Environ Sci*, vol. 580, no. 1, 2020, doi: 10.1088/1755-1315/580/1/012082.

[3] ASCE, *The Vision for Civil Engineering in 2025*. Virginia, 2007. doi: https://doi.org/10.1061/9780784478868.001.

[4] R. Rustum, O. Aga, I. Abdel-Magid, R. Bero, A. B. S. Hariri, and F. Q. Faris, "Development of Environmental Engineering Curriculum: A Case Study From University Of Dammam ," *International Journal of Educational Studies*, vol. 1, no. 3, pp. 125-137, 2014, [Online]. Available: https://journals.esciencepress.net/index.php/IJES/article/view/342

[5] L. Zhenhua, C. Ying, Z. Yumin, D. Jianbo, and Z. Xiyu, "Reform and Practice of Talents Cultivation mode for Civil Engineering," in *7th International Conference on Social Network, Communication and Education (SNCE 2017)*, 2017, pp. 273-276. doi: 10.2991/SNCE-17.2017.55.

[6] J. He and J. You, "Problems and Suggestions in the Graduation Design of Private Undergraduate Colleges," in *Proceedings of the 2020 International Conference on Social Sciences and Big Data Application*, 2020, pp. 10-14. doi: 10.2991/ASSEHR.K.201030.003.

[7] Q. He, "Research on Teaching Reform and Innovation of the Graduation Design of Civil Engineering Major," in *2nd International Conference on Education & Education Research*, 2017. doi: doi.org/10.25236/eduer.2017.021.

[8] Y. Liu, B. Du, and J. Huan, "Reform designing of the civil engineering graduate design program," in *Conference on*

Education Technology and Management Science (ICETMS 2013), 2013, pp. 610-612. doi: 10.2991/ICETMS.2013.167.
[9] F. J. Prins, R. de Kleijn, and J. van Tartwijk, "Students' use of a rubric for research theses," *Assess Eval High Educ*, vol. 42, no. 1, pp. 128-150, 2015, doi: 10.1080/02602938.2015.1085954.
[10] N. Muhammad Noh, M. Raizamzamani Md Zain, Y. Sahol Hamid, I. Akmar Abu Bakar, and M. Mohamad, "Analytic Rubric in Evaluating the Continuous Assessment in Projects of Civil Engineering Undergraduate Students in Dynamics Subject," *Asian Journal of University Education (AJUE)*, vol. 17, no. 4, pp. 352-366, 2021, doi: doi.org/10.24191/ajue.v17i4.16221.
[11] D. R. Sadler, "Indeterminacy in the use of preset criteria for assessment and grading," *Assess Eval High Educ*, vol. 34, no. 2, pp. 159-179, 2009, doi: 10.1080/02602930801956059.
[12] A. F. Hadwin, L. Wozney, and O. Pontin, "Scaffolding the Appropriation of Self-regulatory Activity: A Socio-cultural Analysis of Changes in Teacher–student Discourse about a Graduate Research Portfolio," *Instr Sci*, vol. 33, no. 5, pp. 413-450, 2005, doi: 10.1007/S11251-005-1274-7.
[13] G. A. Torres Díaz, J. T. Perea Valencia, D. M. García Leyva, and S. M. de la Hoz Escorcia, "Atributos didácticos de las rúbricas en la formación del ingeniero civil: una mirada desde la estática," *Rev Cienc Soc*, vol. 28, no. 1, pp. 202-215, 2022, [Online]. Available: https://dialnet.unirioja.es/servlet/articulo?codigo=8297219
[14] UTPL, "Rúbrica para las tesis en ingeniería Civil," 2015. [Online]. Available: https://utpl-my.sharepoint.com/:w:/g/personal/ydgarcia1_utpl_edu_ec/ET0LTYPrV5pBsmxxt5Qs5voBhe-KH5eamxEfLXeuJDtWIg?e=zqMbiV
[15] Y. García-Ramírez and S. Segarra-Morales, "Improving the degree design of the civil engineering career," *HUMAN REVIEW. International Humanities Review / Revista Internacional de Humanidades*, vol. 11, no. Monográfico, pp. 1–13, 2022, doi: 10.37467/REVHUMAN.V11.3833.
[16] State College, "Minitab 14.2 Statistical Software [Computer program]." PA: Minitab, Inc., 2005. [Online]. Available: www.minitab.com
[17] D. Kahneman, *Thinking, fast and slow*. Straus and Giroux, 2011.

Y.D. García-Ramírez is a Civil Engineer from the Universidad Técnica Particular de Loja - UTPL (Ecuador) in 2006. Specialist in Mountain Road Engineering from the National University of San Juan - UNSJ (Argentina) in 2009. Doctor in Civil Engineering from UNSJ (Argentina) in 2014. He is an associate professor at UTPL (Ecuador) in highway design subjects at the undergraduate and postgraduate levels. He is currently director of the master's degree in Civil Engineering with a mention in mountain roads at the same university. He has over 40 publications including books, journals, and conferences related to highways and civil engineering education.
ORCID: https://orcid.org/0000-0002-0250-5155