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Influence of Belbin's Role on Database Design: An Exploratory Experiment

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Abstract. Software process has been studied from various perspectives, among them, the human factor is one of the most important due to the intrinsic social aspect of the discipline. This study aims to explore the benefits of using Belbin's role theory in tasks —team and individual— related to the software development process, particularly in Database Design (DB) Design. In this paper two controlled experiments with students are presented. In the first experiment integrated teams with compatible roles identified in the students and teams integrated through a traditional strategy were compared, during the task of DB conceptual design. In the second experiment, individual students were the experimental subjects, the performance of the Belbin roles identified in them were compared, in the task of the DB logical design. The dependent variables in both experiments were the effort in the task, and the quality of the generated design. Results in the first experiment did not show significant differences in both variables, a possible limitation was the complexity of the task. The second experiment also did not show significant differences in the effort variable; however, in the variable related to the quality of the logical design, the monitor-evaluator role presented significant differences when compared with the other six identified roles; these results are consistent with previous studies identified in the literature. We plan to continue experimenting with other tasks in order to get a deeper understanding of applying the Belbin's theory in software process to accumulate experiences.

Keywords: software process; human factor; Belbin's roles; database design, quality

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Влияние ролей Белбина на дизайн базы данных: исследовательский эксперимент

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Аннотация. Программный процесс изучался с различных точек зрения, среди которых человеческий фактор является одним из наиболее важных в связи с присутствующим социальным аспектом. Это исследование направлено на изучение преимуществ использования ролевой теории Белбина в задачах – командных и индивидуальных, – связанных с процессом разработки программного обеспечения, особенно в проектировании баз данных (БД). В этой статье представлены два контролируемых эксперимента с участием студентов. В первом эксперименте сравнивались интегрированные команды с совместимыми ролями, определенными у студентов, и команды, интегрированные с помощью традиционной стратегии, во время решения задачи концептуального проектирования БД. Во втором эксперименте испытуемыми выступали отдельные студенты, и сравнивалиось выполнение выявленных у них ролей Белбина в задаче логического проектирования БД. Зависимыми переменными в обоих экспериментах были трудозатраты при выполнении задачи и качество созданного дизайна. Результаты в первом эксперименте не показали существенных различий по обеим переменным, возможным ограничением была сложность задачи. Второй эксперимент также не показал существенных различий в переменной трудозатрат; однако в переменной, связанной с качеством логического плана, роль наблюдателя-оценщика показала значительные отличия по сравнению с другими шестью идентифицированными ролями; эти результаты согласуются с предыдущими исследованиями, указанными в литературе. Мы планируем продолжить эксперименты с другими задачами, чтобы получить более глубокое понимание применения теории Белбина в программном процессе для накопления опыта.

Ключевые слова: процесс разработки программного обеспечения; человеческий фактор; роли Белбина; дизайн базы данных, качество

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1. Introduction

The study of development and management processes in Software Engineering (SE) has been developed considering various variables; however, the social aspect, intrinsic to this discipline highlights the human factor as a research topic [1]. In a recent article about the software process improvement, a categorization of the human factor is proposed [2]; where each team member should present a commitment with the assigned task according to his/her role, that is their responsibilities role. Even though, the role tasks achievement can be analyzed from an individual point of view, we have to consider that many tasks or activities are performed in a development team context. In [3] the author pointed out that the formation of a software development team is not an accident, but a complex process in which the team members establish work relations, get agreements on the project goals, and determine their functions as part of the team.

The knowledge and technical skills with which an individual contributes to the organization, according to his/her position, is the well-known functional role. On the other hand, the behavior of an individual in interrelation with colleagues is another type of role known as team role, a role with not direct association with the required skills for a particular task at hand. However, the team role absence or presence has a significant influence in the project and the team success [4].

The purpose of this study is to explore whether Belbin's role theory can be useful to the manager of a software project, in the assigning the right personnel to tasks that are developed both as a team and individually. For its empirical validation, the study is contextualized in tasks related to the design process of a database.

The following section presents the theoretical framework that supports Belbin's role theory, as well as the process of designing a database. Section three presents a controlled experiment carried out with teams of students —as experimental subjects— in the conceptual design task of a database. The fourth section describes a second experiment, in this case, with individuals as experimental subjects in the logical design task of a database. Finally, section five presents the conclusions of the empirical study, as well as future work identified by the researchers.

2. Background

Among team role studies, the Belbin work [5, 6] is well-known among consultors and researchers, mainly because this theory offers a mechanism to identify the primary role a person can assume in a team, according to his/her behavior, as well as a balance and compatibility approach among team roles.

In SE, there are studies that underpin the Belbin team roles theory to explore benefits for the software development process and the software products [7]. Most of those studies are based on the software development team formation as an alternative to get compatible roles [8, 9]. A second group of studies are focus on individual task performance [10, 11].

It should be noted that the authors have carried out a set of linked experiments in recent years, both with development tasks [12, 13] and software management [14, 15].

2.1 Belbin team roles theory

The Belbin roles proposal presents three role categories: action oriented roles: Sharper, Implementer, and Completer/Finisher; person oriented roles: Chairman, Resource/Investigator, and Teamworker; and cognitive oriented or mental roles: Plant, Monitor/Evaluator, and Specialist [3]. In addition to this classification, the Belbin offers some identification mechanisms for the primary role a person can assume in a team, accordingly to that person behavior. We believe that the Belbin theory main contribution is the analysis of the interaction among roles, towards inside the team [16].

2.2 Database design task

The database design process, as part of an information system, is typically conceived as an abstraction process with different representation levels. According to [17] the most consensual process has three stages, and therefore, three representation levels: conceptual design, logical design, and physical design.

A database design has its origin in the data requirements specified in the requirement software development phase, which are transformed to a first level of abstraction – conceptual design – in which are represented the information resources of the organization, regardless the users or the applications. The most recognized data model for such abstraction is the Entity/Relation Model, based on the real world perception, with objects called entities and the relations among those entities [18].

A second level abstraction aims to transform the conceptual model by adapting it to the data model that supports the Database Management System (DBMS) that will be used for implementation — Logical Design.

In the twentieth century the relational systems dominated the market, and that is why it was selected for the second phase of the process; this model is fundamental for the modern DB technology [19]. It deals with three main information aspects: the data structure, the data manipulation, and the data integrity. The database relational model is based on the mathematical theory of relations, and data is logically structured in a relation represented as a table. Because the Entity/Relation and the Relational models share the same design basic principles, it is possible to apply a set of derived rules that allow transforming the conceptual model to a logical relational model [20].

Finally, the physical design has the purpose of the implementation, as efficiently as possible, of the logical model. For this process, the DBMS sub-language data definition is used.

3. Method for Experiment 1

One of the most used empirical methodologies in the field of SE is experimentation, specifically, experimentation in controlled environments [21]. This methodology helps us to identify and, when appropriate, to understand the possible relationships between factors and dependent variables, both parameters involved in software process. Among the characteristic elements of the controlled studies found in the literature, the use of groups of students as experimental subjects stands out. In [22] the authors indicate that this academic sample allows the researcher to obtain preliminary evidence to confirm or refute hypotheses that can be later contrasted in industrial contexts. The first experiment aims to explore, through the execution of a controlled experiment with students, the influence of the use of Belbin's Theory in the integration of development teams with members who present compatible roles, on the task of Database Conceptual Design.

3.1 Planning

In accordance with the purpose of our study, this experiment aims to comparing metrics related to the quality of the Database Conceptual Design, using integrated teams with Compatible Team (CT), as well as randomly integrated or Traditional Team (TT).

The first pair of statistical hypotheses uses as the dependent variable, a metric related to the software product, the quality of the Database Conceptual Design.

- H_{01}: The mean of the conceptual designs quality (CDQ) generated by the CT is the same as the mean of the quality of the conceptual designs generated by the TT.
- H_{11}: The mean of conceptual designs quality (CDQ) generated by the CT differs from the mean of the quality of the conceptual designs generated by the TT.

A second pair of statistical hypotheses were generated considering effort as the dependent variable, a metric related to the process of Database Conceptual Design.

- H_{02}: The mean of the effort invested by the CT is the same as the mean of the effort made by the TT in the Database Conceptual Design task.
- H_{12}: The mean of the effort made by the CT differs from the mean of the effort made by the TT in the Database Conceptual Design task.

For our study, factorial design with a source of variation, and two treatments for each of the two dependent variables is an appropriate experimental design.

3.2 Execution

The convenience sample used for the experiment consisted of 34 students who participated voluntarily, from the Software Engineering program of the Autonomous University of Yucatan. The participants were enrolled in the subject “Experimentation in Software Engineering” during the August-December 2019 semester. With this group of student volunteers, 17 development teams – experimental subjects – were formed, of which 8 teams were integrated with compatible roles (CT:

Compatible Teams) and the remaining 9 – control teams – randomly or traditionally (TT: Traditional Teams).

At the beginning of the experimental session, the requirements specification document was delivered and read, clarifying doubts regarding the specifications; requested to record the start time of the task. Likewise, instructions were given so that the teams, at the end of the task, record the time of completion, digitize the model and upload the generated Conceptual Model to the Institutional Learning Management System.

Table 1 illustrates the assignment of the teams to the treatments, as well as the data collected through the experiment.

Table 1. Data obtained in the first experiment

Team	Treatment	CDQ	Effort
I	CT	1.86	51
II	CT	1.25	41
III	CT	1.62	39
IV	CT	1.50	40
V	CT	1.56	42
VI	CT	1.42	39
VII	CT	1.47	30
VIII	CT	1.78	53
IX	TT	1.57	17
X	TT	2.32	42
XII	TT	1.62	38
XII	TT	1.31	33
XIII	TT	1.58	54
XIV	TT	1.89	39
XV	TT	1.51	51
XVI	TT	2.29	47
XVII	TT	1.58	38

3.3 Analysis

A descriptive and inferential statistical analysis was carried out with the information collected, using the statistical software "Statgraphics" to describe the behavior of the data, as well as to evaluate the statistical hypotheses previously defined.

Tables 2 and 3 present some of the most important measures of central tendency and variability for the dependent variables Conceptual Design Quality (CDQ) and Effort.

Table 2. Statistical summary to the CDQ variable

Treatment	#	μ	Median	Ơ
CT	8	1.5575	1.53	0.19616
TT	9	1.7411	1.58	0.35243

Table 3. Statistical summary to the effort variable

Treatment	#	μ	Median	Ơ
CT	8	41.875	40.5	7.25923
TT	9	39.888	39.0	10.9367

In order to visually compare the two treatments, boxplots were generated to analyze the dispersion and symmetry of both data sets. In Fig. 1 we can observe a lot of similarity in both treatments, from which there seems to be no difference for the Effort variable. In case of the CDQ variable, although the CT presented a more symmetric behavior, a visual difference cannot be distinguished with respect to the TT (see Fig. 2).

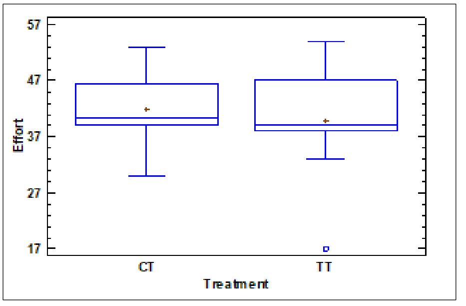

Fig. 1. Box plot for the Effort variable

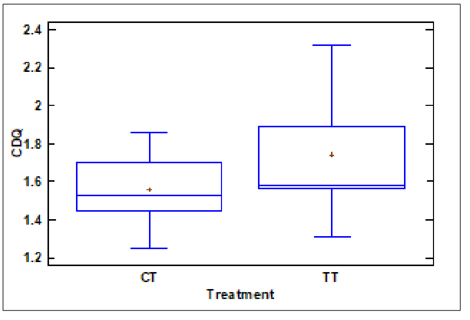

Fig. 2. Box plot for the CDQ variable

For the inferential analysis, the one-way analysis of variance was chosen, because it allows performing hypothesis tests to determine whether or not there are significant differences between the means of the values collected in the dependent variable. The analysis of variance [23] is a technique to build a statistical model that describes the impact of a single categorical factor on a dependent variable. The result of the ANOVA evaluation is illustrated in Table 4.

Table 4. ANOVA result for dependent variables

Dependent variable	**F**	**p-value**
CDQ	1.70	0.2125
Effort	0.19	0.6699

In both variables, the p-value of the F test is greater than 0.05, therefore, the null hypotheses H01 and H02 cannot be rejected; that is, in both cases there are no statistically significant differences between the means of the two treatments.

3.4 Model validation

It is important to mention that the ANOVA model has three associated assumptions that must be validated [23]. The assumptions of the model are: (1) experimental errors of its data are normally distributed, (2) there is no difference between the variance of the treatments, and (3) there is independence between the samples. The three assumptions were validated.

3.5 Results

Once the ANOVA model was validated, the results of the experiment showed that it was not possible to demonstrate the existence of significant differences, although on average the TC presents slightly lower metrics in the CDQ, and the values obtained from the TT show greater variability. In the case of the effort variable, the behavior of the data was similar in both treatments, so the null difference between them was verified with the analysis of variance.

4. Method for Experiment 2

The second controlled experiment was contextualized in a task performed individually; The experiment intends to explore the influence of Belbin's role —identified in the student— in the Database Logical Design task.

4.1 Planning

The factor considered in the study is defined as the role played by the subject in the Database Logical Design task. Nine treatments are identified, which correspond to the nine team roles proposed by Belbin. The first pair of hypotheses uses as dependent variable, a metric related to the Database Logical Design Quality (LDQ) generated by students.

- H_{01}: The means regarding the LDQ generated by each of the roles do not present differences.
- H_{11}: The means regarding the LDQ quality generated by each of the roles, differ in at least a two of them.

The second pair of hypotheses uses as dependent variable, the effort to complete the individual task of generating Database Logical Design.

- H_{02}: The effort made to generate the Database Logical Design for each of the roles does not present significant differences.
- H_{12}: The effort made to generate the Database Logical Design for each of the roles shows significant differences in at least one pair of them.

To evaluate the LDQ, Correctness as a factor was selected [24]. Regarding the second dependent variable Effort, operationally the Time – in minutes – used by a student to complete the task will be considered. In this case, it will be obtained through the difference between the task end time and the task start time. Factorial design with one source of variation, and nine treatments for each of the two dependent variables is the most appropriate experimental design for our study.

4.2 Execution

The convenience sample consisted of 33 of the 34 student volunteers who participated in the first experiment, one of the students reported sick for the second experimental session. All the students completed the self-perception instrument proposed by Belbin [5], in order to identify —by the researcher— their main role, thus ruling out that said information could represent a distractor in the execution of the experiment. It should be noted that this instrument does not include the role of Specialist, and in the case of the sample, no student was identified with the role of Resource Researcher.

Table 5 presents the total sample of the 33 experimental subjects distributed in the seven resulting treatments. For the analysis of the LDQ variable, three products were discarded because the digital files were not clear for their analysis. Likewise, for the Effort variable, two subjects with chairman role did not record the completion time of the task, so they were not considered.

Table 5. Sample for the second experiment

Treatment	Sample (#)		
	Treatment	**LDQ**	**Effort**
Plant	2	2	2
Teamworker	4	3	4
Chairman	4	4	2
Completer Finisher	8	7	8
Implementer	5	4	5
Sharper	5	5	5
Monitor Evaluator	5	5	5
Total	*33*	*30*	*31*

Prior to the execution of the experiment, a session was dedicated as a review of the subject related to Database Logical Design, studied in a subject from the immediately prior semester to the one the students were studying.

During the experimental session, the Database Conceptual Design was delivered, doubts about the model were clarified, and it was requested for them to record the start time of the task. Instructions were also given so that the subjects, at the end of the task, record the completion time, digitize the model and upload the generated Logical Model to the institutional Learning Management System.

At the end of the session, the experimental subjects delivered the designed logic model, these documents were the experimental objects used for the experimental analysis phase.

4.3 Analysis

As in experiment 1, a descriptive and inferential statistical analysis was performed with the information collected to describe the behavior of the data, as well as to evaluate the statistical hypotheses previously raised.

Table 6 presents some of the most important measures of central tendency and variability for the LDQ variable. We can see that the Monitor-Evaluator role presents the highest mean and, after the Plant role, it is the second treatment with the least variability. It is worth mentioning that both roles are classified as mental.

Table 6. Statistical summary to the LDQ variable.

Treatment	#	μ	Median	Ơ
Plant	2	0.6489	0.6489	0.0272
Teamworker	3	0.6857	0.6667	0.1406
Chairman	4	0.7295	0.7253	0.1030
C-F	7	0.6920	0.6296	0.1235
Implementer	4	0.6172	0.6142	0.0400
Sharper	5	0.7574	0.8009	0.1483
M-E	5	0.9484	0.9506	0.0369

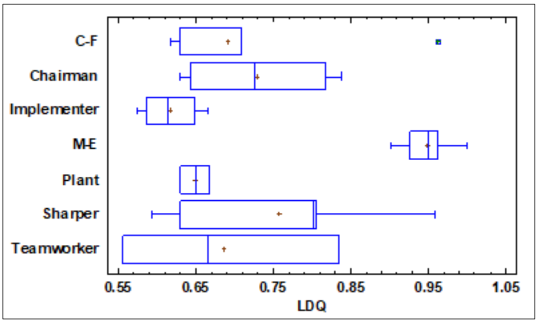

Fig. 3. Box plot for the LDQ variable

To visually analyze the behavior of the data, we generated a box plot. In Fig. 3, we can see the outdated behavior of the Monitor-Evaluator treatment data; this leads us to think that there is a possible difference with the other six treatments.

Table 7 lists some of the most important measures of central tendency and variability for the Effort variable.

Table 7. Statistical summary to the effort variable

Treatment	**#**	**µ**	**Median**	**Ơ**
Plant	2	14.0	14.0	5.6568
Teamworker	4	22.75	22.0	5.4390
Chairman	2	20.0	20.0	1.4142
C-F	8	19.37	18.9	4.8384
Implementer	5	15.6	15.0	3.5071
Sharper	5	15.4	13.0	4.8270
M-E	5	19.4	20.0	3.0495

We can observe that the social roles Teamworker and Chairman are those with the greatest effort in the task, being the Chairman the role with the least variability among the seven treatments. We also observed that the increased time allocated for the task occupied only one third of the time planned for the task.

The box plot in Fig. 4 illustrates the behavior of the treatments for the effort variable; visual analysis does not allow to identify significant difference in any subset of treatments.

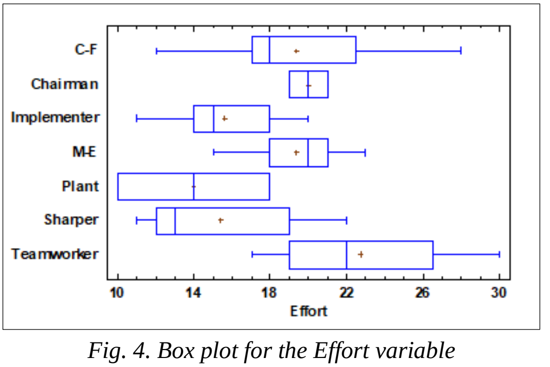

Fig. 4. Box plot for the Effort variable

In order to statistically evaluate the differences between the treatments of the LDQ and Effort variables, the one-way Analysis of Variance was applied. The result of evaluating the ANOVA is illustrated in Table 8.

Table 8. ANOVA result for dependent variables

Dependent variable	F	p-value
LDQ	4.49	0.0030*
Effort	1.85	0.1314

In the case of the LDQ variable, the p-value of the F test is less than 0.05; therefore, the null hypotheses H01 can be rejected. That is, we can affirm that there are at least one pair of treatments that present statistically significant differences between their means, with a 5% significance.

To identify which of the treatments are different, we generate the graph of means with confidence intervals according to the LSD test, which is illustrated in Fig. 5. This graph allows a visual and statistical comparison of the means of the treatments. As we can see, it seems that the only treatment that presents a lag with respect to the other six treatments is the one corresponding to the Monitor-Evaluator role.

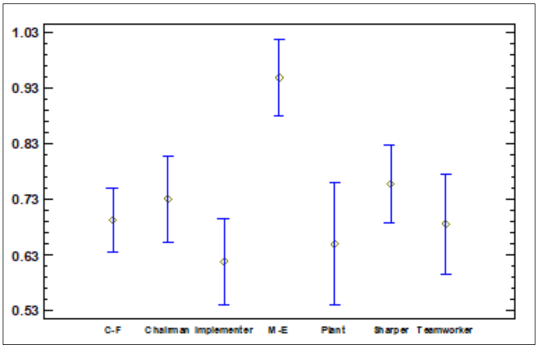

Fig. 5. Means plot for LDQ variable

The multiple-range test for the quality variable, using the LSD method, shows differences between six pairs of treatments, as illustrated in Table 9. This analysis matches with the visual analysis in Fig. 5.

Table 9. Multiple range test for LDQ variable

Contrast	Sig.	Difference	+/- Limits
Plant - ME	*	-0.299537	0.184751
Teamworker - ME	*	-0.262757	0.161264
Chairman - ME	*	-0.218904	0.14813
CF - ME	*	-0.256437	0.129299
Implementer - ME	*	-0.331173	0.14813
Sharper - MA	*	-0.191049	0.139658

In the case of the Effort variable, the p-value of the F test is greater than 0.05; therefore, we should reject the null hypothesis H_{02}. That is, we can affirm that there is no evidence, with a 5% significance, of differences between the means of the treatments.

4.4 Model validation

To correctly interpret what was obtained in the statistical analysis, the three assumptions of the ANOVA model were validated and we can affirm that the comments derived from Table 9 are valid.

4.5 Results

With the controlled experiment we found that for the LDQ variable, the Monitor Evaluator role presents significant differences, with a degree of better quality than the other six treatments (roles). On the other hand, for the task effort variable, the treatments did not show significant differences.

5. Conclusions and Future Work

This study aims to explore the influence of Belbin's role theory on tasks —team and individual— related to software development, particularly to Database Design.

In a first controlled experiment, the Conceptual Design Quality (CDQ) and the effort required for the aforementioned task were considered as dependent variables, such as treatments, integrated development teams based on Belbin's theory, and randomly integrated teams – called traditional equipment. The treatments did not show significant differences in both variables. With what was observed in the experiment raises the question if the task might not require the work of a team, but rather being designed as an individual task.

The second experiment, derived from reflection on the results obtained in the first, considered as dependent variables the Logical Design Quality (LDQ) and the effort required for the aforementioned individual task; the treatments considered in the study were the seven team roles identified in the participating experimental subjects, with the purpose of identifying if there is a particular role better for the task. The results of the experiment allowed to identify that the Evaluator Monitor role presented significant differences in the Logical Design Quality variable, having obtained a better quality degree than the other six participating roles in the experiment.

It is pertinent to comment that the Evaluating Monitor role is one of the two mental roles identified in the experiment. This result partially coincides with the results reported in [10] in the sense that it is one of the three identified roles – Specialist, Monitor-Evaluator and Finalizer – with a good contribution performance to the design task. It also coincides with what was commented in [7], regarding the fact that it is one of the two roles – Plant and Monitor-Evaluator – that present preference for the design phase. In the case of the effort variable, although the Plant role presented an average of lower time required for the task, the ANOVA did not identify significant differences in at least one pair of roles; possibly the task was not complex enough to require longer dedication times. This not allowed us to observe differences in the effort required between the participating roles.

With the results obtained in this study, the authors propose to continue with the development of controlled experiments in other tasks related to the software process, in order to generate knowledge about possible relationships between types of tasks and roles with better performance in them. In the case of database design, the lessons learned in both experiments, particularly in the first one (the team performance), make it possible to identify as future work, considering Database Design as an entire task – Conceptual Design, Logical Design and Physical Design – to explore the influence of Belbin's theory on development teams. This task is more complex, requires a longer period of development, and even within teams, it would allow mixing individual and team activities to achieve it.

References

[1] Juristo N., Moreno A. Basics of Software Engineering Experimentation. Kluwer Academic Publishers, 2001, 418 p.

[2] Morales N., Vega V. Factores Humanos y la Mejora de Procesos de Software. Propuesta inicial de un catálogo que guíe su gestión. Revista Ibérica de Sistemas y Tecnologías de Información, issue 29, 2018, pp. 30-42 (in Spanish).

[3] Humphrey W. Introduction to the Team Software Process. Addison Wesley, 2000, 463 p.

[4] Senior B. Team roles & Team performance: Is there 'really' a link? Journal of Occupational and Organizational Psychology, vol. 70, issue 3, 1997, pp. 85-94.

[5] M. Belbin. Management teams. Why they succeed or fail. John Wiley & Sons, 1981, 179 p.

[6] M. Belbin. Team roles at Work. Butterworth Heinemann, 1993, 152 p.

[7] Schoenhoff P.K. Belbin's Company Worker, The Self-Perception Inventory and Their Application to Software Engineering Teams. Master's thesis. Virginia Polytechnic Institute and State University, 2001, 161 p.

[8] Pollock M. Investigating the relationship between team role diversity and team performance in information systems teams. Journal of Information Technology Management, vol. 20, issue 1, 2009, pp .42-55.

[9] Abdulrahman A., Omar M. et al. An Analysis of Belbin Team Roles in Software Engineering Team. Journal of Engineering and Applied Sciences, vol. 12, issue 5 SI, 2017, pp. 6878-6883.

[10] Henry S., Stevens K. Using Belbin's leadership role to improve team effectiveness: An empirical investigation. The Journal of Systems and Software, vol. 44, issue 3, 1999, pp. 241-250.

[11] Estrada E., Peña A. Influencia de los roles de equipo en las actividades del desarrollador de software. Revista Electrónica de Computación, Informática, Biomédica y Electrónica, issue 1, 2013, 19 p. (in Spanish).

[12] Aguileta A., Ucán J., Aguilar R. Explorando la influencia de los roles de Belbin en la calidad del código generado por estudiantes en un curso de ingeniería de software. Revista Educación en Ingeniería, vol. 12, issue 23, 2017, pp. 93-100 (in Spanish).

[13] Aguilar R., Muñoz M. et al. Explorando la influencia de los roles de Belbin en la especificación de requisitos de software. Revista Ibérica de Sistemas y Tecnologías de la Información, issue 36, 2020, pp. 34-49 (in Spanish).

[14] Aguilar R., Díaz J., Ucán J. Influencia de la Teoría de Roles de Belbin en la Medición de Software: Un estudio exploratorio. Revista Ibérica de Sistemas y Tecnologías de la Información, issue 31, 2019, pp. 50-65 (in Spanish).

[15] Aguilar R., Gómez O. et al. Influencia de la Teoría de Roles en actividades de Gestión: Un experimento controlado con estudiantes de Ingeniería de Software. Revista Ibérica de Sistemas y Tecnologías de la Información, issue 39, 2020, pp. 131-146 (in Spanish).

[16] Aguilar R. A Strategy Assisted by Intelligent Virtual Environments. PhD Thesis. Polytechnic University of Madrid, 2008.

[17] De Miguel A., Piattini M., Marcos E. Diseño de Bases de Datos Relacionales. España, Ra-Ma, 1999, 576 p. (in Spanish).

[18] Silberschatz A., Korth H., Sudarshan S. Database Systems Concepts. 7th ed. McGrawHill, 2020, 1376 p.

[19] C.J. Date. An introduction to database systems. Pearson Education, 2004, 1040 p.

[20] Basili V., Selby R., Hutchens D. Experimentation in Software Engineering. IEEE Transactions on Software Engineering, vol. 12, issue 7, 1996, pp. 733-743.

[21] Genero M., Cruz-Lemus J., Piattini M. Métodos de investigación en ingeniería de software. España; Ra-Ma, 2014, 314 p. (in Spanish).

[22] Aguilar R., Diaz J. Procesos de Evaluación a la Calidad de la Primera Licenciatura en Ingeniería de Software en México. Revista Tecnología Educativa, vol. 3, issue 1, 2016, pp. 43-53 (in Spanish).

[23] Gutiérrez H., De la Vara R. Análisis y Diseño de Experimentos. México: McGraw Hill, 2012, 489 p. (in Spanish).

[24] McCall J.A., Richards P.K., Walters G. F. Factors in Software Quality, Volumes I, II, and III. US Rome Air Development Center Reports, US Department of Commerce, USA, 1977.

[25] Wohlin C., Runeson P. et al. Experimentation in Software Engineering. Springer. 2012, 260 p.

[26] Höst M., Regnell B., Wohlin C. Using Students as Subjects – A Comparative Study of Students and Professionals in Lead-Time Impact Assessment. Empirical Software Engineering, vol. 5, issue 3, 2000. pp. 201-214.

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