RESEARCH ARTICLE

Information seeking behavior of engineering graduate students
a study based on Tom Wilson's model

Etiene Siqueira Rocha [1]   ID https://orcid.org/0000-0002-6222-7206
Helen de Castro Silva Casarin [2]   ID https://orcid.org/0000-0002-3997-9207

[1] Federal Inst. Education, Science anda Techology of São Paulo, São Carlos, SP, Brazil / e-mail: etiene.so@gmail.com
[2] Paulista State University, Marília, SP, Brazil / e-mail: helen.casarin@gmail.com

ABSTRACT
Introduction: This study investigates the information behavior of engineering graduate students according to CAPES' classification: Production Engineering, Mechanical Engineering, Aerospace Engineering, Naval and Oceanic Engineering. **Objective:** The aim was to verify the searching and obtaining of information by graduate students and to compare the information behavior of these four groups included in the study. Participants were students of 20 graduate programs with a grade 5 or higher in the Capes' assessment. A web-based questionnaire with 15 questions was applied for data collect. The SPSS software was used to verify the relations between the active and passive information seeking behavior and information resources selection among students. **Results**: The results indicate that graduate students active seek information mainly. They have difficulties in interacting with databases and do not use keywords and Boolean operators. Information resources most used were scientific journals, books, theses and dissertations. This study observed that graduate students do not present significant differences in their information behavior, suggesting that despite the specificities of each subarea, the graduate students have similar informational behavior. **Conclusion**: It was concluded that specificities of Engineering have been not influenced the students' information behavior.

KEYWORDS
User behavior. Information users. Academic libraries. Engineering.

O comportamento de busca de pós-graduandos em Engenharia
um estudo a partir do modelo de Tom Wilson

RESUMO
Introdução/Objetivo: Estudo do comportamento informacional de pós-graduandos dos cursos de Engenharia de Produção, Mecânica, Aeroespacial e Naval e Oceânica, que compõem a área da Engenharia III da CAPES, analisando as formas de busca e obtenção de informação utilizadas pelos pós-graduandos e comparando o comportamento informacional dos sujeitos entre as subáreas incluídas no estudo. **Metodologia**: Os sujeitos da pesquisa foram discentes de 20 programas de pós-graduação com nota igual ou superior a cinco na avaliação da Capes. O instrumento de coleta de dados foi um questionário eletrônico com 15 questões. Utilizou-se o software SPSS para verificação da existência de correlação entre o comportamento de busca ativo, passivo e seleção das fontes de informação. **Resultados**: Os resultados indicam que os pós-graduandos buscam informação principalmente de forma ativa. Eles apresentam dificuldades na interação com as bases de dados, não costumam elaborar estratégias de busca utilizando palavras-chave e operadores booleanos. As fontes de informação mais utilizadas foram os periódicos científicos, livros, teses e dissertações. A comparação dos resultados entre as quatro áreas não revelou diferença significativa, o que sugere que, apesar das especificidades de cada subárea, os pós-graduandos possuem comportamento informacional semelhante. **Conclusão**: Concluiu-se que as especificidades da Engenharia têm

| 1

pouca influência no comportamento informacional dos alunos.

JITA: DD. Academic libraries.

| 2

1 INTRODUCTION

Historically, the Users Studies are conducted by libraries and information centers to identify the users' profile, habits, information needs, seeking and use. Such studies gather information about users should be applied in the design of information products and services according to users (DIAS; PIRES, 2004). These studies can be applied to evaluate products and services aiming their improvement.

The first studies in this field investigated human behavior in relation to libraries to the planning and designing of information systems, for example, use of specific sources of information or users' frequency of visiting libraries. However, no research focused on motivations for information-seeking activities (SAVOLAINEN, 2007).

According to Case and Given (2016), between 1940 and 1970, the major part of the user studies focused on scientists and engineers. After this period, there was an expansion of the scope and contexts investigated, although these two groups are still among the most studied.

During the 1980's, researchers as Brenda Dervin and Nicholas Belkin inaugurated a new focus to investigations in information science (CASE; GIVEN, 2016) looking to take user' perspective about searching and using information as well libraries attendance and information services. This change resulted in a new paradigm for the area. Until then, research was centered on systems use and information sources. The user-centered paradigm focuses on individual needs and information use (WILDEMUTH; CASE, 2010).

Because of this new paradigm, varying amounts of user-centered research has been done in contexts that extrapolated the library use and sought to identify how individuals deal with information in their daily lives. Such research was called information behavior. In an article published in 2000 Professor Tom Wilson presented a key definition of information behavior. According to this definition, information behavior studies includes how people interact with information sources and channels, searching or avoiding information in daily activities (WILSON, 2000). Complementing Juan Calva-González (2004, p.108, our translation) states that the "action taken by an individual whether verbal or non -verbal to meet their information needs" was information behavior. This means that information behavior covers actions related to search and use of information, such as subscribing to alerts in databases, casual searching in specialized journals and avoiding information sources with contradictory or uncomfortable information (CASE; GIVEN, 2016). In the last decades, a large number of models have been proposed to include the investigation of both users´ cognitive and subjective aspects, searching and using information, and how these aspects are interrelated (WILSON, 2006; KUHLTHAU, 2006). Considering that different groups of individuals share common activities, goals or interests should have similar information behavior (CALVA-GONZÁLEZ, 2004; MUANDLLER, 2005) this study adopted the domain analysis' perspective, which is conceptualized by Hjorland as "[...] body of knowledge, defined socially and theoretically as the knowledge of a group of people sharing ontological and epistemological commitments" (2017, p. 442).

1.1 The information behavior of Engineering graduate students

The engineering is a broad field, including several specialized branches. Rugarcia *et al.* (2000) point out that the volume of information that engineering students must know, exceeds the capacity of course program. According to the authors, until 1980 the main labor market for Chemistry Engineering students, for example, was chemical, or petrochemical

industry. However, since then, many new fields of activity have emerged, such as biotechnology and computer science. Thus, to be effective in this wide range of professional action's possibilities, the students must know not only the contents of their specific area, but also other correlated areas (RUGARCIA *et al.*, 2000).

Bennett and Buhler (2010), Leatherman and Eckel, (2012), Hussain and Ahmad (2014), Case and Given (2016), Wellings and Casselden (2017), and Barlog, Badurina and Lisek (2018) conducted studies that highlight aspects of the information behavior of engineering graduate students:

- online scientific journals are considered the main source of information,
- they use Google and Google Scholar frequently, considering the internet extremely useful due to convenience and speed,
- engineering graduate students prefer online resources and services provided by the library due to the possibility of remote access,
- they prefer the digital format, but report difficulties in organizing the information resources obtained in this format,
- bibliographic materials' accessibility is a relevance criterion in information sources selection,
- generally, they do not feel satisfied with the dissemination of resources and services offered by libraries,
- informal information sources, such as interaction with colleagues at work, and researchers at events in the area represent a significant role in the information behavior of this group,
- academic engineers (teachers and students) show a different information behavior in relation to those working in the labor market, giving preference to formal and electronic sources.

Therefore, it is necessary to emphasize the connection between the information behavior, and the context of these individuals. Wilson (1999) outlined in his model the influence of environmental variables in the information-seeking behavior. Thus, it is pertinent to include some considerations about the academic, and scientific context of graduate students.

Historically, the university is a major producer and promoter of scientific knowledge for society. The systematic development of science and academic training of professionals and researchers are made in the university (WANDERLEY, 2017). Merkel (2001) points out that universities has a fundamental role in the academic formation of researchers. These institutions have focused on research activity with scientific rigor as well a research culture that is a set of actions and values that are established to support and encourage students and scholars to develop scientific research (MERKEL, 2001; HU; KUH; GAYLES, 2007). Currently research culture is planned for other levels of Brazilian education in the Base Nacional Comum Curricular, which is an official document that defines the set of learning that all students must develop from the first school years to high school (BRASIL, 2018).

In Brazil, public universities, in general, have an established research culture, with some exceptions in private universities. The public universities adopt a policy that supports the development of research including actions such as access to international databases and scientific journals; agreements with funding agencies; set up institutional repositories, and thesis and dissertation databases; availability of laboratories and scientific teams. Thus, public universities have attention focused on the infrastructure that allows the development of

research. An article published in the Journal of University of São Paulo (ESCOBAR[1], 2019), based on data from Clarivate Analytics, indicates that 60% of Brazilian scientific research is produced by public universities, making them along with other research institutes, the pillars of scientific research in Brazil. These institutions with a research culture also have graduate programs considered excellent due to evaluations conducted periodically by CAPES. Hence, it is assumed the universities of excellence in Brazil provide a favorable scientific research environment, and contribute to active information behavior of students and researchers. They have different dynamics from other institutions which knowledge transmission is the main objective. This context of excellence was the background of the study reported here.

1.2 Methodology

The area Engineering III was selected, according to the classification of areas of knowledge of CAPES[2], as the domain investigated in this research since the areas comprise a "[...] set of interrelated knowledge, collectively constructed, gathered according to the nature of the research object for teaching, research and practical applications". This area is composed of four subareas: Production Engineering, Mechanics, Aerospace, Naval and Oceanic, which are chosen "according to the object of study and recognized and widely used methodological procedures". Besides it was decided to restrict the data collection to top rank Programs in CAPES' evaluation of Engineering III, that state the edge of domain analyzed.

A set of 21 Postgraduate Programs met this choice of criteria, but one of them did not authorize data collection. Of the 20 programs that comprised the universe of research, 12 were in Mechanical Engineering, five in Production Engineering, two in Aerospace Engineering and one in Naval and Oceanic. The number of students enrolled in the 20 programs was 3609, with 1920 master's students and 1629 PhD students, according to data provided by the programs between September and October 2013.

Data collection was performed using a questionnaire. The questions were based on Wilson's information behavior model (1999), that includes: active search, that is when the individual is effectively looking for information; passive search, means a type of unintentional search (or other behaviors) that results in a relevant information acquisition; ongoing search, means occasional searches conducted to update the information previously established by active search; passive attention, which are situations in which the individual finds relevant information without being, however, performing a search itself (Wilson,1999); and information search, which is the interaction of individuals with some information system.

The instrument had 15 questions being 14 multiple-choice questions, and an open-ended question. The questionnaire was applied through the Surveymonkey platform. The research protocol involved a first contact with programs' coordinators individually via email to authorize the data collection. Once approved, a link to the survey was sent to programs, which sent the link to the email of all regular students.

As shown Table 1, 423 students answered the questionnaire, 11,7% of the total students in the research universe. 6.5% of subjects were in a PhD´s degree, and 43.5% in the master's degree. 72.1% of subjects self-declared as men and only 27.9% were women. This

| 5

---

[1] https://jornal.usp.br/universidade/politicas-cientificas/15-universidades-publicas-produzem-60-da-ciencia-brasileira
[2] https://www.gov.br/capes/pt-br/acesso-a-informacao/acoes-e-programas/avaliacao/instrumentos/documentos-de-apoio-1/tabela-de-areas-de-conhecimento-avaliacao

result confirms the sexist stereotype present in Engineering, which discourages women in this area (FERNANDES; NORONHA; FRAGA, 2018).

Table 1. Distribution of graduate students in the research universe by subarea and graduate degree

Programs	Master Students	PhD Students	Total
Aerospace Engineering	15	19	34
Mechanical Engineering	124	144	268
Naval and Oceanic Engineering	5	8	13
Production Engineering	40	68	108
Total	184	239	423

Source: the authors, research data

The subjects' background in research was asked. It was found that most part of subjects (55.1%) participated in scientific initiation projects and 44.9% participated in other researchers' projects. Considering that most subjects had previous experience in academic research, it is possible to assume that the contact with academic research at the undergraduate may contribute to the entry of the student in graduate *strict sense*. This result suggests an influence of research culture of institutions of excellence.

An analysis results was descriptive including: graduate information-seeking behavior, information sources used, participation in training for database use, and choice criteria to evaluation of contents was carried out. Analysis involved looking for a statistically significant variance in the information-seeking behavior of subjects of the four subareas of Engineering III, as well as the responses of master's and PhD students. For that, SPSS (*Statistical Package for Social Sciences*), version 19 was used with the application of the Kruska – Wallis test and the Mann-Whitney test.

| **6**

1.3 Presentation and analysis of results

The respondents were asked to indicate how often they performed bibliographic surveys to investigate active search. The results showed that 65.4% of participants stated that they always carry out bibliographic surveys for research development, and 38.5% frequently perform this activity, which demonstrates that bibliographic surveys is constant action to most subjects. However, a continuing bibliographic survey is the answer considered adequate for this question, mainly because the participants are graduate students. This fact may have influenced the participants' responses. The Mann-Whitney test identified a statistically significant association between the student's postgraduate level and the frequency of bibliographic surveys, with PhD tending to conduct bibliographic surveys more frequently than master's students (p=0.021). Comparation of these results among the four subareas of Engineering III showed that Mechanical Engineering students (59.8%) were who indicated carry out surveys in a more constant way. However, the Kruskal-Wallis test showed no statistically significant difference between the students answers in different subareas.

The following section contains passive search behavior questions. First, the frequency of students' participation in discussion lists, groups on social media, and study groups on the

research topic were observed. According to the results, 43.7% of the respondents indicated to participate "at times", 30.7% "often", and only 17, 7% of the students assigned the option "always". No significant difference was identified between the responses of students at the graduate level (PhD x master's degree). Examining the answers of four subareas students, Kruskal-Wallis test indicated a significant difference (p= 0.041), being that Engineering Naval and Oceanic students has more participation in mailing lists, social media groups, study groups on their research topic then the other participants. This result demonstrates that students of that subarea have passive search behavior more often than colleagues from other subareas. It is possible that this behavior is due to the specific body of knowledge necessary for the research development in that subarea. The intense influence of social media on the information behavior of subjects in contemporary society is worth mentioning, Bik and Goldstein (2013) reported that researchers and scientists consider social media one of the most useful sources of information today. Carol Tenopir et al. (2015) found that researchers have used unconventional channels such as social media to seek out relevant information not just to spread them as most authors indicate.

To provide greater evidence for the passive search, a question about frequency use of databases alert services was applied. The results indicated that most students do not use such services frequently, as 45.9% of the participants indicated "never", and 25.5% "sometime". Only 12, 8% indicated using this service frequently. The Mann-Whitney test was used to verify the relationship between databases alert service use and the graduate level of degree, but a significant association was not identified. When comparing students' responses by subareas, Kruskal-Wallis test indicated that database alert services use is more frequently for students of Naval and Oceanic Engineering than for those in the other subareas (p=0.003).

These results differ from Leatherman and Eckel (2012) study, who reported that researchers in Engineering area use alert services mainly due to time savings provided, and the constant need to update study topics. However, research´s subjects do not have incorporated this practice. The British Library (2012) report, Researchers of Tomorrow, described the information behavior of Generation Y´s PhD students indicating that they are not exploring all available tools on the internet, such as alerts, podcasts, geospatial analysis and data mining, although PhD students are familiar with the technology. This is to be the case for research participants who are probably familiar with the technology, but do not fully use specific resources and services toward research, for example.

It was asked to graduate students about the participation in scientific events for research monitoring, and to make interpersonal contact with colleagues in related areas. 44% of subjects indicated to participate in conferences and meetings "sporadically", but only 7.5% of the students checked the option "never". The relationship between ongoing search behavior and students' graduate level was verified. The Mann-Whitney test revealed a significant association (p=0.000) to PhD students and more frequent participation in events than master students. Additional analysis was performed using Kruskal-Wallis test, which did not indicate any statistically significant difference between the subareas focused on this study. This result is mirrored partially Hussain and Ahmad (2014) research, which indicated that scholars and engineering students consider congresses as the main source of informal information about new topics, and publications.

Finally, it was asked how often the participants find relevant information without being consciously searching, which a passive attention in Wilson and Walsh (1996) definition. This seems to be a recurrent action among participants because only 5.2% of respondents checked option "never". Comparing students' responses from each Engineering III subarea, it was observed that almost half of the students of Naval and Oceanic Engineering (53.8%) and Production (49%) programs indicated they accidentally found information frequently. The

| 7

students of Aerospace Engineering (55.8%) and Mechanics (43.3%) indicated they accidentally found information with sporadic frequency. However, Kruskal-Wallis test did not indicate a statistically significant difference in passive attention of four subareas students in this research.

The identification of the search behavior of Engineering graduate students in information systems was observed by the frequency use of keywords, and Boolean operators to make their searches more specifics and how often they felt difficulties consulting databases.

Regarding the use of keywords, 71% of the participants indicated that they "always" use keywords to search databases. The Kruskal-Wallis test did not indicate a statistically significant difference between the frequency of use of keywords and the four subareas participating in this study, which indicates that the use of keywords is common for the four subareas.

However, the use of Boolean operators among the participants is not frequent, as 30% of the participants indicated the option "sometimes" and 28.5% indicated never using them. This indicates that, despite most students user with keywords often, they do not use Boolean operators to create search strategies, which could contribute to an effective recovery and points to a possible demand in training these students. This result is consistent with the research carried out by Korobili and Malliari (2011). When comparing the results of the four subareas, the Kruskal-Wallis test did not identify any statistically significant difference between them.

Concerning the frequency with which graduate students experience difficulties in performing information retrieval in databases, 51.8% indicated that they experience difficulty "sometimes", 8% "frequently", 1.4% "always" and 38.8% stated that they "never" experienced difficulties. The majority of graduate students experience difficulties with a certain degree of frequency, which points to the need for an investment in the training of graduate students to use the databases. No statistically significant difference was identified between the degree attended by the participants and the frequency with which they experience difficulties in performing the searches. Comparing the subareas, it is highlighted that 69.2% of the Naval and Oceanic Engineering graduates indicated that they had difficulty to carry out bibliographic surveys "sporadically". Nonetheless, will be verified one statistically significant association between the subject responses of the four subareas studied.

To check the availability of the participants to spend time, effort and financial resources to obtain materials for their research, the participants were asked to indicate how much they were willing to invest in their searches.

With regard to the use of time to perform searches for bibliographic materials, it was requested that they indicate the degree of agreement regarding the statement: "For me it's okay to spend time searching for information for my research". The results indicated that 44.7% of the total participants agreed with the statement and 33.1% partially agreed, that is, most participants indicated no problem with spending time in the search for information activities for your researches. This tendency is maintained between masters and PhD since the Mann-Whitney test does not find a significant association between the responses of these two groups. Comparing the responses among the four subareas, it was found that there is no difference significant between them, according to the Kruskal-Wallis test. It is concluded that, in general, graduate students from the four subareas are willing to carry out exhaustive bibliographic surveys. This result differs from the research of Hussain and Ahmed (2014), according to which professors and students of Engineering encounter problems of lack of time to make bibliographic surveys.

With regard to the students' efforts to obtain information, they were asked to point out the degree of agreement in relation to the statement: "I use only the materials that are available in the nearest libraries". According to the results, 47% of the total participants disagreed and 24.3% disagreed in part of the statement, showing that they are willing to make efforts to obtain

| 8

materials in libraries beyond that are closer. A significant association was found between the responses of master's and PhD students. The PhD (p=0.000) tend to agree more with that statement, that is, they are less willing to search materials unavailable in nearby libraries that masters. This result may be related to the fact that often the PhD student in the Engineering area carries out professional activities in parallel, which reduces the time and availability to search for materials in addition to those that are available in the libraries to which they have access. By comparing the results obtained between the four subareas a significant association wasn´t observed.

So, the participants demonstrate a commitment in the search for materials for their research regardless of their geographic location. It is possible to consider that digital information resources reduce the need for face-to-face consultation to libraries for more specific cases. This aspect, however, will be discussed later. In this sense, Niu and Hemminger (2012) identified that academics make about 20 visits to libraries over twelve months, that is, less than two visits per month. Corroborating, Barlog, Badurina and Lisek (2018) identified in their study that only 13% of PhD students indicated the libraries they visited more. This result indicated that the most graduate student didn´t go to the library.

Still regarding the willingness of graduate students to make efforts to obtain materials for their research, was asked their degree of agreement in relation to the following statement: "I prefer to use the materials that are available on the Internet". It was observed that 35% of the total graduate participants agreed and 39.5% partially agreed, demonstrating that most preference for materials found on the Internet. It is necessary to investigate better if these materials found on the internet by graduate students are open access scientific materials or if they use, for example, remote access to databases signed by the CAPES Portal by VPN. It was not observed a significant association between the responses of graduate of four subareas focused on the research or between the masters and PhD responses. This trend toward the use of materials available on the internet may be linked to the easy and speed of recovery of materials on the *web*. This result confirms the existing works that express that engineers and researchers in the Engineering area make intensive use of the resources available on the internet (WELLINGS; CASSELDEN, 2017; BARLOG, BADURINA; LISEK, 2018).

| **9**

About the participants in bear expenses to get on materials for their research, it was asked the degree of agreement of subjects in relation to the claim that they mainly use materials for which no need to pay. It was found that 66.9% of students agreed with the statement and 21.5% partially agreed and only 2.8% of disagreed. When comparing the answers given by the students of the four subareas investigated the Kruskal-Walis test showed no statistical difference. Thus, it can be considered that the participating graduate students are not willing to use financial resources to obtain bibliographic materials for their research. It can be assumed that this behavior is because libraries and databases signed by them have supplied most of the needs of the students. Therefore, the need to acquire other materials in addition to those already available is uncommon. In addition to this, the existence of tools, such as Sci Hub and LibGen, which allow the obtainment of articles from signed databases (HOULE, 2017), although they are not legal means, have practically excluded the need for expenditure cost of obtaining scientific material. It is also possible to add the availability of free relevant scientific materials in *pre-print* repositories (GRIGAS; JUZĖNIENĖ; VELIČKAITĖ, 2016).

The instruction on use databases, including the coverage of issues, indexed journals, building search strategies and handling of results, allows users autonomy and quality in the information retrieval. Thus, considering the importance of participating in this activity, the graduate students were asked whether they had received instruction on searching databases. Most students (60.5%) reported receiving some kind of training, which is positive, but it

demonstrates that libraries is unable to reach all students to their institutions, even graduate since 39.5% of participants stated have not received information on the use of databases.

The forms of guidance indicated by the participants are quite varied. The individual guidance with the librarian was indicated by 24.6% of total, followed by participation in short courses (23%) and workshops (10.8%). The graduate students also indicated participation in courses that addressed the use of databases in some of its content (8.3%); 7.8% reported having received guidance from their advisor or other lecturers and 5.2% of other colleagues from graduate school. The Kruskal - Wallis test did not indicate significant association between the responses of the participants in the four subareas covered by the research. The results also revealed that guidance for the use of databases is most common for the PhD students that for the masters students, since 64.4% of PhD said receiving guidance and 55.4% of masters that indicates have received guidance, but the Mann-Whitney test did not indicate a significant difference between the responses of the two groups. This result is not expected because the masters is less academic experience that PhD students, which impacts opportunities to receive training for the use of databases. Thus, this aspect could be better investigated.

Thus, it can be considered that despite the collective effort of the academic community of the investigated universities to instruct students on the databases, there must be an even greater effort to reach students at different levels, in particular those who are involved in research and graduate studies. The results indicate the need for a more systematic and constant work of guidance for the use of databases, or even for an information literacy program aimed at graduate students. Gunapala's study (2014) on the information needs of postdoctoral students in Science indicated that students would like the library, both physically and digitally, to concentrate essential information for the student's life at the university, as well as guidance on products and services available in the library. In addition, the study by Barlog, Badurina and Lisek (2018) indicated that PhD students would like the library to offer courses and workshops on how to search for scientific information, just as they are not aware that access to databases is provided by team and library work.

Subsequently, graduate students were asked to indicate which means they used to identify bibliographic materials for developing their research. The results were grouped in Table 2.

Table 2. Means used for the identification of bibliographic materials

Response options	Master's degree	Doctorate degree	Total	%
Bibliographic references indicated in texts that you have read or consulted	175	230	405	95.7
Internet search sites	173	216	389	92
Contact with professors, specialists or colleagues of the post-graduation	139	160	299	70.7

| 10

CAPES journals portal	112	172	284	67.1
Database (such as Engineering Index or Metades, for example)	119	157	276	65.2
Consult bibliography of disciplines taken in graduate school	94	114	208	49.2
Onlie library catalogs	84	109	193	45.6
Others	15	16	31	7.3

Source: the authors, research data

It was observed that the consultation of the references listed in documents consulted by the students was the most used means to identify relevant materials for their research, having been indicated by 95.7% of the subjects. According to Green (2000), the consultation of the references of a specific document for the identification of other relevant information resources is called *citation chasing*. The results of this study do not corroborate those of other researches that indicate that this practice is quite common among researchers in the Humanities area (BARRETT, 2005; BASS et al, 2005), but not among researchers in the Exact area. It is possible that the use of online documents, in which the references present links that direct to the mentioned sources, can facilitate the use of this strategy to obtain relevant materials, expanding this practice to other areas, including Engineering. That is, the use of technologies can influence the information behavior of users and, consequently, mitigate the differences in information behavior of users from different areas, which can be better investigated in other studies.

| **11**

The use of site search is quite common among participants, as 92% indicated using them as a means of identifying materials for their research. This result confirms the results of research on the information behavior of engineering graduate students (KOROBILI; MALLIARI, 2011; NIU; HEMMINGER, 2012). According to the Researchers of Tomorrow (2012) report, PhD students in Engineering prefer Google to perform their searches.

The third means used by the participants to identify relevant materials for their research were contact with professors, specialists or colleagues from graduate school, having been mentioned by 70.7% of the respondents. Studies of Barlog, Badurina and Lisek (2018) and Wellings and Casselden (2017) have indicated that engineering graduate students and engineers rely heavily on colleagues, lecturers or professionals to obtain relevant information.

The CAPES Journal Portal was mentioned by 67.1% of the participating graduate students. Specific databases such as the Engineering Index or Metadex, for example, were the fifth most used form, with 65.2% of the total respondents. This result does not coincide with those obtained by Barlog, Badurina and Lisek (2018). According to the authors' research, databases are the most used means by researchers in the field of Engineering for the identification of scientific articles. In connection with this item, it was found that 17 respondents indicated the following bases: ScienceDirect, Scopus, Web of Science, Compendex, SpringerLink and Proquest in the option "Other", and the most cited was *ScienceDirect*, with

six nominations. The indication of the name of specific databases in the option "Others" demonstrates that the respondents do not identify these sources as databases or that they understood that the corresponding option referred only to the databases Engineering Index or Metadex, although the statement of the question mention that the bases were just examples. The Kruskal-Wallis test did not indicate a significant association between the responses of students from the four Engineering subareas participating in the research.

In order to better understand the sources of information used by graduate students, they were asked to indicate three materials that they considered essential for developing their research. The question was open and the answers were grouped into categories based on similarity. A first option, the three items that received the most recommendations were: scientific journal articles, books and databases. As a second option, the three most indicated items were books (38%), scientific articles (25%) and theses and dissertations (11%). As a third option, books were indicated by 22.8%, after scientific articles and theses and dissertations. Thus, despite the diversity of materials indicated by graduate students as essential for their research (19 in all), the preference for scientific articles, books and theses and dissertations prevails.

Some participants indicated which were the titles of journals most important to their research that are: *Engineering Fracture Mechanics; Progress in Energy and Combustion Science; Energy & Fuel; Optical Engineering*; and *Heat Transfer*. The study conducted by Bennett and Buhler (2010) points out that researcher in the fields of Engineering always notice the name of the scientific journal used, indicating that the journal gives a certain degree of importance or credibility to the articles they publish. Twelve participants are further indicated concern to mention the quality of the journal that uses, mentioned Qualis[3] of the journal used. Thus, there is a concern among graduate students with the quality of the materials they use. These aspects can be a reflection of the research culture that permeates universities included in the study that stimulates the use of bibliographic material with authority.

Still on the information sources used by the participants, six participants highlighted names of researchers from their respective areas of study as essential information sources for the development of their research, with Thomas Thundat and Paulo Sergio de Paula Herrmann. We can consider that these researchers are exponents in their field, they are considered informal information sources. This result is consistent with the research by Barlog, Badurina and Lisek (2018), who pointed out that informal information sources occupy an important role for this group.

Considering that graduate students indicated using materials available on the internet, knowing the criteria they use to evaluate and select these materials is important. So, it was asked to the graduate students to indicate the criteria used by them to select materials for their research. The question was closed and the participants were informed that they could indicate how many alternatives applied to their case. The results are in Table 3.

Table 3. Criteria used by graduate students to select materials for their research

Criteria	Master students	PhD students	Total of answers	% in relation to the total number of respondents N=423
Document timeliness	133	206	339	80.1

---

[3] Qualis "is a system used to classify the scientific production of graduate programs in relation to articles published in scientific journals"

If the bibliographic material is well established and known in the area	140	187	327	77.3
If the document is of a high scientific level	126	186	312	73.8
Type of material	132	153	285	67.4
If the author is recpected in the area	102	143	245	57.9
By the language of the document	32	40	72	17
Other	9	13	22	5.2

Source: the authors, research data

The results demonstrate that the main criterion used by the participants to select materials for their research is the "topicality" of the document, indicated by 80.1% of the respondents, which is consistent with the type of material most used by them (scientific article). The quality of the material, including "Scientific recognition" and the "high scientific level" of the material were specified by 77.3% and 73.8% of the participants, respectively, which reinforces the students' concern with the quality of the materials demonstrated in previous questions, in which they aimed, for example, to consider the Qualis classification of the journals used by them. This result, however, does not match the Orlu (2016), which indicates the masters use the relevance of the information to the detriment of topicality as the materials selection criteria. Another factor that deserves to be highlighted is that the "Type of material", which is normally highly valued by the Humanities area (ROMANOS DE TIRATEL, 2000; GEORGE *et al*. 2006), was pointed out by 67.4% of the participants, surpassing the author's authority, which was indicated by 57.9% of the participants. This result indicates that postgraduate students in the area of Engineering III also have preferences for a certain type of material, in particular international scientific articles online, as previously presented.

In the "Others" option, the following criteria were indicated: relationship between the subjects of the document and the research theme, with seven responses; number of citations received by the document, with four indications; depth of the document's content, with three indications; impact factor of the document, with two responses; quality of the document's writing, with two responses; the author's affiliation, with two responses; and, if the relevant information is condensed in the title and summary, with two indications. A statistically significant difference was identified between the participant's level (master's x PhD) and the use of some criteria for the choice of materials for their research. Among doctoral students, the choice considering the timeliness of the materials is more accentuated (p=0.00). This group also takes more into account the high scientific level of the document than the master's students (p=0.031). Such results are within the expected range, as PhD students are required to carry out more robust research and with a certain degree of innovation, which requires material with characteristics similar to those pointed out by them. The Kruskal-Wallis test did not identify a statistically significant association between the criteria used by the respondents in the four subareas of Engineering included in this research, demonstrating that the students have similar criteria for the choice of materials for their research.

The criteria recommended by information literacy for the selection of information sources in general are: authority, which understands the credibility of the information;

| 13

timeliness of content; and content coverage, which covers the depth of the subjects covered (GÓMEZ; MITER, 2005). Given the above, it is clear that the participants in this research are relying on the criteria considered as solid for the selection of materials for developing of their research.

It was also asked, what is the degree of importance of some aspects of the content for the choice of documents used by them for the elaboration of their research. The option that was highlighted as the most important for the participants was "Documents whose theme was recommended by my advisor", was indicated by "Important" by 49.6% of graduate students and "Very important" by 44.7%. The responses of masters and doctoral students regarding this item were compared, as shown in Graph 1. The Mann-Whitney test, however, did not pointed significant difference in relation to this item. In this way, it is perceived that the advisors have great influence in the choice of information resources used by their advisors. This result is similar to that of Orlu (2016), according to which the master's students consider meetings with their advisor crucial, due to the indications and recommendations on the progress of the research and the identification of sources of information. Regarding the analysis by subareas of specialty, the Kruskal-Wallis test did not identify a statistically significant association, indicating that the advisors' recommendation is equally important for all sub-areas considered in the research.

Graph 1. Degree of importance of the documents recommended by the participants' supervisor

Source: the authors, research data

| 14
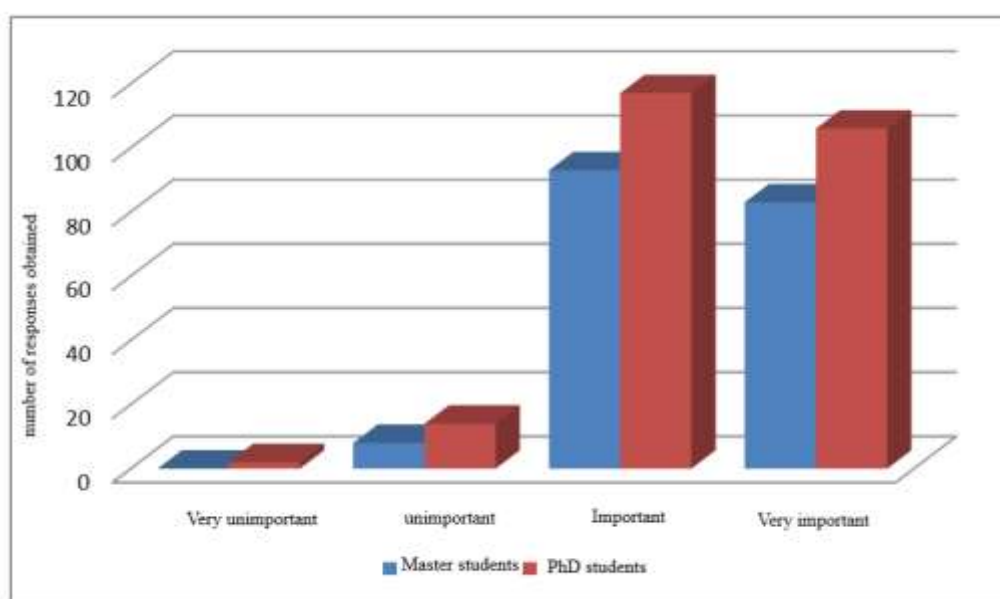
Regarding the selective exposure (WILSON; WALSH, 1996) was asked to graduate students to rate the degree of importance of documents with contradictory approaches to them for they had new perspectives on the topic of their researches. In another supplementary question we were asked to indicate the degree of importance of documents with contents that confirm their ideas on the subject researched. As seen in Graph 1, most subjects values the two options, since both received high levels of responses as "important" and "very important". However, there was a preference of graduate students by documents that confirm their ideas, which reached high marking as "very important".

Graph 2. Degree of importance of documents with contradictory approaches for graduate students
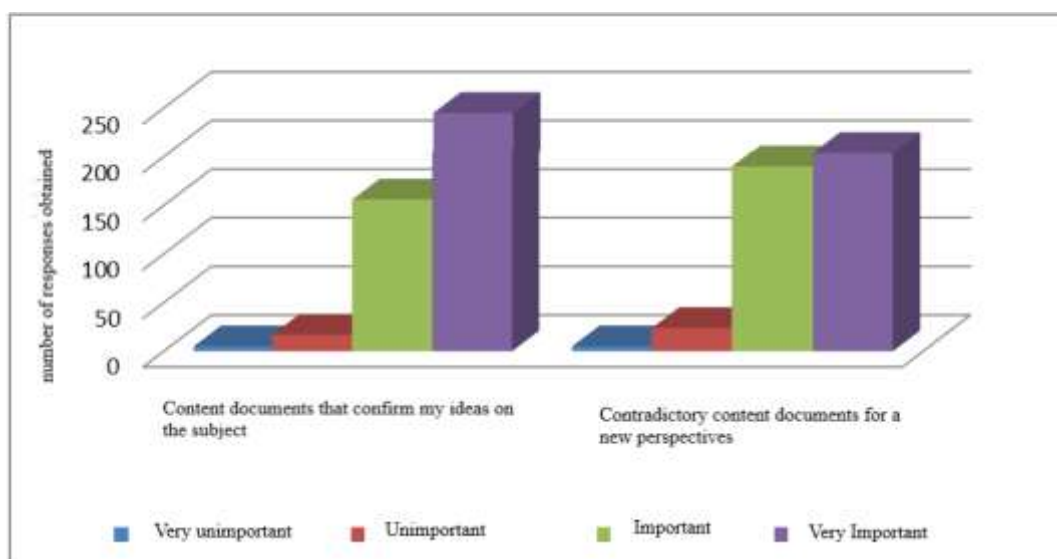
Source: the authors, research data

When comparing the responses of the four subareas, there was no statistically significant difference for these two items. It possible infer from the results that the trend to selective exposure, considered common to all individuals (CASE; GIVEN, 2016), does not negatively influence the information behavior of the participants, as the graduate students evaluate how important both the use of documents whose contents are more compatible with their own convictions, as well as contradictory and innovative contents on their research topic.

| 15

1.4 Final considerations

Studies on information behavior allow us to raise subsidies for the planning of resources and services that reflect the real needs of users, since such studies aim to identify the practices and preferences of users in relation to information.

Adopting the perspective of domain analysis, this study sought to identify the ways of searching and obtaining information used by students of Postgraduate Programs that make up the area of Engineering III of CAPES. The results showed that the participants perform all types of searches foreseen in the Wilson's model (2000), and active search, represented by conducting bibliographic surveys, is more common among the participants than the passive search actions. This activity, however, still needs to be improved because a considerable percentage of participants (39.5%) did not participate in any orientation to perform search in databases and 28.5% indicated never use Boolean operators to perform the searches. In addition, the majority (61.2%) admitted that they feel some degree of difficulty in conducting searches.

The main criteria used by participants are checking relevant document references and search on the Internet (with indications above 90% of respondents), while the search in databases and Portal CAPES was mentioned approximately 60% of the participants. Considering the context of the participants and the activity of developing postgraduate research, consulting the databases should be a priority. Thus, it is necessary to complement the study on this domain, such as, for example, the analysis of citations of the theses and dissertations and of the scientific production of the students to identify the main types of information used by them, which will allow to have a more of the information behavior of individuals in this domain.

The research also revealed that in most aspects analyzed, the information behavior of master's and PhD students is similar, except of the following: frequency of conducting

bibliographic surveys, participation in scientific events, willingness to seek information in the nearest libraries and the criteria used to select the materials for use in the research. In all of them, doctoral students have adopted a more proactive position than master's students, which conforms to expectations.

The information behavior of graduate students from the four sub-areas of Engineering III proved to be similar. There was a difference statistically significant for students in the area of Naval and Oceanic Engineering only in the items referring to passive search, alert service use and monitoring of mailing lists. Thus, it indicates that students of four subareas covered by this study have similar information behavior, which enhances the characterization of this area as a domain.

Thus, it is possible conclude that research on the information behavior of graduate students of Engineering III have important results for planning and library management to courses of Engineering in relation to the demand for users' training for optimal use of sources of information. Considering that the research was carried out in centers of excellence, it is assumed that this is also a reality in other graduate programs in the area. Such investment can improve the quality of research and, consequently, of graduate programs.

CRediT

| 16

REFERENCES

BARLOG, Kornelija Petr; BADURINA, Boris; LISEK, Jadranka. Information Behavior of Electrical Engineering and Computing Doctoral Students and Their Perception of the Academic Library's Role: A Case Study in Croatia. **International Journal of Libraries and Information Studies**, v.68, p.13-32, 2018. Available at: https://doi.org/10.1515/libri-2017-0017. Access at:10 jul. 2019.

BARRETT, Andy. The Information-Seeking Habits of Graduate Student Researchers in the Humanities. **Journal of Academic Librarianship**, v. 31, n. 4, p. 324-331, jul. 2005. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0099133305000534. Access at:15 ago. 2018.

BASS, Abigail *et al*. **The Information Behavior of Scholars in the Humanities and Social Sciences**. Washington: University of Washington, 2005. Available at:

http://faculty.washington.edu/harryb/courses/LIS510/Assign_2/Team_2_Scholars.pdf. Access at:30 set. 2018.

BENNETT, Denise Beaubien; BUHLER, Amy. Browsing of E-Journals by Engineering Faculty**. Issues in Science and Technology Librarianship**, v. 61, spring, 2010. Available at: http://istl.org/10-spring/refereed2.html. Access at:30 jan. 2019.

BIK, Holly; GOLDSTEIN, Miriam. An introduction to social media for scientists. **PLoS Biology**, v. 11, n.4, 2013. Available at: https://doi.org/10.1371/journal.pbio.1001535. Access at:01 jul. 2018.

BRASIL. Ministério da Educação. **Base Nacional Comum Curricular:** Educação é a base. Brasília: MEC, 2018. Available at: https://bit.ly/38ujUx3. Access at:25 fev. 2020.

BRITISH LIBRARY**. Researchers of tomorrow:** the research behavior of generation Y doctoral students. 2012. online report. Available at: http://www.jisc.ac.uk/publications/reports/2012/researchers-of-tomorrow. Access at:10 out.2018.

CALVA-GONZÁLEZ, Juan José. **Las necesidades de información:** fundamentos teóricos y métodos. México: Universidad Nacional Autónoma de México, 2004. 272p.

CASE, Donald; GIVEN, Lisa. **Looking for information**: a survey of research on information seeking, needs, and behavior. 4. ed. Emerald, 2016. 528p.

DIAS, Maria Matilde Kronka; PIRES, Daniela**. Usos e usuários da informação**. São Carlos: Editora da UFSCar, 2004. 48p.

FERNANDES, Alice Oliveira; NORONHA, Isabela; FRAGA, Laís Silveira. O elefante na sala de aula: gênero e CTS no ensino de Engenharia. **Revista Tecnologia e Sociedade**, v. 14, n. 32, p. 156-172, 2018. Available at: https://periodicos.utfpr.edu.br/rts/article/view/7842. Access at:27 ago. 2020.

GEORGE, Carole. *et al*. Scholarly use of information: graduate students' information seeking behavior. **Information Research**, v.11, n.4, p. 272, 2006. Available at: http://www.informationr.net/ir/11-4/paper272.html. Access at:10 dez. 2019.

GREEN, Rebecca. Locating sources in humanities scholarship: The efficacy of following bibliographic references. **Library Quarterly**, v. 70, n. 3, p. 201-229, 2000. Available at: https://www.journals.uchicago.edu/doi/abs/10.1086/630018. Access at:15 nov. 2018.

GOMÉZ, Carmen; MITRE, María. Aprender a buscar y avaluar información. In: MOLINA, María Pinto (Coord.). **Portal Alfin-EEES**: Habilidades e competencias de gestión de información para aprender a aprender en el marco del espacio europeo de enseñanza superior. Granada: Ministerio de Educación y Ciencia, 2005. p. 65-109.

GUNAPALA, Nirmala. Meeting the needs of the "invisible university:" identifying information needs of postdoctoral scholars in the sciences. **Issues in Science and Technology**

| **17**

Librarianship, n.77, summer 2014. Available at: http://www.istl.org/14-summer/refereed2.html. Access at:15 fev. 2019.

GRIGAS, Vincas; JUZĖNIENĖ, Simona; VELIČKAITĖ, Joné. 'Just Google it' – the scope of freely available information sources for doctoral thesis writing**. Information Research**, v. 22, n.1, 2016.

HJØRLAND, Birger. Domain Analysis. **Knowledge Organization**, v.44, n.6, p. 436-464, 2017.

HOULE, Louis. Google Scholar, Sci-Hub and LibGen: Could they be our New Partners? In: ANNUAL IATUL CONFERENCE, 38., 2017.   **Proceedings of** […] Italy: University Library, 2017. Paper 3. Available at: https://docs.lib.purdue.edu/iatul/2017/partnership/3/. Access at: 20 nov. 2018.

HU, Shouping; KUH, George; GAYLES, Joy Gaston. Engaging Undergraduate Students in Research Activities: Are Research Universities Doing a Better Job? **Innovative Higher Education**, v.32, n.3, p.167-177, 2007. Available at: https://link.springer.com/article/10.1007/s10755-007-9043-y. Access at: 10 out. 2018.

HUSSAIN, Akhtar; AHMAD, Parvez. Information Seeking Behaviour of the Teachers and Students at College of Engineering, King Saud University,Riyadh: A study. **Asian Review of Social Sciences**, v. 3, n. 1, p. 45-54. 2014. Available at: https://bit.ly/30zJqNi. Access at:10 jan. 2020.

KOROBILI, Stella; MALLIARI, Aphrodite; Zapounidou, Sofia. Factors that influence information seeking behavior: the case of greek graduate students. **Journal of academic librarianship,** v.37, n.2, p.155-165, 2011. Available at: http://eprints.rclis.org/32101/1/2011%20Aristotle_postprint.pdf. Access at: 16 mar. 2019.

KUHLTHAU, Carol. Kuhlthau's Information Search Process. In: FISHER, Karen; ERDELEZ, Sanda; MCKECHNIE, Lynne. **Theories of information behavior**. New Jersey: Information Today, 2006.

LEATHERMAN, Carrie; ECKEL, Edward. The use of online current awareness services by natural sciences and engineering faculty at Western Michigan University. **Issues in Science and Technology Librarianship**, v. 69, spring 2012. Available at: http://www.istl.org/12-spring/refereed1.html. Access at: 1 dez. 2018.

MERKEL, Carolyn Ash. **Undergraduate Research at Six Research Universities**: a pilot study for the Association of American Universities. California Institute of Technology, 2001. Available at: http://www.aau.edu/education/Merkel.pdf. Access at:16 fev. 2019.

MUELLER, Suzana Pinheiro Machado. A publicação da ciência: áreas científicas e seus canais preferenciais. **Datagramazero**, v.06, n.1, fev. 2005. Available at: https://repositorio.unb.br/handle/10482/980. Access at:18 maio 2020.

NIU, Xi; HEMMINGER, Bradley. A study of factors that affect the information-seeking behavior of academic scientists. **Journal of the American Society for Information Science**

and Technology, v.63, n.2, p. 336–353, 2012. Available at: https://doi.org/10.1002/asi.21669. Access at:15 jul. 2018.

ORLU, Aondoana Daniel. Information seeking behaviour of masters students: affective and behavioural dimensions. **Library Philosophy and Practice**, summer, mar. 2016. Available at: https://bit.ly/3qDiBlZ. Access at:08 mar. 2019.

ROMANOS DE TIRATEL, Susana. Accessing Information use by humanists and social scientists: a study at the Universidad de Buenos Aires, Argentina. **The journal of academic librarianship**, v. 26, n. 5, p. 346-354, sept. 2000. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0099133300001415. Access at:20 set. 2019.

RUGARCIA, Armando *et al.* The future of engineering education I. a vision for a new century. Chem. Engr. Education, v.34, n.1, p. 16–25, 2000. Available at: https://eric.ed.gov/?id=EJ607230. Access at: 20 nov.2019.

SAVOLAINEN, Reijo. Information behavior and information practice: reviewing the "Umbrella concepts" of information-seeking studies. Library quarterly, v. 77, n. 2, p. 109–132, 2007. Available at: https://www.jstor.org/stable/10.1086/517840. Access at: 16 mar. 2019.

TENOPIR, Carol *et al.* Scholarly article seeking, reading, and use:a continuing evolution from print to electronic in the sciences and social sciences. **Learned Publishing,** v.28, n. 2, apr., 2015. Available at: https://onlinelibrary.wiley.com/doi/pdf/10.1087/20150203. Access at: 22 fev. 2021.

WANDERLEY, Luiz Eduardo. **O que é a universidade?** São Paulo: Brasiliense, 2017. E-book.
WELLINGS, Susan; CASSELDEN, Biddy. An exploration into the information-seeking behaviours of engineers and scientists. **Journal of Librarianship and Information Science,** 2017. Available at: https://journals.sagepub.com/doi/abs/10.1177/0961000617742466. Access at: 10 jan. 2019.

WILDEMUTH, Barbara; CASE, Donald. Early information behavior research. **Bulletin of the American Society for Information Science and Technology**, v. 36, n. 3, Feb/Mar. 2010. Available at: https://doi.org/10.1002/bult.2010.1720360309. Access at: 24 set. 2018.

WILSON, Tom D. Models in information behaviour research. Journal of Documentation, v.55, n.3, p. 249-270, jun. 1999. Available at: https://www.emerald.com/insight/content/doi/10.1108/EUM0000000007145/full/html. Access at: 20 ago. 2019.

WILSON, Tom D. Human Information Behavior. **Information Science Research**, v. 3, n. 2, 2000. Available at: http://inform.nu/Articles/Vol3/v3n2p49-56.pdf. Access at: 20 nov. 2020.

WILSON, Tom D. Evolution in Information Behavior Modeling: Wilson's model. In: FISHER, Karen E.; ERDELEZ, Sanda.; MCKECHNIE, Lynne. **Theories of information behavior**. New Jersey: Information Today, 2006

WILSON, Tom. D.; WALSH, Cristina. **Information behavior**: an interdisciplinary perspective. Department of Information Studies, 1996.

| 20