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Information management impacts when students configure the project-work

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Abstract

Usually, a beginning activity in PBL is seeking available information relevant to the decision-making to configure the project-work. How students deal with that information has effects in both the learning outcomes and the project product. In this context, Aalborg University has structured the project-work to students can learn through while working in the project. Students begin their undergraduate program learning how to work projects by an initial short project P0, followed by a more extended subject project P1, to be accomplished in about three-quarters of a semester. This study explores how students address the project information when setting the project-work. 17 participants from two engineering programs answered open-ended interviews. Then, the study used a verbatim transcription by Thematic Analysis for code and correlations. The results indicate impacts in several features such as identification, search, quality and share of information, among others as roles and task assignment.

Keywords: Project-work, PBL implementation, group performance, learning, culture

Type of contribution: PBL research

1   Introduction

Among skills, the curricular Learning Outcomes must include search, selection and categorization of relevant information for a task (ABET, 2019; Lattuca et al., 2006; Shuman, 2005). The information management capacity helps the collaborative project-work since it facilitates the process of information sharing between team members and, consequently, performing a working plan. After identifying a problem area or theme, the first task of the team members is to seek for the pertinent and coherent information that will lead them with rigour to the problem formulation (incl. specifications for a given product). This information includes identification of topics, issues about the problem, existing solutions available in the market, identification of knowledge gaps, identification of solution methods, and identification of stakeholders

Unfortunately, the implementation of information management skills in the curriculum is one of the critical aspects of skills development which has not had satisfactory results (Chen et al., 2013; Dobbs et al., 2015; Enders et al., 2019; Moore et al., 2018). There could be many factors influencing results such as the technological revolution, and social networks, which have made the flow and availability of information greater. Likewise, there could be a gap between what students of the Generation Z face compared in what Millennials continue doing, or which approaches those of early generations are accustomed to each one seeking and managing information in different ways (Abram, 2007a, 2007b; Grenčíková & Vojtovič, 2017; Taylor, 2012).

In project-work, students must solve an engineering problem in a specific area of knowledge, but in a collaborative team. In PBL, the problem usually comes from a real situation. These problems often are complicated for the students due to lacking knowledge and experience in the subject area. For first semester students, the lack of soft skills is an additional factor in this complexity, making problems seem harder to solve for them. On the learning cycle, when a problem first occurs, it is expected that in the early stages of the project, students will focus on the issue and the process reflecting about information and ways to solve problems. In PBL, the problem formulation view as a central stage, the formulation includes the purpose, the context and both the project methodology and the possible methods of solving the problem.

The main purpose of project-work is giving a media for students' learning. It begins when students deal with information to organize a project. Thus, understanding how first semester students address information can help improve project-work methods, including guidelines and recommendations for facilitation, and implementing modern active learning strategies to the project-work principles.

2   Information behaviour

The problem formulation and its subsequent solution require accessing and seeking for information. However, the way information is searched for and used depends on both the expertise and the role of who does it. Researchers and university students look for information in databases with the resources made available in those universities, in magazines and through Internet search engines (Allard et al., 2009). In turn, graduate researchers and staff in organizations have traditionally searched for information in internal documents such as reports or from other colleagues, but currently, they are doing it by using search engines (Chaudhry & Al-Mahmud, 2015; Leckie et al., 1996). How they search for or can access the information will determine the search behaviour, the value and the use of transmitted data.

While in the late twentieth-century, engineering information was sought from internal organisational sources, where oral communication on technical knowledge predominated predominated (Fullerton & Leckie, 1999; Leckie et al., 1996), in the first decade of 2000, the search began to be carried out in other types of non-human information sources and using the assistance of others, as highlighted by Wellings and Casselden (2019). However, recent reports show that search behaviour has changed and has focused on information systems (Johri et al., 2014). Nevertheless, Generation Z or post-millennials, that is those born since 1997, are using social networks to obtain the information they need and resorting to informal sources of information (Mercer et al., 2019; Zhitomirsky-Geffet & Blau, 2017). This generation began university studies after 2015. Those information sources often are viewed as non-valid for technical and scientific projects in PBL.

In academia, students share information informally without the necessary knowledge for recognizing and finding reliable sources of information (Mercer et al., 2019). Furthermore, there is excessive confidence in the students' thinking that their abilities to find information are superior to those of staff like teachers, researchers or engineers, producing in them low levels of frustration (Phillips et al., 2019). Consequently, mutual learning turns difficult among the university students since the recommendations of the facilitators may not be considered.

However, when students are enrolling into the university, the behavior with the information is different between them. Students must deal with a higher number of sources of data compared to requirements in a high school library. Hence, they do not have sufficient skills to search for valid or reliable information leading to issues with the problem solving, and at the same time leading to issues in collecting an irrelevant amount of data from online searches (EBSCO, 2019).

This study adds knowledge about the work-process of PBL for the early stages of problem-formulation among students with a scarce background in project-work. The study seeks to answer the following research question: What information behavior do the first-year engineering students apply for the project-work? Additionally, the study addresses a sub-question: How are students addressing the information seeking?

3   Methodology

The study uses a case to answer the research questions. The participants were students from the first semester of the Mechanical Engineering and Energy Engineering programs at Aalborg University in the fall semester of 2017. The researcher interviewed 17/83 students who voluntarily agreed to participate. Each one of the participants was interviewed individually close to the project deadline. Students were from four project-work teams. The open-ended interviews lasted around 30 minutes each. They were videotaped, answered in English and transcribed verbatim. All students participated in the 30 ECTS semester activities, including the 10 ECTS collaborative PBL-project and the 5 ECTS course "Introduction to PBL", and all had previously completed a short-term pilot-project of 5 ECTS during the initial weeks. During the pilot-project, teachers and facilitators introduce students to project-work and problem formulation, according to the Aalborg PBL model (Aalborg University, 2015). In the following first semester project, the students apply the acquired skills to develop a disciplinary project chosen from a pool of approximately 10 projects aligned with the first semester curriculum. The open-ended interviews were conducted near the project-report submission deadline, focusing on several topics. The researcher will analyse the data thematically seeking recurring patterns and associations between those patterns (Braun et al., 2008; Terry et al., 2017).

The Thematic Analysis (TA) searches for relevant topics among the participants' verbatim responses. The study will use NVivo version 12 (QSR, 2015) to facilitate pattern searching among the responses. In addition, NVivo will help to analyse the answers from the coding and then grouping for themes in recurrent readings. It concludes by looking for association of patterns between the participants' responses.

4   Findings

Table 1 shows the themes found for the 17 participants according to their verbatim transcription. The analysis of information behaviour produces five groups with their sub-themes: Information Management (IM), skills, supervision, conflicts, and sharing.

The IM theme refers to the way students managed information in the project-work and the time they spent on it, as well. The IM has 11 relevant sub-topics described in Table 1. The sub-topics with the highest number of participants and recurrences indicate a consensus among students on initial information, information sources, classification, quality, and spending time in organizing data. In addition, the analysis found sub-themes regarding tasks to address information with roles and assignments. In this category, two subthemes describing how the students write relevant data for the report in parallel, i.e. when some were doing it simultaneously, or in serial when everyone writes the same step by step. Finally, just with a single participant, how the students store data, i.e. in the cloud.

The students' skills theme, mainly characterized by the lack of background regarding information for the problem formulation and its identification, as table 1 shows. In addition, this theme includes lacking experience in the project-subject, satisfaction for project-work, and abilities to search or find relevant information

Supervision grouped themes relates to the students' perception over the supervisors' role but also the understanding of the supervisors' experience with the relevant information to formulate and develop the project. Also, the TA found sub-themes such as lack of interaction with the supervisor for no get a negative personal reputation. Besides, two students declared some negative attitude in supervisors to provide data.

Information Conflicts (IC) refers to the spending energy of the individual to carry out the project tasks. The IC includes changes in motivation, internal struggles to address information, and the perceived consequences of the individual on the job on collecting data. Besides, five sub-themes emerged as consequences of conflicts such as a lot of information, frustration, randomness, few data collected and starting the project-work too late.

Sharing information is student perception about how any information with value was communicated between team members. These were divided into two sub-themes: effectiveness and meetings.

Table 1: Themes and recurrences regarding information

Theme	Participants	Recurrences
Information Management	17	409
Initial information	17	159
Information sources	14	68
Information classification	10	70
Information quality	10	27
Spending time	9	41
Having roles	6	20
Task assignation	3	5
Information purpose	3	4
Information is sequential for the report	1	7
Information is parallel for convenience	1	4
Cloud to manage	1	4
Skills	17	397
Information background	17	211
Information identification	13	117
Search satisfaction	8	30
Skills in search information	7	22
Subject knowledge background	6	17
Supervisor and information	17	103
Comes from supervisor	15	32
Supervisor knows information	9	44
Avoid because our background	2	9
Behaviourism	2	2
Expected from supervisor	1	16
Information conflicts	16	116
Lot of information	15	86
Frustration	6	14
Information is random	3	6
Minimal information	3	6
Start late	3	4
Share information	6	18
Effectively	6	16
In meeting	2	2

Figure 1 shows themes with the highest score from student interviews in TA. Dealing with initial information, information sources and information identification were the more recurrent claims followed by themes about information management, lot of data available, and information origin. The bigger the area the more relevant is for the students, helping to for cluster analysis in discussion section.

After coding students' interview answers with TA, the researcher selected themes with the highest recurrence and participation among the students to find a correlation between them. The mechanism to associate themes is the word frequency from the declared argument in the verbatim transcription. Correlation and word frequency with NVivo produced the grouping cluster shown in Figure 2. The cluster will be the starting point for the discussion in the next section.
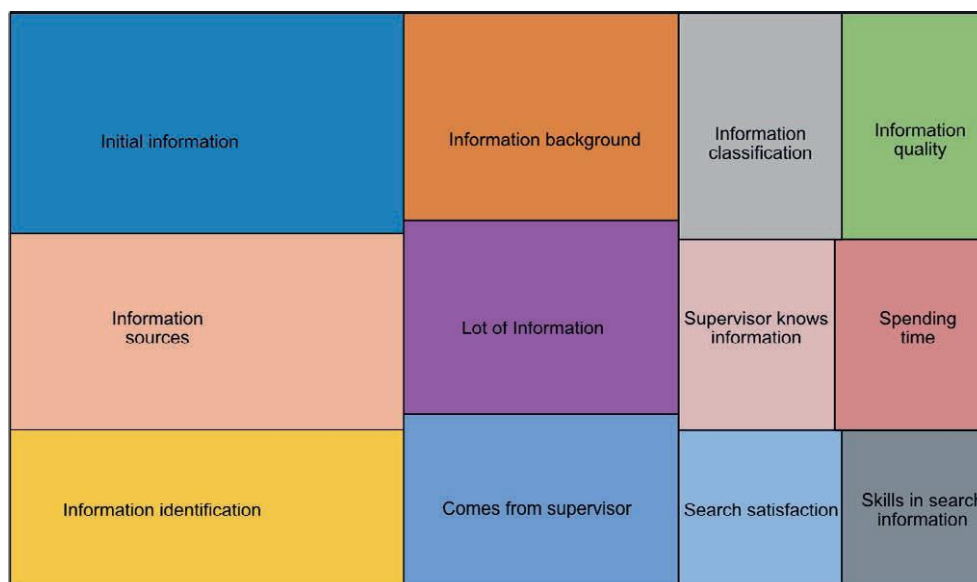

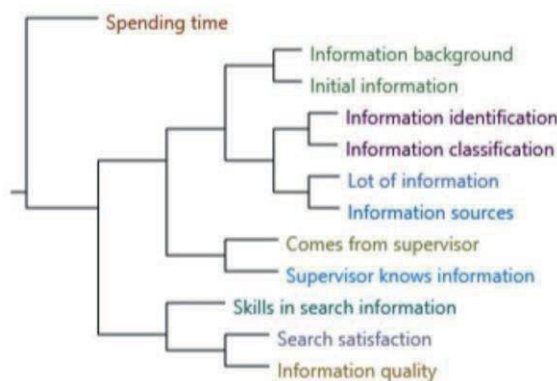Figure 1: Relevant themes select by recurrence. Adapted from Nvivo 12

Figure 2: Themes clustered by word similarities. Taken from Nvivo 12

5   Discussion

The findings in Figure 2 are consistent with the purpose of the PBL learning principles. In PBL, there is a premise about the students' responsibility in their learning as is pointed out by Kolmos and de Graaff (Kolmos et al., 2009; Kolmos & de Graaff, 2015). The complexity of the information and the initial lack of knowledge in the information push students to identify, collect and classify data to formulate the project problem that is a core in the Aalborg model (Holgaard et al., 2017). It was the more recurrent aspect grouping in 6 from 28 other themes.

The Figure 2 on the upper right side indicates a relationship between the students' experience and how they deal with the initial information. There is coherence with the project-work problem formulation. It could be explained moving ahead into the branches in the figure. These are marked by four main themes: (1) identification of information, (2) sources, (3) the amount and, (4) classification of data. As it emerged from the students' answers, at the late stage of the project-work and before receiving feedback on its results, it is evident that the students are aware of how important the information for the project is.

Identifying information is a skill that students must acquire during the project-work. That skill is not only an accreditation requirement (ABET, 2015; EUR-ACE, 2015), but it is a skill expected to lead project-work (de Graaff et al., 2016; Kofoed et al., 2003).

One student said:

"… it was a bit hard to decide because it said the technology in cell, relate to navigation, we found it's it's very new and they're still being launched a lot of newer methods and technologies, so those... had to find out what what do we were going to use and what was what is the best technology when there's always coming out new technologies… Student" S4

Seeking information is not restricted to databases, as students also tried to identify information from various external sources, causing them to use alternative ways to do tasks. Two other students said:

"…we had, we had interview with the Danish Red Cross, about how they built this, the kind of emergency, disaster, the…" S1

"sources because. what useful. what's not. what is reliable. so, we…" S2

"well, cutting it down to the information you wanted, was was very difficult part, finding individual information was easy enough, just google something else, or use university hear is, that's a base search site for every put in the report, to resolved it, or uses it for a copy and listening to, very convenient, so the information was easy to get, but the hard part was clearly to care down for what is wanted to use" S3

The above references are from questions related to the early stages of the project. At the end of the semester process, the students changed their minds about some aspects.

"…information, something like, the most of the information we used for our project…" S4

"… yes, yes, starting and finding this information immediately was very helpful, it wasn't a wasted all, because we all read something different meaning that we have a different understanding this diversity…" S5

Other engineering studies have also found that students spend more time in the problem formulation stages (Atman et al., 2013).

However, starting the project, there was uncertainty about the information and the lack of knowledge for collecting it. When students have to deal with uncertainty, learning happens (Rogers, 1965). However, its excess can cause unmotivated project-work as evidenced by students' answers related to early project stages; which is aligned with other studies (EBSCO, 2019). The branches of Figure 2 form two dyads of themes that are directly related, which in turn are paired between them. These are the identification and classification with the amount of information and the sources of information. Seemingly, there was a change from the beginning to the end of the project without any stress at the end for the outcome submission.

"still using it now, because now with all the things we, all the knowledge will gather…"
S6

''…informative, we found a lot of information that I didn't know about in the beginning…'' S7

Students recognized flaws in the ability to collect information, and then classify it. Structuring information is another skill that students must acquire. Students invested time structuring data as a task of the project-work. Several learning theories argue learning by doing (e.g. Kolb, 1984), meaning that if the project outcome was successful, this task supported student learning. In addition, it increases the self-efficacy as is stated in other studies (Phillips & Zwicky, 2018). One of the students' responses in this regardwas:

"…and to use everything, we spent a lot of time on structuring it properly and organising more I need it would I guess, say we spent bit too much time structure I'd say in the good part." S8

Below the information branches, there are two more related to the supervisor. The students recognize the supervisor's relevance for the project, being confident about his expertise. Thus, students understand the supervisor as one of the sources of information. That view could happen with two dynamics discussed in detail later. One of the dynamics is when the supervisor is reflective, encouraging students' reflection, causing questions that the supervisor answers. The other is a passive dynamic as the supervisor indicates where to look for the information, showing a path that students must take. Whatever the dynamics, together with the previous paragraph, it contradicts previous studies indicating that current generations believe they know much more and that they also approach information towards informality and ease (Anderson et al., 2001; Masters et al., 2008; Zhitomirsky-Geffet & Blau, 2017).

"…informative, we found a lot of information that I didn't know about in the beginning, and we have also have…" S9

The students waited for the supervisor to give them particular information they needed for the project. However, in line with the skills that students must acquire, supervisors were generally cooperative. One answer indicates a misperception about the role of supervisors, but other indicates cooperation.

"well we try to get more information from our what's called, supervisor but she" S10

" …you want to get more knowledge than you are free to ask them, and then theywill willingly give information to you, so I think that the level of figure out was very good…"
S11

"yeah sometimes we didn't know how to do things and then we just drive it out. And then, then we got something that probably showed us where we had our understanding and that was not correct with that ask our supervisor and he will correct us and say oh, this is something that you need to work on that this is how itworks. Yeah, we can always get help if something we don't understand" S12

At the same time, previous answers indicate that supervisors meet students solely for project issues. In addition, students found support from them to improve skills in information management.

"…therefore the teacher and I try to use this information to me understand how is…yeah this is yeah with the help of the supervisor it was easier…" S13

The last three arms in the lower-left area of the figure indicate the abilities to find information. The students' perception appears to be mediated by the satisfaction and quality of the information found. Students use various sources of information such as scientific articles, databases and external sources, which is consistent with the other studies (Wertz et al., 2013).

> *"…we set that from the beginning we made the very clear that we're gonna be good sources like books or articles, science articles from the internet and then you…"S14*

> *"…find good resources. the MAN diesel and Travels. the company which makes these engines so that we could research yeah it was it was pretty it was pretty good of sources". S 15*

Oppositely, other studies stated that first semester students handle mainly electronic information (Tenopir et al., 2010) for them and mainly from the internet or nearby experts to them.

As in the Aalborg model, students in any project work proposal must organize the information for their learning. Similar problems with the handling of information have been found in the learning models of various disciplines and models (e.g. Johri et al., 2014; Jones, 2017). As the information behaviour showed lack of skills in first-semester students, it could be learned as demonstrated by studies that indicate that advanced semester students manage information better than those of the first semester (Douglas et al., 2014). Thus, it could be learned early to get better learning from the beginning to the end of a curricular program.

6   Conclusion and future work

The study identifies relevant aspects of two introductory engineering programs within a curricular model of PBL. The information behavior of the PBL students supports that PBL is a useful practice to develop and support information skill in the students. Then, PBL has some differences with other general studies regarding information behavior in introductory students.

The study showed several ingredients of information management within PBL. The first one refers to the identification of the information, classification and relevance for the project-work. The second aspect is the role of the supervisor to promote reflection during the project-work and encourage skills in handling data. The third key aspect was the skilled background of the students to find information from rigorous sources, including external sources. Conflicts with information were marked by uncertainty when addressing the problem formulation. Both a lot of information and a lot of sources explain those information conflicts while developing learning in the project-work. At the same time, it became clear that a good portion of project-work, in the early stages, is consumed by getting information.

Since, the information behaviour is cultural, student experience the same issues for many other disciplines and models. Implementing strategies for facilitated student learning plays a role in favour of education. Future work includes answering questions like: What was the relationship between information behaviour and learning outcomes? Perhaps by reconfiguring the project-work intented outcomes in a model, both the product and the process could change student behaviours towards information management.

The study refers to the behaviour of the students with the information, therefore it is situational and therefore culture plays an important role. It could be interesting to find the relationship between the role played by individualistic versus collectivist cultures, or the relationship between idiocentric and allocentric behavioural particularities by some cultures. These characteristics of individuals in culture could have an effect on the ability to search for and share information as well as to manage it.

7 References

Aalborg University. (2015). *PBL- The Aalborg Model* (I. Askehave, H. L. Prehn, J. P. Morten, & T. Pedersen (Eds.)). http://www.aau.dk/digitalAssets/148/148025_pbl-aalborg-model_uk.pdf

ABET. (2015). *Accreditation Policy and Procedure Manual: Effective for Reviews During the 2016-2017 Accreditation Cycle*. www.abet.org

ABET. (2019). *2020-2021 Criteria for Accrediting Engineering Technology Programs*. www.abet.org

Abram, S. (2007a). Millennials: deal with them! Part I. *School Library Media Activities*, *24*(1), 57–58.

Abram, S. (2007b). Millennials: deal with them! Part II. *School Library Media Activities*, *24*(2), 56–58.

Allard, S., Levine, K. J., & Tenopir, C. (2009). Design engineers and technical professionals at work: Observing information usage in the workplace. *Journal of the American Society for Information Science and Technology*, *60*(3), 443–454. https://doi.org/10.1002/asi.21004

Anderson, C. J., Glassman, M., McAfee, R. B., & Pinelli, T. (2001). An investigation of factors affecting how engineers and scientists seek information. *Journal of Engineering and Technology Management*, *18*(2), 131–155. https://doi.org/10.1016/S0923-4748(01)00032-7

Atman, C. J., Adams, R. S., Cardella, M. E., Turns, J., Mosborg, S., & Saleem, J. (2013). Engineering Design Processes: A Comparison of Students and Expert Practitioners. *Journal of Engineering Education*, *96*(4), 359–379. https://doi.org/10.1002/j.2168-9830.2007.tb00945.x

Braun, V., Clarke, V., Braun, V., & Clarke, V. (2008). *Using thematic analysis in psychology Using thematic analysis in psychology*. *0887*(January). https://doi.org/10.1191/1478088706qp063oa

Chaudhry, A. S., & Al-Mahmud, S. (2015). Information literacy at work. *The Electronic Library*, *33*(4), 760–772. https://doi.org/10.1108/EL-04-2014-0063

Chen, M. L., Mourshed, M., & Grant, A. (2013). The $250 billion question: Can China close the skills gap? *McKinsey Report*, *May*, 17–18.

de Graaff, E., Holgaard, J. E., Bøgelund, P., & Spliid, C. M. (2016). When Students Take the Lead. In R. V Turcan, J. E. Reilly, & L. Bugaian (Eds.), *(Re)Discovering University Autonomy: The Global Market Paradox of Stakeholder and Educational Values in Higher Education* (pp. 125–135). Palgrave Macmillan US. https://doi.org/10.1057/9781137388728_9

Dobbs, R., Manyika, J., & Woetzel, J. (2015). *How U.S. companies can fill the skills gap*. Fortune. https://fortune.com/2015/05/12/how-u-s-companies-can-fill-the-skills-gap/

Douglas, K. A., Wertz, R. E. H., Fosmire, M., Purzer, S., & Van Epps, A. S. (2014). First year and junior engineering students' self-assessment of information literacy skills. *ASEE Annual Conference and Exposition, Conference Proceedings*.

EBSCO. (2019). *The Google Generation is at Your Library 's Door : How (Information) Literate are Today's College Students?* https://www.ebsco.com/sites/g/files/nabnos191/files/acquiadam-assets/The-Google-Generation-is-at-Your-Library-Door-White-Paper.pdf

Enders, T., Hediger, V., Hieronimus, S., Klier, J., Schubert, J., & Winde, M. (2019). *Future skills: Six approaches to close the skills gap* (Issue January).

EUR-ACE. (2015). *EUR-ACE Framework Standards and Guidelines*. /Users/Fernando/Documents/Project

Fullerton, A., & Leckie, G. (1999). Information literacy in science and engineering undergraduate education: faculty attitudes and pedagogical practices. *College and Research Libraries*, *January 1999*, 9–29. http://www.ala.org/ala/mgrps/divs/acrl/publications/crljournal/1999/january99/leckie.pdf

Grenčíková, A., & Vojtovič, S. (2017). Relationship of generations X, Y, Z with new communication technologies. *Problems and Perspectives in Management*, *15*(2), 557–563. https://doi.org/10.21511/ppm.15(si).2017.09

Holgaard, J. E., Guerra, A., & Kolmos, A. (2017). Getting a Hold on the Problem in a Problem-Based Learning Environment. *International Journal of Engineering Education*, *Vol. 33*(No. 3), 1070–1085.

Johri, A., Teo, H. J., Lo, J., Dufour, M., & Schram, A. (2014). Millennial engineers: Digital media and information ecology of engineering students. *Computers in Human Behavior*, *33*, 286–301. https://doi.org/10.1016/j.chb.2013.01.048

Jones, M. L. W. (2017). Information Behavior and Knowledge Management in Project-Based Learning (PBL*) Engineering Teams: A Cultural-Historical Activity Theory Approach. In *ProQuest Dissertations and Theses*.

Kofoed, L., Hansen, S., & Kolmos, A. (2003). Teaching and Learning Process Competencies by Experimentation and Reflection. *Das Hochschulwesen. Forum Für Hochschulforschung, -Praxis Und -Politik*, *6*,12.

Kolb, D. A. (1984). The process of experiential learning. In *Experiential Learning*. Prentice Hall.

Kolmos, A., & de Graaff, E. (2015). Problem-based and project-based learning in engineering education: Merging models. In D. Johri & B. M. Olds (Eds.), *Cambridge Handbook of Engineering Education Research* (pp. 141–160). Cambridge University Press. https://doi.org/10.1017/CBO9781139013451.012

Kolmos, A., de Graaff, E., & Du, X. (2009). Diversity of PBL- PBL learning principles and models. In X. Du, E. de Graaff, & A. Kolmos (Eds.), *Research on PBL practice in Engineering Education* (pp. 57–69). Sense Publishers.

Lattuca, L. R., Terenzini, P. T., & Volkwein, J. F. (2006). Engineering Change: A Study of the Impact of EC2000 - Executive Summary. *ABET, Inc.*, 23.

Leckie, G. J., Pettigrew, K. E., & Sylvain, C. (1996). Modeling the information seeking of professionals: a general model derived from research on engineers, health, care professionals, and lawyers. *Library Quartely*, *66*(2), 161–193.

Masters, C. B., Schuurman, M., Okudan, G., & Hunter, S. T. (2008). An investigation of gaps in design process learning: Is there a missing link between breadth and depth? *ASEE Annual Conference and Exposition, Conference Proceedings*.

Mercer, K., Weaver, K. D., & Stables-Kennedy, A. J. (2019). Understanding undergraduate engineering student information access and needs: Results from a scoping review. *ASEE Annual Conference and Exposition, Conference Proceedings*.

Moore, J. P. aus dem, Chandran, V., & Schubert, J. (2018). The Future of Jobs in the Middle East. In *World Government Summit* (Issue January).

Phillips, M., Fosmire, M., Turner, L., Petersheim, K., & Lu, J. (2019). Comparing the Information Needs and Experiences of Undergraduate Students and Practicing Engineers. *The Journal of Academic Librarianship*, *45*(1), 39–49. https://doi.org/10.1016/j.acalib.2018.12.004

Phillips, M., & Zwicky, D. (2018). Information literacy in engineering technology education: A case study. *Journal of Engineering Technology*, *35*(2), 48–57.

QSR. (2015). *NVivo qualitative data analysis Software ;QSR International Pty Ltd. Version 11*.

Rogers, C. R. (1965). *Client-centered therapy, its current practice, implications, and theory*. Houghton Mifflin.

Shuman, L. J. (2005). The ABET "Profesional Skills"-Can They Be Taugh? Can They Be Assesses? *Journal of Engineering Education*, *94*(1), 13–25.

Taylor, A. (2012). A study of the information search behaviour of the millennial generation. *Information Research*, *17*(1).

Tenopir, C., Wilson, C. S., Vakkari, P., Talja, S., & King, D. W. (2010). Cross Country Comparison of Scholarly E-Reading Patterns in Australia, Finland, and the United States. *Australian Academic & Research Libraries*, *41*(1), 26–41. https://doi.org/10.1080/00048623.2010.10721432

Terry, G., Hayfield, N., Clarke, V., & Braun, V. (2017). Thematic Analysis. In C. Willig & W. S. Rogers (Eds.), *The SAGE Handbook of Qualitative Research in Psychology* (Vol. 46, Issue 08, pp. 46-4720-46–4720). SAGE Publications Ltd. https://doi.org/10.4135/9781526405555

Wellings, S., & Casselden, B. (2019). An exploration into the information-seeking behaviours of engineers and scientists. *Journal of Librarianship and Information Science*, *51*(3), 789–800. https://doi.org/10.1177/0961000617742466

Wertz, R. E. H., Purzer, Ş., Fosmire, M. J., & Cardella, M. E. (2013). Assessing Information Literacy Skills Demonstrated in an Engineering Design Task. *Journal of Engineering Education*, *102*(4), 577–602. https://doi.org/10.1002/jee.20024

Zhitomirsky-Geffet, M., & Blau, M. (2017). Cross-generational analysis of information seeking behavior of smartphone users. *Aslib Journal of Information Management*, *69*(6), 721–739. https://doi.org/10.1108/AJIM-04-2017-0083