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## Sources Fostering Academic Well-Being: Students' Perspectives In A PBL Context

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# Contributing Factors to Academic Well-being: Mechanical Engineering Students' Perspectives in A PBL Context

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## ABSTRACT

In a post-pandemic learning era, student academic well-being emerges to the attention of educational researchers. Referring to students' thoughts and behaviors that contribute to doing well in an educational context and their academic life satisfaction, student academic well-being has a significant influence on their recruitment and retention, learning experience, academic achievement, and competence development.

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However, while academic well-being has been regarded as an important indicator of student persistence in their current study and learning outcomes, limited studies have explored engineering students' academic well-being and other supportive factors in engineering education. While several studies have examined how well-being is constituted and how it can be measured from medical, mental health, and eudaimonic philosophical perspectives, understanding engineering student academic well-being from social-cognitive and sociocultural aspects is also important. This is because well-being is not only influenced by personal feelings and perceptions, but also dynamically framed by interpersonal relations, as well as contextual and institutional conditions. To increase retention and help engineering students to become agentic professionals, it is desirable to help them to become proactive and purposeful learners in their studies.

Thus, aimed at filling in this literature gap, this study will adopt the Q methodology to explore how engineering students perceive the sources contributing to their academic well-being in a Danish university. Suggestions will be proposed to optimize future curriculum design to support student academic well-being.

## **1 INTRODUCTION**

In a post-pandemic learning era, students' academic well-being in higher education has gained attention due to its significant influence on students' persistence in their majors, learning experience, academic performance, and competence development (Huamán and Berona 2021; Korhonen et al. 2014). Academic well-being refers to students' views and behaviors contributing to doing well in an educational context and their academic life satisfaction (Donohue and Bornman 2021; Shek and Chai 2020). Understanding students' academic well-being and related impact factors enables educators to help students have better learning experiences and become agentic professionals by optimizing the current learning environment. In engineering education, a rich body of literature has conceptualized and measured students' well-being from diverse perspectives ranging from philosophy and psychology to medicine and mental health (Castro-Sitiriche et al. 2012; Danowitz and Beddoes 2020; Telang et al. 2021). Such efforts provide insights into complex components of students' academic well-being, nevertheless, it remains unclear how the learning environments foster and support students' academic well-being by providing various sources for their learning. Thus, this study explored how engineering students perceive the supportive sources of their academic well-being, particularly, in PBL contexts. Methodologically, the study contributes to the current literature by adopting Q methodology to provide insights into students' subjectivity related to the attainment and improvement of their academic well-being. The research question in this study is:

What are the contributing factors to engineering students' academic well-being from engineering students' perspectives?

## **2 RESEARCH CONTEXT**

This research project is carried out at a leading Danish University that adopts a systemic PBL curriculum design for both undergraduate and graduate engineering programmes. In each semester, students are expected to gain 15 European Credit Transfer System (ECTS) credits from courses and projects separately. In this systemic PBL practice, students become the center of learning by identifying, analyzing, and solving real-life problems in teamwork, while educators take the role of supervisors to facilitate students' learning process. Within this context, students' engagement in the learning environment, with multiple human and non-human resources has a significant influence on their learning outcomes, competence development, learning experience, as well as academic well-being. While the academic benefits of a systemic PBL curriculum design on students' learning experience and competence development have been reported (Kolmos et al. 2021), more attention is needed to explore in which ways students' academic well-being could be supported in this specific learning context. Thus, as a part of a research project on academic well-being, this paper presented a pilot study using a 31-item Q-sort to explore students' perspectives of sources fostering their academic well-being. This study has received ethical approval from the university.

## **3 METHODOLOGY**

Q methodology is primarily concerned with exploring subjectivity by providing a holistic understanding of participants' internal viewpoints (Ellingsena et al. 2010). It has been identified as a "quali-quantological" method because it enables researchers to gain qualitative findings through applying statistical analysis methods (Parker and Alford 2010). Prior studies identified five steps in conducting Q methodology (Ellingsena et

al. 2010; Brown 1980), which are 1) identifying the concourse; 2) developing a Q set with representative statements; 3) specifying the respondents (P-set); 4) implementing Q sorting and post-sorting activities; and 5) conducting factor analysis and interpretation.

### 3.1 Concourse and Q Set Development

In this study, the Q concourse, which refers to a collection of all conceivable statements related to a specific topic (Brown 1980), was developed using a theoretical framework of sources fostering students' academic well-being. Based on a literature review on academic well-being in higher education and validated by the authors' prior study (Chen et al. 2023), this proposed framework contains two domains, including internal sources and external sources. Specifically, internal sources refer to students' personal values and attitudes, such as intrinsic motivation, autonomy, intention, and self-efficacy, that support their academic well-being throughout the study process (Lewis et al. 2009; Stanton et al. 2016; Schmidt and Hansson 2018). External sources focus on the supporting factors from the learning environment that foster students' academic well-being, including interactions with peers, interactions with professionals, support from family and friends, and available resources from the learning environment (Larcus et al. 2016; Trolian et al. 2022; Yukhymenko-Lescroart et al., 2015).

Table 1. Q set of sources for engineering students' academic well-being

Domains	Themes	Statements
Internal sources	Personal values	<ul style="list-style-type: none"> <li>- Enjoying what I study</li> <li>- Feeling motivated in my study</li> <li>- Aspiring for a good career through my academic work</li> <li>- Choosing my study program following my interest</li> <li>- Taking responsibility for my own learning process</li> <li>- Developing professional competencies through my study</li> <li>- Working with people from diverse backgrounds</li> <li>- Feeling financially secured for my study</li> <li>- Having a balance between study and my personal life</li> </ul>
	Agentic actions	<ul style="list-style-type: none"> <li>- Monitoring my academic growth to reach my goals</li> <li>- Being able to solve academic problems</li> <li>- Having clear goals for my academic success</li> <li>- Managing my time well</li> <li>- Making decisions based on what I think is important</li> <li>- Challenging myself to reach my full (academic) potential</li> <li>- Being able to accomplish academic tasks well</li> <li>- Being able to manage stress related to academic work (e.g., stay calm during exams, work towards deadlines, etc.)</li> </ul>
External sources	Interactions within learning environments	<ul style="list-style-type: none"> <li>- Communicating with my peers efficiently</li> <li>- Expressing my opinions comfortably in group discussions</li> <li>- Developing teamwork strategies together with my peers</li> <li>- Reflecting with my peers on our progress toward common goals</li> <li>- Making contributions to the team</li> <li>- Experiencing mutual trust in my study context</li> <li>- Feeling comfortable in the physical study environment</li> <li>- Feeling my performance is fairly assessed in my study context</li> </ul>
	External support	<ul style="list-style-type: none"> <li>- Sharing my academic experience with my family</li> <li>- Communicating efficiently with my instructors/supervisors</li> <li>- Sharing my academic experience with my friends outside my study</li> <li>- Communicating with professional communities (e.g., industry, companies, associations)</li> <li>- Having access to needed resources (literature, databases, software, library services, etc.) in my study</li> <li>- Having access to student support/consulting services at the university</li> </ul>

With the guide of this theoretical framework, a 37-item survey was designed and validated in the authors' prior empirical study (Chen et al. 2023). An initial concourse was further revised and condensed by the research team and later reviewed through two rounds of expert review and one round of student review and pilot, in which

process six statements were deleted because of overlap or irrelevance. The final Q set for this study contained 31 statements, shown in Table 1.

### 3.2 Data Collection and Analysis

With a Q set extracted from the concourse, this study identified engineering students as the respondents (P-set) (McKeown and Thomas, 2013). Participants were recruited from a mechanical bachelor program with students in their fourth-semester study. Among 43 students, 13 students volunteered to participate in this Q study and provided effective responses, including one female, ten males, and two students who preferred not to specify their genders. This is an acceptable number to provide various perspectives in Q methodology.

With the Q set of various sources printed on individual cards, a paper-based version of the Q sorting activity was completed by the participants. They responded to the following condition of instruction: “Based on your experience, what aspects/factors contribute to your academic well-being”, and then ranked the statements from “most relevant” (+4) to “least relevant” (-4).

After the Q sorting, participants were invited to answer several post-sorting questions, including their background information (e.g. gender, semester, nationality, and discipline), and the reasons for their choice of the two most/least ranked items.

Table 2. Results of the factor analysis

Part. No.	Factor Group	Factor 1	Factor 2	Factor 3
<b>Factor One</b>				
10	F1-1	0,6983	0,0292	0,1947
9	F1-2	0,6415	0,4285	0,1256
3	F1-3	0,6225	0,1433	0,4468
13	F1-4	0,6102	0,1421	-0,1102
4	F1-5	0,5813	0,3937	-0,3991
12	F1-6	0,5186	0,3347	0,2150
5	F1-7	0,5170	0,1065	0,3119
<b>Factor Two</b>				
6	F2-1	0,1502	0,9053	0,2550
11	F2-2	0,1321	0,8092	0,3110
<b>Factor Three</b>				
8	F3-1	0,0032	0,1111	0,7686
7	F3-2	0,4272	0,3594	0,5901
<b>Unloaded Statements</b>				
2	F1-8	0,3771	0,2363	-0,0363
1	F2-3	0,1981	0,4015	-0,0426

The last step in Q methodology is factor analysis and interpretation. Using centroid extraction followed by theoretical rotation (Brown 1980), factor analysis was conducted via a Q-analysis software named KADE to identify correlations between the sorting results from participants. A three-factor extraction solution was decided, based on statistical standards and meaningful interpretation of participants' viewpoints (Brown 1980). The results of the factor analysis, explaining 55% of the opinion variance, are reported in Table 2.

## 4 RESULTS

This section illustrates three different viewpoints emerging from the Q sorting and factor analysis. The numbers of statements are indicated in brackets, along with the assigned values in the specific factor array. For example, #1/+4 means that statement 1 has the value of 4 in the factor array of the specific viewpoint. “D” shown in the brackets indicates a significantly distinguishing statement from other factors ( $p$ -value < .05), while “D\*” refers to a higher level of significance ( $p$ -value < .01).

#### **4.1 Viewpoint 1 – Doing academically well while maintaining a healthy balance**

Seven participants, including one female and six males, loaded significantly on Viewpoint 1, accounting for 23% of the variance. These students highlighted internal aspects contributing to academic well-being, which focused on developing their academic competence and maintaining a healthy study-life balance, as the most relevant source to support their academic well-being. As a majority group of participants, students in Viewpoint 1 emphasized their ability to accomplish academic tasks well (#2/+4, D\*) and solve academic problems (#1/+2, D\*). They also valued a healthy balance between study and life (#10/+4, D\*), which distinguished them from other viewpoints. This perspective was further reflected in their post-survey questions, as one wrote, “*I need to have a good balance between school and my life because my free time is important to me, otherwise I would feel burnt out (F1-1)*”.

In general, participants in this group ranked external aspects less relevant to fostering their academic well-being. In particular, they did not value peer support (#6/-1; #7/-1), interdisciplinary/intercultural teamwork (#22/-4), or mutual trust in their learning context (#15/-2, D), as supportive sources for their academic well-being. As explained by Viewpoint 1 participants in the post-sorting questions, these external sources were not considered a priority from a technical point of view, such as to become a good engineer in the future, while academic qualities were highly valued in the engineering field. Thus, they did not feel that the physical learning environment nor teamwork skills had an impact on their academic well-being. Further, a few other aspects were ranked less relevant to their academic well-being, such as making decisions based on what they thought was important (#17/-2, D\*), feeling financially secured for their study (#19/-1, D\*), and taking responsibility for their learning process (#29/-1).

#### **4.2 Viewpoint 2 – Enjoying the study with intrinsic motivation**

Viewpoint 2 comprised two participants (one male and one preferring not to say) and accounted for 19% of explained variance. In comparison to Viewpoint 1, participants in this group also highlighted the contribution of internal aspects to their academic well-being, but with different emphases. Viewpoint 2 participants highly valued their intrinsic motivation, emphasizing the enjoyment of study (#21/+4), and personal feelings of being motivated (#23/+4). They were also distinguished from other viewpoints by engaging in actions that developed their professional competence (#9/+3, D) and challenged themselves to reach their full potential (#31/+3, D\*). As one wrote, “*Feeling motivated and enjoying what I study is quite important to me, and it helps me to keep studying when courses become difficult.*”

Unlike respondents from Viewpoint 1, Viewpoint 2 participants pointed out the contributions of external aspects to their academic well-being. They were distinguished from other viewpoints by emphasizing the importance of the physical learning environment for their academic well-being. They needed to feel comfortable in this environment (#13/+2) and have access to needed resources (literature, databases, software, library services, etc.) (#14/+2, D).

While communication with instructors and supervisors (#27/+1, D) was valued by Viewpoint 2 participants, communication with teammates (#3/-3), family (#5/-3), and friends outside their study (#20/-3) was identified as irrelevant sources to their academic well-being. According to these participants, these aspects were neither important nor helpful for academic learning and well-being.



Composite Q sort for Factor 1

-4	-3	-2	-1	0	1	2	3	4
Sharing my academic experience with my friends outside my university	Monitoring my academic growth to reach my goals	Reflecting with my peers on our progress toward common goals	Feeling financially secured for my study	Feeling comfortable in the physical study environment	Being able to manage stress related to academic work (e.g., stay)	Being able to solve academic problems	Feeling motivated in my study	Having a balance between study and my personal life
Working with people from diverse backgrounds	Having access to student portofolioing services at the university	Making decisions based on what I think is important	Developing teamwork strategies together with my peers	Communicating with my peers efficiently	Developing professional competencies through my study	Making contributions to the team	Choosing my study program following my interest	Being able to accomplish academic tasks well
Sharing my academic experience with my family	Communicating with professional committees (e.g.,)	Taking responsibility for my own learning process	Having clear goals for my academic success	Managing my time well	Enjoying what I study	Feeling my performance is fairly assessed in my study context	Feeling my performance is fairly assessed in my study context	Feeling motivated in my study
Experiencing mutual trust in my study context	Communicating efficiently with my on/supervisors	Having access to needed resources (literature, databases)	Expressing my opinions comfortably in group discussions	Aspiring for a good career through my academic work	Challenging myself to reach my full (academic) potential			

**Legend**

- \* Distinguishing statement at P< 0.05
- \*\* Distinguishing statement at P< 0.01
- z-Score for the statement is higher than in all other factors
- ◄ z-Score for the statement is lower than in all other factors

Fig. 1. The Q sort for Factor 1

Composite Q sort for Factor 2

-4	-3	-2	-1	0	1	2	3	4
Working with people from diverse backgrounds	Communicating with professional committees (e.g.,)	Having a balance between study and my personal life	Having clear goals for my academic success	Developing teamwork strategies together with my peers	Making decisions based on what I think is important	Feeling my performance is fairly assessed in my study context	Developing professional competencies through my study	Enjoying what I study
Sharing my academic experience with my family	Sharing my academic experience with my friends outside my university	Choosing my study program following my interest	Being able to solve academic problems	Reflecting with my peers on our progress toward common goals	Communicating efficiently with my on/supervisors	Feeling comfortable in the physical study environment	Being able to manage stress related to academic work (e.g., stay)	Feeling motivated in my study
Communicating with my peers efficiently	Managing my time well	Being able to accomplish academic tasks well	Being able to solve academic problems	Making contributions to the team	Taking responsibility for my own learning process	Having access to needed resources (literature, databases)	Challenging myself to reach my full (academic) potential	Feeling motivated in my study
Monitoring my academic growth to reach my goals	Having access to student portofolioing services at the university	Experiencing mutual trust in my study context	Expressing my opinions comfortably in group discussions	Aspiring for a good career through my academic work				

**Legend**

- \* Distinguishing statement at P< 0.05
- \*\* Distinguishing statement at P< 0.01
- z-Score for the statement is higher than in all other factors
- ◄ z-Score for the statement is lower than in all other factors

Fig. 2. The Q sort for Factor 2

Composite Q sort for Factor 3

-4	-3	-2	-1	0	1	2	3	4
Having access to student portofolioing services at the university	Sharing my academic experience with my friends outside my university	Being able to accomplish academic tasks well	Communicating with professional committees (e.g.,)	Expressing my opinions comfortably in group discussions	Choosing my study program following my interest	Taking responsibility for my own learning process	Making contributions to the team	Developing teamwork strategies together with my peers
Monitoring my academic growth to reach my goals	Sharing my academic experience with my family	Having access to needed resources (literature, databases)	Communicating efficiently with my on/supervisors	Managing my time well	Making decisions based on what I think is important	Feeling my performance is fairly assessed in my study context	Feeling financially secured for my study	
Having a balance between study and my personal life	Challenging myself to reach my full (academic) potential	Working with people from diverse backgrounds	Developing professional competencies through my study	Being able to manage stress related to academic work (e.g., stay)				
Reflecting with my peers on our progress toward common goals								

**Legend**

- \* Distinguishing statement at P< 0.05
- \*\* Distinguishing statement at P< 0.01
- z-Score for the statement is higher than in all other factors
- ◄ z-Score for the statement is lower than in all other factors

Fig. 3. The Q sort for Factor 3

### 4.3 Viewpoint 3 –Peer learning in project team

Viewpoint 3, explaining 13% of the opinion variance, contains two male students. In contrast with the other factors, participants in this group highly valued the external support from teamwork and peers to foster their academic well-being. Specifically, they highly ranked four statements relating to teamwork, including developing teamwork strategies together with peers (#6/+4, D\*), communicating with peers efficiently (#3/+3, D\*), making contributions to the team (#8/+3), and experiencing mutual trust in the study context (#15/+2, D). While participants in other groups identified working with people from diverse backgrounds as the least relevant source, participants in Viewpoint 3 ranked this statement as a positive source.

Although these external sources related to teamwork and peer support were highly valued, other external sources of support from the learning environment were ranked low by Viewpoint 3 participants. They devalued the need for having access to needed resources (#14/-2, D\*) and receiving student support/consulting services at the university (#16/-4) for their academic well-being. Accordingly, they emphasized the importance of the immediate learning environment over the broader institutional environment.

In the domain of internal aspects/sources, similar to Viewpoint 2 participants, students in this group also emphasized the enjoyment of study (#21/+4), making decisions (#8/+3), and taking responsibility for their learning process (#29/+2) which may be related to their teamwork environment. However, different from students in other

groups, internal sources related to agentic actions were assigned less relevance to their academic well-being, including developing academic competence (#1/-1; #2/-2), aspiring for a good career through their academic work (#25/-3, D), and challenging themselves to reach their potential (#31/-1, D). They did not value setting goals (#4/-3; #28/-4) as a highly relevant source to support their academic well-being, as explained by one student: “I don’t care much about my academic goals. Sometimes it only makes me feel stressed.”

In sum, in terms of sources contributing to academic well-being, Viewpoint 3 participants valued intrinsic motivation (e.g. enjoyment and autonomy) more than extrinsic motivation (e.g. expectations of a good career and competence development). In the domain of external sources, they highlighted the support from peers and teamwork, while contributions of the broader learning environment to their academic well-being were limited.

#### 4.4 Consensus Statements

Several consensus statements were identified among the three viewpoints, as shown in Table 3. In the domain of internal sources, students in the three groups agreed that monitoring their academic growth to reach their goals was an irrelevant source for their academic well-being. In the domain of external sources, their feelings of being fairly assessed in the study context were ranked high among all three groups, indicating the importance of assessment procedures for academic well-being. Furthermore, two statements related to communication with professional communities and families were both identified as irrelevant sources to academic well-being. For one, engineering students in their first two years of study have not yet established relationships and networks with professional communities, while becoming independent from family relationships may be a typical happenstance in the transition to the university context.

No.	Statement	F1 Q-SV	F1 Z-score	F2 Q-SV	F2 Z-score	F3 Q-SV	F3 Z-score
5*	Communicating with professional communities (e.g., industry, companies, associations)	-2	-0,819	-3	-1,307	-1	-0,477
7*	Reflecting with my peers on our progress toward common goals	-2	-0,551	0	0	0	-0,159
9	Developing professional competencies through my study	1	0,510	3	1,310	1	0,160
11*	Feeling my performance is fairly assessed in my study context	3	1,048	2	0,871	2	0,819
13*	Feeling comfortable in the physical study environment	0	0,416	2	0,871	0	0
20*	Sharing my academic experience with my family	-3	-1,987	-3	-1,307	-3	-1,296
23	Feeling motivated in my study	3	1,077	4	1,740	1	0,810
24	Being able to manage stress related to academic work (e.g., stay calm during exams, work towards deadlines, etc.)	1	0,520	3	1,310	2	0,819
27	Communicating efficiently with my instructors/supervisors	-1	-0,470	1	0,440	-1	-0,650
28*	Monitoring my academic growth to reach my goals	-3	-1,090	-2	-0,871	-4	-1,638
30*	Expressing my opinions comfortably in group discussions.	1	0,447	1	0,436	0	0

Table 3. Consensus Statements

\* All Listed Statements are Non-Significant at  $p < 0.01$ , and Those Flagged with an \* are also Non-Significant at  $p < 0.05$

## 5 DISCUSSION AND CONCLUSION

This paper illustrates various engineering students' perspectives of supportive sources for their academic well-being in a PBL context. While many participants valued the support of internal sources for fostering their academic well-being (Stanton et al. 2016; Trolian et al. 2022), others emphasized the contributions of external sources, such as peer support and teamwork (Schmidt and Hansson 2018; Trolian et al. 2022). Based on the findings, this study highlighted the importance of educators and universities to provide students with various sources when designing the curriculum, which enables them to choose and use these available sources based on their subjectivities to foster their academic well-being (Trolian et al. 2022). As a pilot study, one limitation of this study is the small sample size. The results only reflected 13 participants' viewpoints, while students who were not involved in this study might have different opinions. Future studies will be conducted with more participants and in different learning environments for a wider representation of viewpoints on sources of academic well-being.

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