CONNECTIONS BETWEEN EDUCATION AND RESEARCH: ENGINEERING STUDENTS' PERSPECTIVES AND EXPERIENCES

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Abstract

Research-oriented methods are playing an increasingly important role in higher education; therefore, understanding students' attitudes toward research is essential for strengthening the integration of research into engineering study programs. To empirically investigate these issues, a survey was conducted involving civil engineering students from Kaunas University of Technology (KTU) and the Lithuanian Engineering College (LIK). The study examined six key aspects determining students' engagement in research activities: (1) knowledge of research, (2) value-based interest in research, (3) enjoyment of working with scientific literature, (4) enjoyment of working with empirical data, (5) tolerance for uncertainty, and (6) tolerance for disappointment. The study showed that 50.23% of KTU and 30.36% of LIK participants are interested in research. Similar results were obtained regarding working with scientific literature and empirical data. Accordingly, 17.9% of respondents from Kaunas University of Technology and 6.07% of respondents from LIK expressed satisfaction. This phenomenon can be explained by the fact that more educated and independent students are more likely to choose engineering universities than colleges with the same profile. The results of this research are useful for curriculum developers seeking to strengthen the role of research in engineering studies.

Keywords: research-based learning, engineering education, tolerance of frustration, research motivation, higher education.

1 INTRODUCTION

The integration of education and research is considered one of the most important factors in ensuring the quality of modern higher education. The scientific literature emphasizes that universities should not only transfer knowledge but also involve students in the process of its creation, thus developing analytical and critical thinking skills [1]. Research-based learning allows students to better understand the logic of the discipline, methods of scientific cognition and practical application of knowledge.

Brew notes that the interaction of studies and research strengthens the academic environment, because teachers convey not only theoretical content, but also relevant scientific questions, methodology and research culture [2]. Such an approach promotes student autonomy and motivation to learn, and the study process becomes closer to real scientific and professional practice. Meanwhile, Jenkins and Healey emphasize that the most effective integration is achieved when students actively analyze scientific articles, interpret data and participate in solving problems, and not just passively familiarize themselves with research results [3].

In engineering and technology studies, research integration is particularly important due to the rapid technological change and sustainability challenges. Prince and Felder found that active learning methods, based on real scientific problems, improve students' conceptual understanding and ability to apply knowledge in practice [4]. In addition, research-based teaching promotes interdisciplinarity and the search for innovative solutions, which is necessary in modern engineering.

An example of the application of these principles can be the Kaunas University of Technology module "Composite and Wooden Structures", in which the study content is systematically supplemented with the analysis and interpretation of real scientific research. This approach allows students not only to become familiar with the theoretical foundations of materials science, but also to develop the ability to critically evaluate scientific information and apply it in practical contexts.

For example, the study by Nizevičienė et al. on the treatment of phosphogypsum with zeolite and its use in binding materials becomes not only a study material, but also an object of discussion [5]. When analyzing this study, students examine the physical and chemical properties of materials, evaluate

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technological solutions for waste recycling and their impact on the environment. Systemic thinking is also encouraged, linking different disciplines - chemistry, environmental engineering and construction technologies.

In addition, such research-based learning creates the prerequisites for forming the concept of sustainable construction, emphasizing the importance of the principles of the circular economy and the development of innovative materials. Students are involved in problem-based tasks in which they have to propose possible solutions to real industrial or environmental problems, based on scientific research data.

A similar methodological approach is applied in the module “Toxicology and Human Safety”, where inquiry-based learning allows students to delve into the effects of harmful substances on the human body, analyze risk assessment methods and get acquainted with the latest scientific research in this field. Here, students often work with case studies, evaluate real situations and learn to make informed decisions in the context of health safety.

Such integrated study examples not only strengthen the acquisition of theoretical knowledge, but also develop essential competencies: critical thinking, problem solving, an interdisciplinary approach and the ability to apply scientific research in practice. Ultimately, this helps students to better understand the relevance of the disciplines under study and their importance in solving modern technological and environmental challenges.

Summarizing the literature, it can be stated that the integration of research and studies increases the relevance of studies, develops critical thinking and helps prepare specialists who are able to make evidence-based decisions. This direction is considered a strategic condition for the development of higher education, ensuring the innovativeness and competitiveness of universities in the global academic space.

The aim of this study is to examine and compare the perspectives and experiences of engineering students from Kaunas University of Technology (KTU) and the Lithuanian Engineering College (LIK) with regard to research, by identifying key factors influencing students’ engagement in research based learning and by evaluating the significance of integrating research and education within engineering study programs.

2 METHODOLOGY

Student survey. A survey was conducted among students from two higher education institutions: Kaunas University of Technology (KTU) and the Lithuanian Engineering College (LIK). A total of 228 civil engineering students from KTU and 268 from LIK participated in the survey. Data were collected using a structured questionnaire consisting of six thematic subscales, each comprising five specific items. This data collection approach is classified as a quantitative questionnaire-based survey method. Respondents’ attitudes and perceptions were measured using a five-point Likert scale. Participants were asked to indicate their level of agreement with a series of statements, ranging from 1 = Strongly Disagree to 5 = Strongly Agree. The Likert-type scale was chosen because it allows for the systematic quantification of subjective attitudes and is widely used in educational and social science research to assess beliefs, perceptions, and self-reported experiences.

The use of a symmetric five-point response format provided respondents with a neutral midpoint (Neither agree nor disagree), thereby reducing forced choices and increasing the reliability of responses. The collected data were treated as ordinal and were subsequently analyzed using descriptive statistical methods.

3 RESULTS

3.1 Understanding of research among KTU and LIK students

Table 1 presents students’ conceptual understanding of research among respondents from Kaunas University of Technology (KTU) and the Lithuanian Engineering College (LIK). The results indicate that students from both institutions demonstrate a generally solid understanding of fundamental research concepts, although KTU students consistently report higher levels of agreement across most statements. This trend suggests a stronger internalisation of research-related concepts at the university level, potentially reflecting differences in institutional mission, curriculum structure, and exposure to research-based learning.

Most respondents in both groups perceive research as a systematic, scientifically grounded process aimed at generating or deepening knowledge and involving empirical data collection, indicating a solid basic understanding of core research principles. However, the noticeable presence of neutral responses suggests that for some students, this understanding remains largely theoretical and is not fully supported by hands-on experience, limiting their ability to contextualize and apply research concepts in practice.

Table 1. Students' (KTU/LIK) conceptual understanding of research knowledge.

Statement	*Strongly disagree*	*Disagree*	*Neither agree, no disagree*	*Agree*	*Strongly agree*
To me, research is a systematic examination of a problem	4%/3%	0%/3%	**29%/20%**	**36%/53%**	**32%/20%**
Research is a process based on scientific methods that aims to generate new knowledge or deepen existing knowledge	4%/3%	4%/3%	4%/8%	36%/39%	**54%/46%**
Scientific research involves the collection of data (surveys, experiments, observations, etc.) and its interpretation for scientific or academic purposes	7%/3%	0%/3%	7%/7%	39%/42%	46%/44%
Scientific research is unnecessary in higher education.	**46%/31%**	**21%/41%**	**7%/20%**	**21%/3%**	4%/5%

The clearest institutional differences are seen in responses to the claim that research is unnecessary in higher education: while most students in both groups reject this view, KTU students do so more decisively, whereas LIK students more often choose a neutral position. This suggests differences in how research is valued across university and college-oriented study pathways and underscores the need to strengthen research integration in engineering education.

Taken together, the findings demonstrate that engineering students at both institutions possess a generally sound conceptual understanding of research. However, the stronger rejection of research-sceptical views and the slightly higher levels of strong agreement among KTU students point to a more firmly established research culture at the university level. These differences underline the importance of systematically integrating research-based learning approaches, particularly in professional higher education institutions, to strengthen students' understanding of the role and value of scientific research in engineering studies.

3.2 Students' interest in research as part of academic and professional development

Table 2 presents students' attitudes toward research as a component of academic and professional development at KTU and LIK. Overall, the findings indicate a generally positive orientation toward research among students from both institutions, particularly when research is associated with skills development and future career benefits.

Table 2. Students' (KTU/LIK) attitudes toward research as a component of academic and professional development.

Statement	*Strongly disagree*	*Disagree*	*Neither agree, no disagree*	*Agree*	*Strongly agree*
I aim to gain new knowledge and practical experience that will be useful for my studies or future career	0%/2%	4%/3%	18%/19%	**36%/44%**	**43%/32%**
I want to contribute to scientific progress and solutions that can benefit society	7%/ 3%	0%/2%	**18%/44%**	**43%/32%**	**32%/19%**
It is important to me to develop critical thinking, research, and analytical skills	4%/2%	0%/0%	**11%/17%**	43%/44%	**43%/37%**
Research is required to obtain a master's degree	4%/7%	7%/10%	39%/36%	29%/29%	21%/19%

Students from both institutions perceive research primarily as a means of acquiring knowledge, practical experience, and transferable skills relevant to future careers, particularly critical thinking and analytical abilities. At the same time, institutional differences emerge in how research is valued beyond instrumental benefits: KTU students more strongly associate research with scientific progress and societal impact, whereas LIK students more often adopt a neutral stance. Uncertainty regarding research as a formal academic requirement—especially at the master's level—suggests that students tend to view research less as a mandatory component of academic progression and more as a supportive or enabling element of their educational pathway, shaped by institutional context and exposure to research based learning.

In summary, students from both KTU and LIK demonstrate a positive attitude toward research, especially in relation to competence development and career preparation. However, KTU students exhibit a stronger orientation toward research as a contributor to scientific advancement and societal benefit. These findings point to the importance of strengthening research-based learning practices, particularly in college level institutions, in order to foster deeper intrinsic motivation and a broader understanding of the role of research in academic and professional development.

3.3 The joy of working with academic literature

Figure 1 shows students' enjoyment of working with academic literature at the Lithuanian Engineering College (LIK) and Kaunas University of Technology (KTU). The results reveal an overall positive attitude toward engaging with scientific literature in both institutions, although notable differences in the level of enjoyment and confidence can be observed between the two student groups.

KTU students display a more clearly expressed enjoyment of working with academic literature, suggesting greater familiarity with scientific texts and more frequent integration of scholarly sources into their studies. This pattern likely reflects a stronger emphasis on research-based learning at the university level, where students are more regularly exposed to reading, analysing, and applying academic literature in coursework and research tasks.

LIK students also demonstrate interest in academic literature, but a larger proportion of responses indicate moderate enjoyment or neutrality. This may point to more limited experience with scholarly texts or a curriculum more strongly oriented toward practical and applied learning, where engagement with academic literature plays a less central role.

a) *b)*

Figure 1. Students' enjoyment of working with academic literature: LIK (a) and KTU (b). Here: - Easily, without major problems; - Moderately – I can find the information, but sometimes have difficulty evaluating or analysing it; - Poorly – I often have difficulty finding and/or properly analysing the necessary information; - All necessary information is provided by my academic advisor.

Overall, the findings suggest that while students from both institutions recognize the importance of academic literature, systematic and guided engagement with scientific texts is crucial for increasing students' confidence and enjoyment. Strengthening literature-based learning activities may further support the development of critical reading, analytical thinking, and research competencies essential for engineering education and research-based learning.

3.4 Students' enjoyment of empirical and practical research activities

Table 3 presents students' evaluations of their enjoyment in working with empirical data at KTU and the LIK. Overall, the findings indicate a strong positive attitude toward practical and empirical aspects of learning among students from both institutions, particularly when research activities involve real-world applications and hands-on engagement.

Table 3. Students' (KTU/LIK) attitudes toward and enjoyment of working with empirical data.

Statement	*Strongly disagree*	*Disagree*	*Neither agree, no disagree*	*Agree*	*Strongly agree*
Applying theoretical knowledge to real-world situations	4%/2%	0%/2%	**32%/14%**	39%/36%	**25%/47%**
Working with actual measurement equipment and technologies	4%/2%	0%/0%	**11%/2%**	**32%/46%**	54%/51%
Analyzing real data and interpreting results	4%/2%	4%/2%	21%/20%	**43%/49%**	29%/27%
Troubleshooting and improving measurement accuracy	**0%/5%**	4% / 3%	**43%/12%**	**46%/51%**	**7%/29%**
The opportunity to solve real-world problems, not just theoretical tasks	4%/2%	4%/0%	7%/2%	39%/36%	**46%/61%**

Although troubleshooting and improving measurement accuracy elicited a higher share of neutral responses - especially among KTU students - suggesting it is perceived as more demanding, students largely reported strong enjoyment of empirical activities overall. High levels of agreement were observed for applying theoretical knowledge in real-world contexts, working with actual measurement equipment, analysing real data, and solving practical engineering problems. In particular, working with measurement technologies and addressing real-world challenges were rated most positively, indicating that empirical tasks are experienced as engaging and professionally meaningful and effectively strengthen the connection between academic studies and engineering practice.

In summary, both KTU and LIK students report a high level of enjoyment when working with empirical data, particularly in contexts that enable hands-on experimentation, real-world problem solving, and the application of theoretical knowledge in practice. These findings highlight the educational value of empirically oriented, research-based learning in engineering studies and suggest that strengthening such approaches can enhance student motivation, engagement, and the development of professional competencies.

3.5 Students' tolerance of uncertainty in research related decision making

Table 4 illustrates students' decision-making strategies under conditions of uncertainty among respondents from KTU and the LIK. Overall, the findings suggest that students from both institutions tend to adopt active and reflective approaches when dealing with uncertainty, favouring information gathering, consultation, and risk assessment rather than impulsive or avoidant decision making.

Table 4. Students' (KTU/LIK) decision-making strategies under conditions of uncertainty.

Statement	*Strongly disagree*	*Disagree*	*Neither agree, no disagree*	*Agree*	*Strongly agree*
I make a decision based on the information I have and my intuition	**0%/5%**	7%/5%	**21%/31%**	**50%/44%**	**21%/15%**
I try to gather more information, even if it delays the decision	0%/2%	4%/0%	**14%/20%**	**54%/64%**	**29%/14%**
I consult with other people (my supervisor, professors)	**7%/2%**	0%/0%	11%/10%	**39%/56%**	**43%/32%**
I postpone the decision or avoid it until I have enough information	**4%/12%**	**14%/20%**	**18%/36%**	**50%/22%**	14%/10%
I assess the possible consequences and choose the least risky option	**0%/7%**	4%/7%	**21%/15%**	**64%/54%**	**11%/17%**

A majority of students in both groups reported relying on available information combined with intuition when making decisions under uncertainty, but even stronger support was expressed for gathering additional information despite potential delays, indicating a willingness to prioritize decision quality over speed. Consultation with supervisors or other academic staff was also widely endorsed by both KTU and LIK students, highlighting the role of collaboration and external guidance in managing uncertainty and suggesting that students tend to view uncertain situations as a shared, rather than purely individual, challenge in academic and research contexts.

More varied responses were observed for strategies involving decision avoidance. Although half of KTU students agreed that they sometimes postpone decisions until sufficient information is available, LIK students were more likely to select neutral or disagreeing responses. Finally, assessing potential consequences and choosing the least risky option received strong support in both groups, particularly among KTU students, indicating a preference for rational and risk-minimising approaches. Taken together, these findings suggest that students generally demonstrate adaptive tolerance of uncertainty, relying on information seeking, consultation, and careful evaluation rather than avoidance - an important competency for research-based learning and engineering practice.

3.6 Students' tolerance of frustration during research activities

Table 5 presents students' responses to frustration encountered during research activities at KTU and the LIK. Overall, the results indicate that students from both institutions generally demonstrate constructive coping strategies when facing research-related difficulties, suggesting a moderate to high level of frustration tolerance.

Table 5. Students' (KTU/LIK) responses to frustration during research activities.

Statement	*Strongly disagree*	*Disagree*	*Neither agree, no disagree*	*Agree*	*Strongly agree*
I look for what went wrong and try to change the course of the research	0%/2%	4%/5%	**25%/14%**	**54%/63%**	18%/17%
I feel disappointed, but I continue working according to the original plan	**0%/7%**	4%/8%	**21%/32%**	**61%/44%**	**14%/8%**
I ask my instructor or classmates for help or advice	0%/2%	0%/3%	**4%/17%**	**68%/39%**	**29%/39%**
I lose motivation and find it difficult to continue the research	7%/10%	**21%/27%**	36%/32%	25%/22%	11%/8%
I accept this as a learning experience and evaluate the result for what it is	4%/2%	**11%/5%**	25%/29%	**43%/49%**	18%/15%

A clear majority of students reported actively addressing research challenges by identifying problems and adjusting their research approach, indicating a predominantly problem oriented response to setbacks. Many students also demonstrated perseverance by continuing their work despite feelings of disappointment, a tendency that was more pronounced among KTU students. In addition, seeking support from instructors or peers emerged as a widely accepted coping strategy, underscoring the importance of social and academic support networks in sustaining motivation and progress during challenging research activities.

Negative reactions to frustration, such as losing motivation and struggling to continue the research, were less strongly endorsed. Although some students selected neutral responses, relatively small proportions expressed agreement with this statement, indicating that frustration does not typically lead to disengagement. Moreover, many respondents reported accepting setbacks as learning experiences and evaluating outcomes constructively, reinforcing the view that students tend to interpret difficulties as an integral part of the research process rather than as failures. Collectively, these findings suggest that both KTU and LIK students exhibit adaptive frustration tolerance, an essential trait for successful engagement in research based learning and professional engineering practice.

4 CONCLUSIONS

- Engineering students at both Kaunas University of Technology (KTU) and the Lithuanian Engineering College (LIK) demonstrate a solid conceptual understanding of research; however,

the stronger research orientation among KTU students indicates a more established research culture at the university level.

- Students from both institutions show a positive interest in research, mainly valuing it for competence development and career preparation, while KTU students more strongly associate research with scientific advancement and societal impact.
- Engagement with academic literature is viewed positively by students overall, though higher enjoyment and confidence among KTU students suggest that systematic exposure to research-based learning enhances literature related competencies.
- Empirical and practical research activities are highly valued by students from both institutions, as they strengthen student engagement, enhance the relevance of studies, and bridge theoretical knowledge with engineering practice.
- Working with empirical data plays a significant role in increasing students' motivation and professional competence, confirming the importance of empirically and research-based learning approaches in engineering education.
- Both KTU and LIK students demonstrate adaptive tolerance of uncertainty and moderate to high tolerance of frustration, relying on reflective decision making, information seeking, collaboration, and constructive coping strategies-key competencies for successful research based learning and professional engineering practice.

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