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PAPER

The Future of Integrated Business and Engineering: Reading Skills of Business and Engineering Students

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ABSTRACT

Reading literacy is a key competence for vocational education in technical and economic fields. This study analyzes the level of sub-reading processes of text processing in 443 students aged 17 years to investigate the differences in cognitive performance between technical and economic studies. Using a standardized test, it was found that the overall performance of the students is low. Significant correlations were noted between higher cognitive processes, particularly between thinking about the content and drawing inferences. Statistically significant differences between fields of study were found using the Mann-Whitney U test. Engineering students were significantly more successful in information retrieval compared to economics students. The findings underscore the need to develop reading skills across disciplines and promote the integration of technical and economic thinking. The results have implications for curriculum design and pedagogical practice aimed at developing integrated professional competencies. Activities promoting the ability to work with technically structured texts and strengthening interdisciplinary elements through business simulations, case studies, or team projects should be systematically included. Inspiration can be drawn from successful interventions or the implementation of school standards and shared materials for reading activities, which the OECD identifies as examples of good practice.

KEYWORDS

reading skills, technical education, economic education, PISA test

1 INTRODUCTION

In an era of digitalization and rapid technological development, literacy is becoming a key competence that goes beyond traditional reading comprehension. It is no longer simply the ability to decode written text, but a complex skill to critically interpret, analyze, and apply information in a variety of contexts, including the digital environment [1]. Literacy is essential not only for academic success but also for professional employment in the dynamic work environment of the 21st century [2]. According to PISA (2018) Assessment and analytical framework's reading literacy: *"understanding,*

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using, evaluating, reflecting on and engaging with texts in order to achieve one's goals, to develop one's knowledge and potential and to participate in society" [3], p. 28. However, studies show that literacy, which is part of functional literacy, especially in STEM fields, is becoming an increasing challenge in modern society. A functionally literate person is someone who is able to participate in all activities where literacy is necessary for the effective functioning of the group and community in which they find themselves [4]. The authors have shown that engineering students perform relatively poorly in functional literacy [5]. This raises the question of whether the education system can develop the kind of reading literacy of students that will enable them to meet their personal and professional needs in real life related to the competence of reading and producing written texts in the fields of technology and engineering. The modern innovative society increasingly links the worlds of technology and business. Technical professionals need to understand the economic context, and managers or economists need to face technological challenges. Also, the European Key Skills Framework considers both STEM competencies and entrepreneurship as core competences for the 21st century [6]. This finding is acknowledged by another study that highlights effective methods for developing STEM competences [7].

According to the PISA survey, students from Singapore, Ireland, Japan, the Republic of Korea, and Taiwan were found to have the best reading literacy scores by a wide margin. Czech students performed worse than students from these countries in the survey, but their results were above average compared to the average OECD member country. The average score of students from OECD countries decreased in 2022 compared to 2018. There was a greater deterioration in reading literacy performance for European Union countries [1]. Given that our study targets the situation of reading literacy among Czech students, it is important to note that there is a relatively large group of students in a PISA survey whose lack of reading skills may prevent them from effectively dealing with everyday situations that require reading and comprehension of text. The ability to comprehend, reflect on and critically evaluate text is becoming increasingly important in relation to the rapid development of artificial intelligence tools that students are facing and in relation to the development of digital literacy [8]. Digital literacy refers to the ability to access, understand, communicate, and create information through digital devices and technologies [9]. Many individuals lack the necessary digital literacy to protect themselves from these problems [10]. Students with poor reading literacy may be disadvantaged not only in their studies or work but also in their everyday social life [1]. However, there is still a question whether poor reading literacy results are also achieved by older Czech students of higher education aged 16+ and whether their results differ according to the field of study. In view of the increased need to link economic and technical competences and the study of economic subjects among students of technical disciplines [11], our study is aimed at exploring this area in the context of Czech education. Therefore, the subject of our investigation is the following research question:

RQ: Are there significant differences in cognitive performance of the reading sub-activities between students in economics and engineering programs?

2 LITERATURE REVIEW

The PISA measure goes deeper in its definition of literacy. It does not see literacy as just reading, as decoding the text, or as reading aloud. Reading literacy is defined as a broad spectrum of cognitive and linguistic skills, ranging from basic decoding of characters to knowledge of words, grammar, and more complex syntactic structures to connecting the meaning of a text to one's own knowledge of the world. Metacognitive skills are also included. That is the ability to have an awareness of effective strategies for working with text and the ability to use them when reading [3]. Research has pointed out that higher-order thinking, which includes metacognition, has long been confirmed as a critical success factor, both in the academic field and in the workplace [12]. Literacy rests on three pillars—texts, which are used to read; processes, which represent the cognitive activities performed when working with text; and scenarios, which represent model situations and coherent text. Reading processes are considered to be at the core of literacy and are covered by the following cognitive activities: information retrieval, understanding the text, and evaluation and reflection [3]. The situation is illustrated by the research oriented towards finding out the level of reading comprehension of university students. This skill is essential for career advancement, but many students face obstacles in this area. Poor reading skills can make employment prospects more difficult, highlighting the need for interventions tailored to students' needs during their studies [13]. This fact is confirmed by an international study focused on examining interdisciplinary differences in reading literacy among university students of economics and technical programs [14]. The authors used standardized English tests focused on reading comprehension and listening comprehension and statistically evaluated the differences using the Mann-Whitney U test. Students in technical programs achieved significantly better results in reading comprehension than students in economics programs. The study thus shows that the focus of their field of study also affects the level of students' reading skills at the tertiary level.

One of the most recent studies [15] presents several conclusions through meta-analysis. Children's use of digital devices alters the structure and function of their developing brains. Research in 2021 from the US [16] has shown the negative impact of digital reading on word processing. Digital reading leads to a more superficial approach to text than traditional print in the form of books or textbooks. Research responds to these scientific findings through further experiments. It has been found that chatbots could be beneficial in the learning process, especially for improving the reading skills of the young generation [17].

International surveys show that the type of study program, even at secondary schools, is significantly related to reading literacy across different education systems [18]. An international case study examined differences in reading habits and skills between university students in STEM programs and humanities and economics programs. For STEM students, reading and attitudes toward reading had a stronger influence on academic performance. The attitudes toward their reading predicted reading habits differently in the two groups, and reading habits together with attitudes were better predictors of academic success for STEM students than for students in other fields [19].

Research [20] shows that students' attitudes towards ICT significantly influence their literacy performance, and this relationship may be further mediated by students' economic ability. Students' economic ability positively influences their attitudes towards ICT, which may have a mediating effect on their reading performance [21]. On the other hand, engineering education requires a strong emphasis on problem solving, critical thinking, and practical application of knowledge [22]. Problem solving is central to engineering education [23]. Many students leave engineering majors for business careers, arguing that incorporating a business context into STEM curriculum can improve learning outcomes and retain more students in engineering majors [11]. A number of technical universities have introduced entrepreneurship courses for engineers. Two-thirds of engineering students surveyed perceive entrepreneurship education as broadening their career options, while studies point to a lack of entrepreneurship topics in existing programs. As a result, universities have begun to incorporate more new courses, programs, and hands-on projects focused on the business aspects of technology, often with the support of professional organizations (e.g., the National Academy of Engineering). The goal is to produce engineers who, in addition to science and technology, can identify opportunities, understand market forces, commercialize new products, and have the leadership and communication skills to push their ideas [24]. Jobs are becoming more complex and often combine multiple roles, e.g., companies are looking for engineers with a business mindset, analysts able to understand the technical aspects of data, or managers oriented in modern technology [25].

2.1 Justification of the need for the study and derivation of hypotheses

The question of whether and how the level of reading processes (skills) differs between students of different academic backgrounds has not yet been sufficiently explored. It is the differences between economics and engineering students that represent a major research gap. Traditionally, economics programs emphasize working with text, interpreting data, and understanding complex socioeconomic phenomena, while engineering majors focus on exact thinking, algorithmization, and the application of technology [5]. These different educational approaches may lead to different levels of literacy development and thus different readiness of students to solve real-world problems in digital environments. This issue is crucial for the formation of economic competence in students of technical degree programs [21]. Today, we can observe an increase in appropriate teaching tools, such as business simulations, which can significantly influence the development of economic competence in technical students. These simulations, evaluated according to didactic, technological, and organizational criteria, represent an innovative way to link technical and economic thinking while promoting literacy through interactive learning [21]. Examining the level of reading literacy among students of secondary technical and economic programs is important due to their dominance (40%) among four-year schools ending with a school-leaving examination [26].

Based on the above findings, the study aims to investigate whether there are significant differences in reading literacy between students of economics and engineering degree programs. Such research will not only contribute to a deeper understanding of the learning needs of different groups of students but can also provide an empirical basis for the design of targeted curriculum interventions and teaching strategies that reflect the specificities of each degree program. Although our research focuses on 17-year-old vocational school students, which differs from the international PISA assessment, we fully respect the methodology of this assessment. The following hypotheses emerge from the objective and are tested:

- H1: There is a correlation between performances in the sub-cognitive activities of the reading text processing processes.
- H2: Performance in the cognitive activity of text information retrieval depends on the field of study (technical and economic).
- H3: Performance in the cognitive activity of literal meaning depends on the field of study (technical and economic).
- H4: Performance in the cognitive activity of integrating and generating inferences depends on the field of study (technical and economic).
- H5: Performance in the cognitive activity of the content reflection and form depends on the field of study (technical and economic).

3 MATERIAL AND METHODS

3.1 Data and procedure

The process phase of the study was conducted on a quantitative and empirical basis. The study was carried out as a pilot during March–May 2025. The object of the research was to investigate how Czech secondary school students of economic and technical studies at the age of 17 develop their reading literacy at the level of text processing and to find significant differences in cognitive ability scores between disciplines and by the year of study. Because reading text processing is considered to be at the core of reading literacy, comprising 65% of it, we chose it as the dominant component of our study. Reading processes consist of the ability to search for information, to comprehend text, and to judge and reason [3]. We included these cognitive activities in our survey according to PISA 2018 and 2019 (refer to Table 1) and used three standardized independent texts based on PISA 2018. The questions related to the independent texts were selected according to the success rate of their solution by Czech pupils aged 15. Furthermore, the selection of standardized texts and questions was conditioned by the cognitive processes most commonly used in technical, engineering, and economics education. For example, engineering education promotes systems thinking and creativity [27]. Teaching engineering is a challenging task because it emphasizes the development of students' higher-order skills, such as not only systems thinking but also problem-solving and creativity in an interdisciplinary science and technology context [28]. One of the important cognitive processes is thinking [29]. Economic education should promote the development of higher-order thinking, the development of creative skills across the discipline of economics, etc. Economic thinking requires the ability to reason about content and form, assess quality and credibility, interpret and visualize data, draw implications, etc. [30].

Literacy is defined in six levels. Students who do not reach this level do not have sufficiently developed the skills necessary to participate fully in life. PISA 2018 or 2022 [3] highlights the fact that the literacy scale is not constrained from above, and therefore setting an upper limit for the highest literacy level of exceptionally proficient students is burdened with a degree of uncertainty. However, it can be assumed that these students can correctly answer questions whose difficulty corresponds to the highest, sixth level.

Table 1. Specification of the cognitive reading process of text processing

<table>
<tr><th>The Reading Process of Text Processing</th><th>Cognitive Activity, Abbreviations</th><th>Level of Difficulty of Texts</th></tr>
<tr><td>Locate information</td><td>Text information retrieval (COGN 4)</td><td>Separate text No 1
Level 4 – High</td></tr>
<tr><td rowspan="3">Understanding the text</td><td>Literal meaning (COGN 1)</td><td>Separate text No 2
Level 3 – medium</td></tr>
<tr><td rowspan="2">Integrate and generate inferences (COGN 3)</td><td>Separate text No 2
Level 5 – very high</td></tr>
<tr><td>Separate text No 3
Level 5 – very high</td></tr>
<tr><td>Evaluate and reflect</td><td>Reflect on content and form (COGN 2)</td><td>Separate text No 2
Level 5 – very high</td></tr>
</table>

Source: p. 13–14, 61–63 [1].

The cognitive activities included in the reading text processing (refer to Table 1) represent an overlap of lower and higher cognitive goals [31]. The high difficulty of the independent text question 1 focusing on information retrieval (COGN 4) was ensured by offering additional time-based data in the answer choices, including such formats that also required inference. This question was correct for 56% of Czech pupils aged 15 in the PISA survey [1], p. 61. The medium-difficulty question for independent text 2 with an emphasis on literal meaning (COGN 1) tested whether the pupil understood a key passage that was essential for working with other texts in this task. Approximately 57% of Czech pupils gave the correct answer to this question [1], p. 62–63. The very high difficulty of the question for independent text 2 focusing on integrating and generating inferences (COGN 3) was ensured by the fact that the pupil had to demonstrate that he/she understood the gist of the text by linking information from the text. In selecting the correct options, the learner had to distinguish not only cause and effect but also essential information from non-essential information. Less than 20% of Czech pupils answered the question correctly [1], p. 66. The very high difficulty for independent text 3 with emphasis on integrating and generating inferences (COGN 3) is that the text contains conflicting views, and for the interpretation, it is necessary to understand its overall meaning. Czech students' performance on PISA was 8% worse than the OECD average [1], p. 15. The very high difficulty of the independent text of question 2 with a focus on reflecting on content and form (COGN 2) is that the student had to fill it in with whether the selected statements from the text represent facts or opinions. To do this, he or she had to first understand the literal meaning of each statement and then assess whether the statement factually described the content of the book or the course of events or expressed the opinion of the author. All statements were correctly identified by about 22% of Czech pupils in the PISA survey [1], p. 63.

3.2 Research sample

The research sample was focused on Generation Z students aged 17 years in economics and engineering degree programs. The participants were students from secondary vocational schools. The choice of this age group was conditioned by the fact that there is a relatively large group of Czech students aged 15 with insufficient reading skills in the PISA survey. Therefore, we focused on older students at the further education level, who go beyond the PISA survey and could not participate in the last PISA survey of 2022. Students from five secondary schools in the Czech Republic, which implement technical (engineering) and economic study programs, were included in the research. These are secondary economic schools (especially business academies) and secondary technical schools. In the Czech secondary vocational education system, secondary technical schools and business academies are two important types of four-year schools that end with a school-leaving examination. In the academic year 2022/2023, approximately 60,000 students were enrolled in technical fields and around 20,000 students in economic fields (i.e., business academies and related fields) in secondary vocational schools offering maturita programs. Overall, these two areas together represent approximately 40% of all students in secondary vocational schools offering maturita programs. Admission to both types of schools is conditional on passing a unified entrance exam in the Czech language and mathematics, the results of which form a significant part of the applicant's overall assessment. The curricular framework of both schools is based on framework educational programs, but they differ in their subject focus. Business academies emphasize language training (two foreign languages are compulsory) and economics and business subjects such as accounting, marketing, law, and financial literacy. The curriculum also includes a minimum of four weeks of professional practice [32]. Secondary technical schools, on the other hand, focus primarily on technical and scientific disciplines. Emphasis is placed on mathematics, physics, information technology, and specialized technical subjects (e.g., design, technology, and machine operation), and the curriculum includes practical instruction in workshops and laboratories [33]. These differences may have an impact on the development of reading literacy. Both types of schools provide secondary education with a school-leaving examination, which corresponds to the level of upper secondary vocational education in the international classification and allows direct access to tertiary education [34].

The selection of schools was deliberate and was also based on the researchers' experience with the setting in which they have experience in the form of professional interaction in preparing students for university through secondary school vocational activities. We wanted to ensure that the sample included a combination of students. It means those who have higher ambitions in the area of further professional development through cooperation with a university and those who do not have such goals in the area of professional development and further education. Out of the planned 560 students involved, a total of 443 respondents volunteered to participate in the survey to test their reading levels of word processing. The conditions for their participation in the survey were their field of study (economics or engineering) and their age of 17 years, i.e., corresponding to the second year of study in the field. The 79.1% return rate replicates the lower than expected interest of students in participating in the survey. 166 students in the technical field and 277 students in the economic field participated in the survey. It is therefore clear that the results cannot be generalized to all technical and economic schools without further research. However, the structure of our sample corresponds to the main distribution of vocational education and provides a valid insight into both directions of secondary vocational education.

3.3 Collection method

In order to answer the research question and test the defined hypotheses, we used a test method based on standardized texts and questions from the PISA 2018 survey [1]. The wording of the texts was original. Since the research was conducted in the context of Czech education, we used Czech translations of the texts. Therefore, it was not necessary to test the validity and reliability of the research instrument, a test focusing on reading processes of text processing. The testing was anonymized, and all sensitive data was encrypted. The research received ethical review and approval and complied with all institutional procedures. The researchers also obtained written consent from the students involved in the investigation as well as from the management of the participating schools. The test was conducted in one class period with a 45-minute allotment while maintaining uniform conditions across all participating institutions. The test was created in an online environment, and students did not see the results of the survey after submitting their answers. The design of the test, including the score at the level of each question, is shown in Table 2.

Table 2. Types of questions for reading sub-processes and scores

The Reading Process	Cognitive Activity	Text and Type of Question	Score Range
Searching for information	Searching for information in text	Separate text No 1 4 statements, true/false	0–4
Understanding the text	Literal meaning	Separate text No 2 4 statements, true/false	0–4
	Integrate and generate inferences	Separate text No 2 4 statements, true/false	0–4
		Separate text No 3 Just one correct answer out of four options	0–1
Evaluate and reflect	Reflect on content and form	Separate text No 2 4 statements, true/false	0–4

3.4 Data analysis

The null hypotheses were verified at the 5% significance level:

- H_{0-1}: There is no correlation between performances on the cognitive sub-activities of reading text processing.
- H_{0-2}: Performance in the cognitive activity of information retrieval in text is independent on the field of study (technical and economic).
- H_{0-3}: Performance in the cognitive activity of literal meaning is independent on the field of study (technical and economic).
- H_{0-4}: Performance in the cognitive activity of integrating and generating inferences is independent on the field of study (technical and economic).
- H_{0-5}: Performance in the cognitive activity on the content reflection and form does not depend on the field of study (technical and economic).

The original data obtained are of several types. The variable expressing the descriptive characteristics of the students, i.e., field of study, is a nominal variable and is used as a sorting factor to perform the comparative analysis. The data contains numerical variables using standardized test scores. Performance in the cognitive sub-activities as well as overall performance is described by the percentage of correct responses. Because the data do not meet the requirement of normality (verified by the Shapiro-Wilk test) but do meet the requirement of homogeneity of variances (verified by the Levene test), the Mann-Whitney U test was selected from the two-sample tests to assess the H2–H5 hypotheses. The results are shown in Tables 3 and 4.

Table 3. Normality test (Shapiro-Wilk)

Variable	W	*p*
COGN 1 (Literal meaning)	0.699	<.001
COGN 2 (Reflect on content and form)	0.572	<.001
COGN 3 (Integrate and generate inferences)	0.754	<.001
COGN 4 (Text information retrieval)	0.801	<.001

Table 4. Homogeneity of variances test (Levene's)

Variable	F	df	df2	*p*
COGN 1	0.82617	1	441	0.364
COGN 2	0.18605	1	441	0.666
COGN 3	0.61213	1	441	0.434
COGN 4	0.00342	1	441	0.953

A correlation matrix was constructed to determine the correlation relationships between variables in the case of testing hypothesis H1. The tables presented in the Results section show only part of it. The field inside the body of the table always contains the value of Spearman's correlation coefficient *rho*. The compared variables are discrete and ordinal with a limited number of categories. They do not meet the normality requirement. A non-parametric type of correlation was chosen, Spearman's correlation coefficient, whose calculation is based on the order of values. It does not require normality or continuity and works well even with categorical variables. Statistical analysis was performed using SPSS.

4 RESULTS

The results are presented in order of hypotheses.

4.1 Correlation matrix of performance in cognitive activities of reading text processing (H1)

Hypothesis H1 was evaluated using Spearman's correlation coefficient *rho*, which were used to find correlations between performances in the cognitive sub-activities of reading processes (refer to Table 5). Statistical analysis was performed at 95% confidence level.

Table 5. Correlation matrix

		COGN 1 (Literal Meaning)	COGN 2	COGN 3
Reflect on content and form (COGN 2)	Pearson's *r*	0.021	–	
	p	0.662	–	
	Spearman's *rho*	–0.005	–	
	p	0.922	–	
Integrate and generate inferences (COGN 3)	Pearson's *r*	–0.068	0.171	–
	p	0.155	<0.001	–
	Spearman's *rho*	–0.102	0.163	–
	p	0.031	<0.001	–
Text information retrieval (COGN 4)	Pearson's *r*	–0.106	0.088	0.069
	p	0.025	0.065	0.147
	Spearman's *rho*	–0.107	0.109	0.066
	p	0.024	0.022	0.162

The correlation analysis shows that these variables are correlated with each other. A significant correlation was found between these variables. The cognitive activity of literal meaning (1) is negatively correlated with integration and generation of inferences (3) and retrieving information in text (4). The cognitive activity of reflecting on content and form (2) is positively correlated with the ability to link and draw inferences (3) and retrieve information in text (4). Correlations were not found between cognitive activity 1 and 2, i.e., the literal meaning of text and content and form reflection, nor between cognitive activity 3 and 4, i.e., integration and generation of inferences and searching for information in text. At the 5% significance level, we reject the hypothesis H_{0-1}.

4.2 Differences in performance of cognitive activities of reading processes between business and engineering students (H2–H5)

Performance in cognitive activities connected to processing of text reading was described by the arithmetic mean and standard deviation pooled across all participating students (refer to Table 6). In the reading skills for the entire sample ($n = 443$), the mean test performance was found to be 41.2%. There are no large differences in average performance between the fields of study, although the average test pass rate for engineering students is 41.6% and for economics students 41%.

Table 6. Descriptive statistics – performance in reading processes of text processing per test

Field	Mean	Median	Standard Deviation	Minimum	Maximum
Total ($n = 443$)	0.412	0.429	0.053	0.048	0.571
Economic ($n = 277$)	0.410	0.429	0.051	0.238	0.571
Technical ($n = 166$)	0.416	0.429	0.058	0.048	0.524

Table 7 shows the results of the reading cognitive process sub-activities for the whole sample and also for the field of study.

Table 7. Descriptive statistics – performance in cognitive activities of reading processes

	Field	COGN 1 Literal Meaning	COGN 2 Reflect on Content and Form	COGN 3 Integrate and Generate Inferences	COGN 4 Text Information Retrieval
Mean	Economic	0.484	0.685	0.494	0.367
	Technical	0.476	0.688	0.494	0.401
	Total	0.481	0.686	0.494	0.380
Standard deviation	Economic	0.127	0.122	0.120	0.135
	Technical	0.130	0.127	0.116	0.143
	Total	0.128	0.124	0.118	0.139

Higher performance in reading skills was demonstrated by students of technical studies compared to students of economic studies. However, it should be noted that the performance between the disciplines was balanced, and at the same time, reading skills were not found to be at a high cognitive level.

The highest performance (i.e., 68.6% success rate) was achieved by students from both fields of study in the cognitive activity of content and form reflection (COGN 2), while the arithmetic average shows that the results of students from economics and engineering are balanced. However, a noticeably higher performance was achieved by the engineering students. This cognitive activity was explored using a single text to which four statements were linked. The students were asked to evaluate each statement and decide whether it was true or false based on the text (a highly difficult task according to PISA). 82.8–94.4% of the participating students were able to judge the correctness of two of the four statements, while the results of the technicians were significantly higher. The most difficult statements for students were those oriented towards the ability to judge whether the statement factually describes the content of the text and the course of events. 90–94.2% of participating students made an error. The results were comparable between the fields of study. The average success rate for economists ranged between 7.9% and 9%, and the average success rate for engineers ranged between 3% and 9%.

A significantly lower performance, which ranged between 48 and 38% success rate in aggregate, was achieved by students in the remaining cognitive activities. The success rate of 49.4% in the cognitive activity of integration and generation of inferences (COGN 3) was demonstrated by students of both disciplines in agreement. This cognitive activity was examined using two separate texts with four statements (true/false) linked to the first text and a menu of four possible answers with just one correct answer (a highly difficult task according to PISA) linked to the second text. Students made more errors in the subtasks. In two sub-questions, 94% of students were found to be unsuccessful. Students struggled with the ability to distinguish not only the cause and effect but also the essential from non-essential information. In a question in which students had to demonstrate their understanding of the overall meaning of the text, which was that the text contained conflicting views and the correct interpretation of the gist was needed, 52% of students were unsuccessful.

In the cognitive activity of literal meaning (COGN 1), students achieved an overall average success rate of 48.1%. Higher performance was achieved by students of economics (mean: 48.4%) compared to students of engineering (mean: 47.6%). This cognitive activity was investigated using a single text with four statements linked to it. The task was designed to determine whether the student understood a key passage that was relevant to working with other texts in this task (according to PISA, this is a moderately difficult task). High failure rates were found in two of four statements, with 92% of students from both fields of study. The failure rate was higher for engineering students compared to students of economics—5% on average.

The lowest, a 38% average success rate, was achieved by students in the cognitive activity of searching for information (COGN 4). Significantly higher reading proficiency was demonstrated by engineering students (mean: 40.1%) compared to economics students (mean: 36.7%). This cognitive activity was explored using a single text with four statements (true/false) associated. According to PISA measurements, this is a highly difficult task. Difficulty was ensured by offering additional timing data based on the text in response options, including formats such that inference was also required. As many as 94.9% of economics students and 97.2% of engineering students were unsuccessful in two of four statements. In the other two statements, better performance was shown by engineering students. Failure was detected by 18.7% of the students. The failure rate of economics students is higher as compared to the failure rate of engineering students. It was found for 43.7% of the respondents.

Statistically significant differences according to the sorting factors were detected using the Mann-Whitney U test. Table 8 shows the results of the observed differences in performance connected to the cognitive sub-activities of reading text processing between economics students and engineering studies.

Table 8. Significance of differences in cognitive performance between economics and engineering students (H2–H5)

Hypothesis	Cognitive Activity of Reading Text Processing Processes	Field of Study *p*	Effect Size
H_{0-2}	Literal meaning (COGN 1)	0.498	0.02895
H_{0-3}	Reflect on content and form (COGN 2)	0.572	0.02368
H_{0-4}	Integrate and generate inferences (COGN 3)	0.846	0.00974
H_{0-5}	Text information retrieval (COGN 4)	0.005	0.13908

Significant differences between economics and engineering students were found in cognitive activities of information retrieval from the given text. It is the activity of processing of the reading text that was the most difficult for students from both fields of study. Significantly better performance was shown by the students of engineering compared to economics students. At the 5% significance level, we do not reject the hypothesis H_{0-2}–H_{0-4}. At the 5% significance level, we reject the hypothesis H_{0-5}.

5 DISCUSSION

The aim of this study was to investigate differences in performance in the cognitive sub-activities of reading text processing among engineering and economics students aged 17 years. The purpose of this research was to determine whether the differences in cognitive performance reflect the specifics of the field of study. The results show several important trends that have implications for pedagogical practice as well as for the integration of technical and economic competences in education [11]. Our study acknowledges that reading literacy remains a challenge across technical and economic disciplines [5], [25]. The overall success rate of students in the test was 41.2%, which confirms previous findings of the PISA survey on the declining level of reading skills in EU countries, including the Czech Republic [1]. This situation underlines the need for systematic development of reading skills also at the secondary level of education. This fact is particularly connected to the increasing complexity of professional tasks and the digital transformation of society. Students' attitudes towards digital and communication technologies significantly influence their performance in the area of literacy [20].

One of the key findings is the existence of a significant correlation between the sub-cognitive activities. The most significant correlation was found between content and form of reflection and integration and generation of inferences, and then between content and form of reflection and information retrieval. These processes require deeper engagement with critical thinking, metacognition, and conceptual understanding. Our findings are supported by research [12], which shows that teaching focused on one of these cognitive skills has the potential to develop the other secondarily. The cognitive activities of reading and text processing emerge as a result of the integration of multiple cognitive processes, not their isolated training [3]. Conversely, literal meaning was negatively correlated with other cognitive activities besides content and form reflection. These correlations point to structural interconnections between different levels of cognitive processing of text, as defined, for example, in Bloom's revised taxonomy of cognitive goals [31]. This relationship can be seen as an indication of a rigid reading style that fixates on surface information without deeper interpretation or synthesis. Students who focus heavily on the literal meaning of a text may have difficulty in transforming and applying it in a broader context, which is at the core of higher-order reading processes. This finding is in line with studies, [15], [16], which warn that current digital culture encourages scanning and fragmented reading that weakens the ability for deeper reflection and synthesis. The significant correlation between content and form reflection and information retrieval from the text confirms the importance of complex tasks that link multiple sub-skills and require students not only to read but also to actively manipulate textual data, e.g., compare, categorize, evaluate, and argue [3]. Given the demanding nature of jobs in technology and economics, where it is necessary to read effectively but also reflectively, the development of this skill is essential for future careers [21], [22].

So far, there has been no detailed research connected to differences in reading skills of older high school students in technical and economic programs. Our research therefore builds on previous findings by placing them in the Czech context and taking into account the specific skills needed for the 21st century (STEM and business). In terms of differences between technical and economic disciplines, a significantly higher level was found only in the area of text information retrieval in favor of technical students. Our findings are consistent with other research from 2024, but this research is focused on university students. Students in technical and engineering programs achieved significantly better results in reading comprehension (and listening) than students in economics [14]. This may reflect their more frequent experience with exact, instructional text or the specific structure of technical documents where quick and accurate retrieval of key information is important. The results are consistent with the characteristics of technical education, which emphasizes analytical thinking and problem solving with unambiguous results [5], [23]. In contrast, no significant differences were found between disciplines in literal meaning or content reasoning activities. This fact may show that no analyzed disciplinary approach offers an effective tool for developing these complex skills. Poor ability to interpret text fundamentally limits not only cognitive performance but also future job performance, especially in a techno-economics-integrated profession. In the context of this integration, it is important for students to be able to both read and interpret technical manuals and assess the credibility of sources or draw economic inferences from technical data [13], [24], [25]. Our results were obtained in the field of Czech secondary vocational education, which combines general subjects with specialized modules and is predominantly school-based and supplemented by practical training. This model differs from other fields such as grammar schools or even bachelor's degree programs, where students are older and are exposed to more demanding disciplines and often foreign-language texts. We consider the results to be transferable to other Czech secondary vocational schools with a similar curriculum and practical training. The transfer is applicable in a partial way for the first years of professionally oriented bachelor's degree programs if work with application texts prevails over theoretical articles.

Our study has some limitations. Given a sample of 443 students, the results of the study cannot be generalized, although this sample is sufficient for statistical analysis. The study focused exclusively on 17-year-old students from five secondary vocational schools that were deliberately selected. This is a limitation of the research that affects the generalizability of the findings. Thus, the results do not capture the development of reading skills over a longer time frame. This study did not consider affective variables (i.e., motivation to read, self-efficacy, or relationship to the field). Although the participants studied in technically or economically oriented programs, their prior expertise was not directly checked. Ideally, it would be appropriate to perform this check through a preliminary test or by including study results as covariates. Socioeconomic status is one of the significant predictors of results [35]. However, in our research, detailed demographic data connected with the gender or socioeconomic background of students was not available and therefore could not be included in the analyses. It cannot be ruled out that some of the differences found between students in technical and economic programs are partly influenced by hidden demographic characteristics of the sample.

6 CONCLUSION

This study has provided new insights into the reading level of text processing in engineering and economics students aged 17. Although the overall level of reading skills was not high, the analysis showed that engineering students showed statistically significantly higher cognitive performance in information retrieval. The results confirm that reading skills in the broader sense, such as the ability to work with technical text, understand the context, and critically evaluate it, remain a key but often underdeveloped competence. We consider this fact to be an essential finding and the practical implication of our study in view of the growing demands of the labor market, which expects technical-economic profiles equipped not only with technical knowledge but also with communication and analytical skills.

With respect to the fact that engineering students showed significantly higher performance in information retrieval but fell behind expectations in more complex tasks requiring synthesis, it is appropriate to target the development of their higher-order skills, particularly critical and systems thinking. Similarly, students of economics need to place more emphasis on analytical procedures, logical deduction, and the ability to work with exact information as required by the modern technological environment. Particularly in engineering disciplines, there should be a systematic incorporation of tasks that lead students to assess and interpret textual sources with a greater degree of linguistic and content complexity. At the same time, activities that promote the ability to search for and extract data from technically structured texts should be included in economic education, thereby enhancing students' interdisciplinary adaptability. Thus, the strengthening of interdisciplinary elements in education can be recommended, e.g., through business simulations, case studies, or team projects focusing on real situations combining technical and economic elements. In the process of education, there should also be included regular diagnosis of reading skills beyond the age of 15, when most students leave the PISA testing framework. Singapore and its Strategies for English Language Learning and Reading program can be cited as an example of successful intervention in countries that maintain high levels of reading literacy. The primary education program focuses on the systematic development of reading strategies and working with multimodal texts. Evaluations show significant learning gains, and this is followed up by the secondary curriculum "English Language Syllabus" with an emphasis on metacognitive strategies. Another successful approach is the implementation of school standards and shared materials for reading activities, including teacher mentoring [35]. Targeted interventions can prevent future problems when entering university or the labor market. Our study has theoretical implications for the effective development of technical (engineering) and economic thinking skills for their integration. Therefore, the research will prospectively be expanded not only in the number of secondary vocational schools and respondents but also in the structure of the cognitive sub-activities of reading processes and the inclusion of affective variables.

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