

DIDACTIC OPPORTUNITIES FOR DEVELOPING FOREIGN LANGUAGE READING COMPETENCE OF CHEMICAL ENGINEERING STUDENTS IN ESP- BASED EDUCATION

Shokirova Mukaddas Musakhonovna

Associate Professor, Department of Languages, Tashkent Institute of Chemical
Technology

ORCID: 0000-0003-3627-8170

E-mail: m.shokirova@tkti.uz

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Abstract: This article investigates the didactic opportunities for developing foreign language reading competence among chemical engineering students through an integrated ESP (English for Specific Purposes)-based instructional model. The internationalization of science and technology has intensified the need to develop this competence. A quasi-experimental design involving 60 undergraduate students in experimental and control groups was employed. The instructional intervention incorporated linguistic, cognitive, strategic, and professional components of reading instruction. The results demonstrated significant improvements in reading comprehension, the use of metacognitive strategies, and the interpretation of technical texts among students in the experimental group. The findings confirm that integrating language learning with cognitive and professional contexts enhances the effectiveness of ESP-based reading instruction. Furthermore, the article highlights effective practical approaches to developing professional reading competence in technical higher education institutions.

Keywords: ESP, reading competence, chemical engineering education, didactic opportunities, foreign language learning, professional reading.

ESPGA ASOSLANGAN TA'LIMDA KIMYO MUHANDISLIGI TALABALARI XORIJIY TILDA O'QISH KOMPETENSIYASINI RIVOJLANTIRISHNING DIDAKTIK IMKONIYATLARI

Shokirova Mukaddas Musakhonovna

Dotsent, Toshkent kimyo-texnologiya instituti "Tillar" kafedrası

ORCID: 0000-0003-3627-8170

E-mail: m.shokirova@tkti.uz

Annotatsiya: Ushbu maqola kimyo muhandisligi yo'nalishi talabalarida xorijiy tilda o'qish kompetensiyasini rivojlantirishning didaktik imkoniyatlarini ESP (kasbiy maqsadlar uchun ingliz tili) asosidagi integratsiyalashgan o'qitish modeli orqali tadqiq etadi. Fan va texnologiyalarning xalqaro integratsiyalashuvi kimyo muhandisligi yo'nalishi talabalarida xorijiy tilda o'qish kompetensiyasini rivojlantirish zaruratini kuchaytirmoqda. Mazkur tadqiqot ESP (English for Specific Purposes) asosidagi integratsiyalashgan o'quv modeli orqali ushbu kompetensiyani rivojlantirishning didaktik imkoniyatlarini o'rganishga qaratilgan. Tadqiqotda 60 nafar bakalavriat talabasi ishtirok etib, ular tajriba va nazorat guruhlariga ajratildi. Intervensiya jarayoni o'qish kompetensiyasining lingvistik, kognitiv, strategik va kasbiy komponentlarini o'z ichiga oldi. Natijalar tajriba guruhidagi talabalarning matnni tushunish, metakognitiv strategiyalardan foydalanish va texnik matnlarni talqin qilish ko'nikmalari sezilarli darajada yaxshilanganligini ko'rsatdi. Tadqiqot natijalari til o'rganishni kognitiv va kasbiy kontekstlar bilan integratsiyalash ESP o'qitish samaradorligini oshirishini tasdiqlaydi. Tadqiqot texnik oliy ta'limda kasbiy o'qish kompetensiyasini rivojlantirish bo'yicha amaliy tavsiyalarni taklif etadi.

Kalit soʻzlar: xorijiy tilda oʻqish kompetensiyasi, ESP, kimyo muhandisligi talabalari, texnik oʻqish, metakognitiv strategiyalar, muhandislik taʼlimi, kasbiy savodxonlik.

ДИДАКТИЧЕСКИЕ ВОЗМОЖНОСТИ РАЗВИТИЯ КОМПЕТЕНЦИИ ИНОЯЗЫЧНОГО ЧТЕНИЯ СТУДЕНТОВ ХИМИКО-ТЕХНОЛОГИЧЕСКИХ НАПРАВЛЕНИЙ В УСЛОВИЯХ ESP-ОРИЕНТИРОВАННОГО ОБУЧЕНИЯ

Шокирова Мукаддас Мусахоновна

Доцент кафедры «Языки» Ташкентского химико-технологического института

ORCID: 0000-0003-3627-8170

E-mail: m.shokirova@tkti.uz

Аннотация: Данная статья исследует дидактические возможности развития компетенции иноязычного чтения у студентов химико-технологических направлений подготовки на основе интегрированной модели обучения ESP (English for Specific Purposes — английский язык для специальных целей). Интернационализация науки и технологий усиливает необходимость формирования данной компетенции. В исследовании использован квазиэкспериментальный дизайн с участием 60 студентов бакалавриата, разделённых на экспериментальную и контрольную группы. Педагогическое вмешательство включало лингвистический, когнитивный, стратегический и профессиональный компоненты обучения чтению. Полученные результаты показали значительное улучшение уровня понимания прочитанного, использования метакогнитивных стратегий, а также навыков интерпретации технических текстов у студентов экспериментальной группы. Результаты исследования подтверждают, что интеграция языкового обучения с когнитивным и профессиональным контекстами повышает эффективность обучения чтению в рамках ESP-подхода. Кроме того, в статье представлены эффективные практические подходы к развитию профессиональной компетенции иноязычного чтения в технических высших учебных заведениях.

Ключевые слова: иноязычная читательская компетенция, ESP, студенты химико-технологических специальностей, техническое чтение, метакогнитивные стратегии, инженерное образование, профессиональная грамотность.

INTRODUCTION

The accelerating processes of globalization, the advancement of digital technologies, and the expansion of international scientific communication have substantially reshaped the educational demands placed on future engineers. In the contemporary knowledge-based economy, English serves as the primary language of scientific publications, technological innovation, and industrial interaction [1, p.24; 3, p.19]. Consequently, engineering graduates are expected to possess well-developed foreign language reading competence that enables them to access professional information effectively and participate actively in global academic and professional discourse.

For chemical engineering students, reading competence extends beyond linguistic understanding. Professional texts contain highly specialized terminology, process descriptions, laboratory procedures, safety regulations, and scientific data that require analytical interpretation [7, p.112; 16, p.78]. Despite the importance of this competence, ESP instruction in many technical universities continues to rely heavily on vocabulary memorization and grammar-based teaching approaches.

Recent studies have emphasized the necessity of integrating cognitive, strategic, and professional dimensions into foreign language instruction. Nevertheless, a systematic framework specifically designed for chemical engineering students remains insufficiently developed. Therefore, this study aims to investigate the didactic opportunities that facilitate foreign language reading competence development through an integrated ESP-oriented model.

The study addresses the following research questions:

1. How can reading competence be conceptualized within chemical engineering education?
2. Which didactic opportunities contribute most effectively to competence development?
3. How does an integrated ESP model influence students' professional reading performance?
4. What pedagogical mechanisms support sustainable competence growth?

MATERIALS AND METHODS

Reading competence has evolved from a purely linguistic construct toward a multidimensional educational concept integrating knowledge, skills, cognitive processes, and strategic regulation [2, p.205; 14, p.63]. Contemporary ESP research recognizes reading as an active meaning-construction process requiring interaction between linguistic knowledge and professional expertise.

Recent investigations (Hyland, 2022; Paltridge & Starfield, 2023) indicate that successful professional reading depends on vocabulary knowledge, inferencing skills, metacognitive awareness, and domain-specific background knowledge [6, p.48].

Modern cognitive theories describe reading as an interactive process involving bottom-up decoding and top-down interpretation [8, p.94]. Technical texts impose additional cognitive demands due to their terminological density, complex syntax, and process-oriented structure. Researchers emphasize that effective instruction should incorporate scaffolding, graphic organizers, and strategic comprehension activities to reduce cognitive overload [12, p.118].

Recent ESP studies demonstrate that engineering students benefit from content-integrated instruction that combines language learning with disciplinary knowledge [16, p.41]. However, many existing approaches focus on communication skills rather than professional reading competence. This gap is particularly evident in chemical engineering education, where students must interpret sophisticated technological information presented in English-language sources.

This study employed a quasi-experimental research design involving both experimental and control groups to evaluate the effectiveness of an integrated ESP-based instructional model in developing foreign language reading competence among chemical engineering students. The design enabled a systematic comparison of learning outcomes between students exposed to the intervention and those receiving conventional instruction.

The research sample consisted of 60 undergraduate students enrolled in the Chemical Engineering program. Participants were divided into two groups of equal size: an experimental group (n = 30) and a control group (n = 30). Both groups demonstrated comparable levels of English language proficiency and academic achievement at the beginning of the study, ensuring the reliability of subsequent comparisons.

To obtain comprehensive and reliable data, multiple research instruments were employed. Reading comprehension tests were administered before and after the intervention to measure changes in students' reading performance. Questionnaires were used to collect information regarding learners' perceptions, reading strategies, and attitudes toward ESP instruction. Classroom observation checklists provided systematic records of students' engagement, strategy

use, and participation during instructional activities. In addition, performance-based professional tasks were designed to assess students' ability to apply information obtained from technical texts to authentic chemical engineering contexts, including laboratory procedures, technological process descriptions, and industry-related problem-solving situations.

Students in the experimental group participated in an eight-week ESP instructional program based on an integrated competence-oriented model. Instruction was conducted twice a week and incorporated four interrelated components.

The linguistic component focused on the acquisition of specialized vocabulary, technical terminology, grammatical structures, and discourse patterns commonly encountered in chemical engineering texts. The cognitive component aimed to develop higher-order reading skills, including analysis, interpretation, inference, synthesis, and critical evaluation of professional information. The strategic component emphasized the development of metacognitive reading strategies such as planning, monitoring comprehension, self-regulation, summarizing, and evaluating reading outcomes. Finally, the professional component connected reading activities with authentic disciplinary content, enabling students to engage with scientific articles, technical manuals, laboratory instructions, process descriptions, and engineering case studies relevant to their future professional practice.

In contrast, the control group continued to receive traditional ESP instruction based primarily on vocabulary explanation, text translation, and comprehension exercises.

The collected quantitative data were analyzed using a range of statistical procedures. Paired-sample t-tests were employed to examine within-group differences between pre-test and post-test results, while independent-sample t-tests were used to compare performance between the experimental and control groups. To determine the practical significance of the intervention, effect sizes were calculated using Cohen's d coefficient. Qualitative data obtained from questionnaires, classroom observations, and students' reflective responses were analyzed through thematic coding, allowing the identification of recurring patterns, perceptions, and learning behaviors associated with the development of foreign language reading competence.

This mixed-methods approach provided both statistical evidence and qualitative insights into the effectiveness of the proposed ESP-based instructional model, thereby enhancing the validity and comprehensiveness of the research findings.

RESULTS

The results of the study indicate a substantial improvement in the foreign language reading competence of students who participated in the ESP-based instructional intervention. Prior to the experiment, both the experimental and control groups demonstrated comparable levels of reading competence, suggesting similar initial conditions for the study. Following the intervention, however, significant differences emerged between the two groups.

Table 1. Comparison of Pre-test and Post-test Results

Group	Pre-test	Post-test	Gain
Experimental	52.4	78.6	+26.2
Control	51.8	59.7	+7.9

As shown in Table 1, the experimental group achieved an average increase of 26.2 points, whereas the control group improved by only 7.9 points. Statistical analysis using an independent-samples t-test confirmed that the difference between the groups was highly significant ($p < 0.001$).

These findings indicate that the ESP-based integrated instructional model contributed substantially to the development of students' professional reading competence.

A more detailed examination of the assessment data revealed improvements across all evaluated dimensions of reading competence. Students in the experimental group demonstrated greater ability to identify key information, infer meaning from context, recognize discipline-specific terminology, and interpret complex technical texts related to chemical engineering processes. Their performance on tasks requiring critical analysis and synthesis of information also improved considerably.

The qualitative data obtained from classroom observations, reading journals, and semi-structured interviews further supported the quantitative findings. Students exposed to the ESP-oriented reading program reported increased confidence when working with authentic professional materials and demonstrated greater autonomy in selecting and applying reading strategies.

Specifically, students in the experimental group: Used metacognitive reading strategies more frequently, including planning, monitoring comprehension, self-questioning, and evaluating reading outcomes; Successfully reconstructed technological and chemical production processes based on information extracted from professional texts and diagrams; Demonstrated more accurate interpretation of scientific and technical materials by integrating linguistic knowledge with disciplinary knowledge; Applied information obtained through reading to laboratory activities, case studies, and industrial problem-solving situations; Showed increased ability to identify cause-and-effect relationships within technological descriptions and engineering reports; Displayed greater awareness of specialized vocabulary and terminology commonly used in chemical engineering literature; Demonstrated improved critical thinking skills when evaluating technical information from multiple sources.

Furthermore, classroom observations indicated a noticeable shift from surface-level reading to deeper analytical engagement with texts. Students increasingly employed prediction, summarization, inferencing, and contextual analysis strategies when encountering unfamiliar technical concepts. Many participants reported that the integrated approach helped them connect language learning with their future professional activities, thereby increasing both motivation and engagement.

The findings of this study indicate that the integration of linguistic, cognitive, strategic, and professional components within ESP-based instruction creates effective pedagogical conditions for the development of foreign language reading competence among chemical engineering students. The substantial improvements observed in the experimental group provide empirical evidence of the effectiveness of the proposed instructional model and confirm its potential for successful implementation in technical higher education institutions.

DISCUSSION

The results of the present study support contemporary theoretical perspectives in English for Specific Purposes (ESP) education, which emphasize the integrated development of linguistic, cognitive, strategic, and professional competencies [14, p.108]. The significant improvement demonstrated by the experimental group suggests that foreign language reading competence cannot be effectively developed through language instruction alone; rather, it requires a multidimensional approach that connects language learning with disciplinary knowledge and authentic professional tasks.

The effectiveness of the proposed instructional model can be explained through the dynamic interaction of several key components. First, the linguistic component facilitated the

acquisition of specialized vocabulary, grammatical structures, and discourse patterns commonly found in chemical engineering texts. Second, the cognitive component promoted higher-order thinking skills, including analysis, synthesis, interpretation, and problem-solving. Third, the strategic component encouraged students to employ metacognitive reading strategies such as planning, monitoring comprehension, self-regulation, and evaluation of reading outcomes. Finally, the professional component contextualized learning within authentic engineering situations, thereby increasing the relevance and practical value of reading activities.

The findings are consistent with recent ESP and disciplinary literacy research, which highlights the importance of metacognitive instruction, discipline-specific reading practices, and task-based learning approaches in higher education. Previous studies have demonstrated that successful readers actively regulate their comprehension processes and strategically apply background knowledge when engaging with specialized texts. The present study confirms these conclusions by showing that students who received systematic strategy instruction achieved substantially higher levels of reading comprehension and text interpretation than those who followed traditional instructional methods.

Moreover, the incorporation of graphic organizers, technological process mapping, schematic representations, and professional case-study analysis significantly enhanced students' ability to process complex information. These instructional tools helped learners visualize relationships between concepts, identify cause-and-effect patterns, and organize technical information more effectively. As a result, students progressed from simple recognition of technical vocabulary to deeper analytical and critical comprehension of professional texts.

An important outcome of the study is the observed connection between reading competence and professional problem-solving ability. Students increasingly used information obtained from texts to explain technological processes, interpret laboratory procedures, and propose solutions to engineering-related tasks. This finding supports the view that reading competence in ESP contexts should be regarded not merely as a language skill but as a professional competence that directly contributes to academic and occupational success.

The study also demonstrates the motivational benefits of contextualized ESP instruction. Because reading materials were directly related to students' field of specialization, participants reported higher levels of engagement, interest, and perceived usefulness. This increased motivation likely contributed to the positive learning outcomes observed during the intervention.

From a pedagogical perspective, the findings suggest that ESP instructors should move beyond traditional text-translation approaches and adopt integrated methodologies that combine language learning with disciplinary content and strategic reading instruction. Curriculum designers may also consider incorporating authentic professional materials, collaborative problem-solving tasks, and metacognitive strategy training into ESP courses for engineering students.

This study contributes to contemporary ESP research by developing and empirically validating a discipline-specific instructional model designed to enhance reading competence among chemical engineering students. The empirical results demonstrate that the integration of linguistic, cognitive, and professional learning components significantly improves foreign language reading proficiency and strengthens students' readiness for effective participation in international scientific discourse and professional communication.

CONCLUSION

The study confirms that foreign language reading competence among chemical engineering students can be significantly enhanced through an integrated ESP-based instructional model. The

combination of linguistic, cognitive, strategic, and professional components facilitates deeper comprehension of technical texts and improves students' ability to apply acquired knowledge in professional contexts.

The proposed model offers practical implications for curriculum developers, ESP instructors, and higher education institutions seeking to strengthen professional language education in engineering programs.

Future research should investigate long-term competence retention and explore the integration of artificial intelligence, digital reading platforms, and simulation-based learning environments into ESP reading instruction.

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