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Metacognitive awareness of pharmacists at different stages of the educational continuum: a comparative study

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Introduction: This study investigates the metacognitive awareness of pharmacy students and pharmacists at various educational stages.

Methods: We compare metacognitive indicators among 2nd and 5th-year students from Sechenov University Institute of Pharmacy and pharmacists undergoing additional professional education at Sechenov University Institute of Postgraduate Education. Metacognitive awareness was assessed using the Metacognitive Awareness Inventory, Evaluation of Metacognitive Knowledge and Activity, and a self-reflection scale.

Results: Significant differences were found between 2nd and 5th-year students' metacognitive awareness, with 5th-year students showing higher levels of metacognitive knowledge. Pharmacists undergoing additional education displayed higher metacognitive awareness than undergraduate students, with differences observed in declarative and procedural knowledge, error control, and evaluation.

Conclusion: Cognitive and regulatory metacognitive indicators develop throughout the educational continuum, emphasizing the need to cultivate reflexive qualities in future pharmacists. Tailored approaches for improving metacognitive abilities among pharmaceutical specialists are essential. Further exploration of the motivational aspect of metacognitive awareness in pharmacy education is warranted.

KEYWORDS

metacognitive awareness, metacognitive knowledge, metacognitive activity, selfreflection, social reflection, pharmaceutical education

1 Introduction

Enhancing the professional competence of pharmacists is vital for ensuring accurate medication dispensing, patient counseling, and medication management, all of which directly impact public health outcomes. There is a growing demand for the development of pharmaceutical education programs aimed at preparing highly skilled professionals for the pharmaceutical industry. Beginning from the early stages of education, developing the learners' ability to acquire knowledge and metacognitive awareness is crucial. It is essential to understand how these indicators evolve across various stages of the educational continuum to inform effective educational development strategies.

J. Dunlosky and J. Metcalfe distinguish three types of metacognitive processes: metacognitive knowledge, metacognitive control, and metacognitive management (Dunlosky and Metcalfe, 2009). Metacognitive knowledge consists of a person's declarative knowledge of facts, beliefs, and phenomena that they can express, making them available for conscious understanding. Metacognitive control is related to evaluating the current state of ongoing cognitive activity. For example, it involves judging the correctness of problem-solving or assessing reading comprehension. Metacognitive control regulates ongoing cognitive activity, particularly its initiation, decision to continue, modification, and termination, including using a new tactic to overcome a complex problem.

Metacognition, or 'thinking about thinking,' is considered an important aspect of learning. It can be applied to various educational processes including executive thinking, social cognition, self-efficacy, and self-awareness through reflection (Dunlosky and Metcalfe, 2009; Georghiades, 2004; Larkin, 2023; Moraitou and Metallidou, 2021). In other words, metacognition is the ability to understand, realize and control one's learning. Metacognition plays a key role in the formation of clinical and critical thinking in future health professionals during education (Saribeyli, 2018; Kashapov and Bazanova, 2021). Metacognition regulates the professional development of medical and pharmacy professionals throughout their careers by pointing out what they do not know and encouraging them to fill in the gaps in their knowledge (Moiseeva, 2010). It is worth mentioning that specialists of different professions develop metacognitive processes differently (Kashapov, 2021). Many researchers in this field have noted that self-regulatory and metacognitive processes are underutilized by medical students. Faculty should promote the development of students' metacognitive awareness and use various strategies to help students reduce medical errors, learn more effectively, and improve academical performance (Serafimovich and Bazanova, 2018; Kebaetse et al., 2018).

Metacognitive ability may act as a critical feature of education, as it is assumed that a learner with higher self-awareness rather than higher intellectual ability performs better in academic achievement (van Houten-Schat et al., 2018; Chernyavskaya and Sidorova, 2020). Self-awareness is challenging to develop and difficult to assess, and it is a non-cognitive skill that medical students need to develop during higher education (Schraw and Dennison, 1994; Motycka et al., 2010). Given that self-assessment is integral to metacognition, improvement in a learner's self-assessment accuracy might be interpreted as indicative of metacognitive development. It has been found that pharmacy students are inclined to overestimate their performance compared to their professors` assessment of that performance (Steuber et al., 2017). However, students tend to improve their self-assessment accuracy by the end of the studies, indicating the development of metacognitive processes (Steuber et al., 2017). The analysis of the relationship between self-assessment accuracy and academic performance in pharmacy students showed Dunning-Kruger effect (Nisly et al., 2020). Students with lower academic performance tended to overestimate their abilities, while students with higher academic performance underestimated their abilities. Another important aspect of metacognitive knowledge is self-efficacy, which is related to a student's confidence about their abilities rather than actual abilities (Abeyaratne et al., 2022). Beliefs and performance usually do not match. Different learning strategies have been shown to have different effectiveness, and many students need more basic learning principles and knowledge of how to learn more productively (Rivers et al., 2020; Dunlosky and Rawson, 2019). While cognitive strategies help students learn, metacognitive strategies help them ensure they have internalized the knowledge. Therefore, proper development of self-efficacy, formed with self-regulation skills, is significant (Kornell and Bjork, 2007). The development of self-efficacy enables students to establish realistic goals and employ efficient strategies, thereby enhancing their overall learning outcomes. (Fomina, 2022). Self-regulation is crucial for all learners, especially students (Shilenkova, 2020).

The concept of self-efficacy was proposed in the frameworks of social cognitive theory (Bandura, 2001). A. Bandura defines self-efficacy as "metacognitive capability to reflect upon oneself and the adequacy of one's thoughts and actions" (Bandura, 2006). Self-Efficacy is a person's particular set of beliefs that determine how well one can execute a plan of action in prospective situations. Numerous researches based on social cognitive theory revealed positive influence of student self-efficacy on academic achievement (Basileo et al., 2024; Al-Khresheh and Alkursheh, 2024; Bozzato, 2024). Some researchers focus on relationship between student's academic performance, emotionality, self-efficacy, engagement and perceived autonomy. Studies found that high self-efficacy positively influences on academic achievements and vice versa (Lo, 2023; Trigueros et al., 2020). At the same time, many studies were carried on out on the basis of self-determination theory. They supported positive relationship between satisfaction of students' basic psychological needs and their academic performance (Carmona-Halty et al., 2019; Ahn et al. (2021).

Unlike secondary education, at higher education tiers, students are faced with independence in matters of time management and the ability in planning for learning (Perikova and Byzova, 2020). At the same time, most students are inadequately prepared to overcome the challenges they encounter during higher education, and effective time management is one of many essential skills. Students must also develop active learning qualities such as initiative, persistence, and adaptation (Prokhorov et al., 2020). Students' academic success is generally related to their ability to use effective strategies for self-regulated learning. The results of this study show not only the existence of some self-regulation strategies used by pharmacy students but also the relationship between these strategies and academic achievements (Schunk and Zimmerman, 2012). Professors need to be aware of students' current level of self-regulation and use this information to facilitate effective learning strategies.

Self-reflection gives students opportunities to reflect on their previous experiences and improve their actions, abilities, and knowledge in the future (Colthorpe et al., 2019). Thus, to investigate self-assessment and self-reflection, one group of student pharmacists was asked to take a standardized test, and another group was asked to take the same test but with additional questions to encourage self-assessment and reflection. As a result, the students who answered self-assessment and self-reflection questions performed better on the test (Laktionova, 2017). Some teaching methods for forming analytical-reflexive competence in medical students provide opportunities for self-assessment, self-evaluation, and reflection (Austin et al., 2008). One approach is to recommend faculty members find time and space to share their cases from professional practice with students by applying reflective activities. Sharing challenging cases, successes, or failures results in a reconstruction of the learning experience. In doing

so, learners can describe their experiences and become aware of their biases and subsequent thoughts and emotions that may affect their ability to make sense of new ideas and information (Minakova and Fedorova, 2020).

Critical thinking can be defined as the systematic and objective process of information analysis for making evidence-based judgements (Nazar et al., 2021). Reflection on thought processes and actions is vital in developing critical thinking skills (Bogdan et al., 2019). The use of reflective thinking, which is essential to make critical decisions, can lead students to thinking on a higher level (Persky et al., 2019). Research in higher education has demonstrated the advantage of reflective thinking-oriented activities in increasing students` motivation for course activities and developing self-awareness (Loginova and Danilova, 2018).

Another example of a metacognitive process that needs to be shaped in pharmacy students is asking for help (Yilmaz and Keser, 2016). Awareness of knowledge gaps is an important skill in students' professional development. Some studies found an association between asking for help solving problems and academic success (McLaughlin et al., 2017). They showed that pharmacy students are less likely to seek help for less familiar material than for more familiar material, resulting from their lack of awareness of their knowledge (Ryan and Shin, 2011).

Longitudinal studies of pharmacists' metacognitive awareness have been conducted with relatively short follow-up periods (beginning and end of the course, semester) (Steuber et al., 2017; Chu et al., 2018; Isaacs et al., 2022). Such studies have not been conducted outside the United States, particularly in Russia.

Modern pharmacists work not only in pharmacies, dispensing the drugs, but also at all stages of the drug life cycle, including research and development, high-tech pharmaceutical production, preclinical and clinical drug trials, and regulatory affairs. In addition to high professional qualifications, pharmaceutical industry employees need soft skills, such as communication, creativity, negotiation skills, ability to work in various interdisciplinary teams, and continuous acquisition of additional knowledge and skills (Martirosov and Moser, 2021). Students need cognitive, behavioral, and social strategies to achieve better results during collaborative group work and overcome teamwork obstacles (Korol and Zavadsky, 2020; Semenova et al., 2022). Since regulating these processes has a metacognitive nature, students need to recognize and understand their thinking and that of the group (Lobczowski, 2020). To solve professional problems, pharmacists must have sufficient metacognitive awareness and the ability to realize their own thoughts and find optimal solutions. Therefore, the modern pharmaceutical education system should facilitate acquiring and developing metacognitive knowledge and skills.

The development of metacognitive awareness among pharmacists becomes relevant in light of the necessary direction of modern pharmaceutical activity in the post-Soviet space: clinical pharmacy (Ivashov and Sergienko, 2013; Poleszak et al., 2015). Graduates of pharmaceutical universities will work as clinical pharmacists, requiring developed metacognitive skills (Persky et al., 2019).

Clinical pharmacy is a scientific and practical field in which pharmacists leverage their understanding of clinical symptoms of diseases, interpretation of patient examination results, and principles of drug therapy. They serve as the primary source of information on drug safety, efficacy, and economic aspects and play a crucial role in enhancing the quality of preventive and therapeutic measures. Pharmacists progressively collaborate with physicians in numerous countries, assuming a more proactive role in the treatment process and sharing responsibility for ensuring therapy quality and optimal outcomes.

Clinical pharmacy embodies the philosophy of pharmaceutical care, an innovative approach involving continuous, expert counseling of patients and physicians on the judicious use of medications, proper storage conditions, selection of dosage forms, and therapy costs. Critical thinking within a complex healthcare setting is essential for medical students transitioning to clinical practice. Metacognition is essential for critical-thinking development of students for monitor and evaluate their own thought processes (Lai, 2011). Metacognitive awareness is a theoretical and practical framework for elucidating previously unconscious cognitive processes. Medical specialty faculty should aim to cultivate metacognitive awareness in students, as it enhances clinical reasoning skills through critical analysis and problem-solving. Pedagogical approaches such as case-based learning, simulated and standardized patient interactions, and experiential learning are valuable tools for fostering metacognitive awareness in pharmacy students. Consistent assessment of metacognitive awareness by pharmacy educators provides valuable insights into students' cognitive strategy development for future clinical reasoning. Enhancing the ability to plan and evaluate cognitive processes can empower medical students and faculty to engage in more meaningful problem-solving within clinical practice, tackling complex issues with greater efficacy.

Modern medicine's significant challenge is the high prevalence of medical errors in prescribing and dispensing (Calligaris et al., 2009). According to the U.S. Food and Drug Administration, approximately 7,000 patients in the United States die each year due to medication errors (Holquist, n.d.). These errors erode patients' trust in the healthcare system and escalate treatment costs. Various factors influence this multifaceted problem and affect physicians and pharmacists. One contributing factor to medical errors is health professionals' overconfidence in their judgments, known as the hindsight effect.

There was developed free online virtual simulation MyDispense in Monash University in Australia for pharmaceutical students. It improves student skills in drug dispense, allows opportunities to simulate real life communications with patients, checking prescriptions, provision of medicines (Khera et al., 2023). The study carried out in Qatar University concluded that MyDispense use in study process enhances students` metacognitive abilities (Al-Diery et al., 2024). According to students` satisfaction survey, 84% agreed that MyDispense provides them opportunity to safely make errors (Ferrone et al., 2017).

The accreditation standards set forth by the Accreditation Council for Pharmacy Education (ACPE) and the Association of American Medical Colleges (AAMC) for accrediting pharmacy and medical education institutions encompass the development of students' metacognitive skills. Schools and colleges of pharmacy are mandated to establish an environment and foster a culture conducive to nurturing self-awareness, autonomy, lifelong learning, professional conduct, leadership, collegial relationships, and collaboration within and across academic units, disciplines, and professions.

Interactive lectures, active learning exercises, and pre-planned activities conducted outside the classroom are implemented to enhance students' metacognitive abilities during instructional sessions. These adaptable methods can be tailored based on students' proficiency levels and class size (Persky et al., 2019).

The most of metacognition researches in pharmaceutical education are carried out in the USA, however these studies are conducted all over the world. Saudi scientists reported about positive effects of metacognition studies interventions on undergraduate pharmaceutical student's academic performance (Yusuff, 2015). Namibian researchers found out that reflective practice introduction in study plan promotes metacognition in first-year pharmaceutical students and facilitates their transition from school to university education (Wessels et al., 2019). Australian study is devoted to searching education strategies for improving pharmaceutical students metacognition skills essential for successful therapeutic decision-making (Walker et al., 2023). Chinese researchers concluded that educational interventions, developing metacognitive skills, enhance students' personality traits necessary for patient-centered pharmaceutical care practice (Hu et al., 2021).

This paper examines the evolution of metacognitive awareness among pharmacists across various stages of their educational and professional journey, contributing to our understanding of how metacognition influences professional development in the pharmaceutical sector.

This study seeks to address the following research inquiries:

1 What are the peculiarities of cognitive, regulatory, and reflexive indicators of metacognitive awareness among pharmacists at various stages of professional education?
2 How do cognitive, regulatory, and reflexive indicators of metacognitive awareness vary among pharmacists at different stages of professional education?

> *Hypothesis*: The indicators of metacognitive awareness of pharmacists unevenly increase throughout their professional activity.

2 Methods

We conducted a study using a questionnaire on pharmacists' metacognitive awareness at different stages of education. The questionnaire was administered online via Google Forms, a web-based survey administration software, at Sechenov University between February 18 and April 5, 2022. The study included 52 2nd-year pharmacy students (21.8% of the total number), 52 5th-year students (25.3% of the total number), and 51 pharmacists (27.6% of the total number). All respondents were adults and provided informed consent.

2.1 Sample design

The study was conducted at the Sechenov University Institute of Pharmacy and involved only 2nd—and 5th-year pharmacy students and certified specialists in the pharmaceutical industry.

2.2 Research methods

We employed the "Metacognitive Awareness Inventory" methodology (Schraw and Dennison, 1994) to assess 2nd-year students ($N = 48$, average age - 19.5 years), 5th-year students ($N = 46$, average age 22 years), and pharmacists ($N = 46$, average age 36 years, average work experience 14 years). Respondents rated 52 statements on a five-point scale based on their level of agreement, where one indicated "totally disagree," and five indicated "totally agree." The questionnaire evaluated cognitive activity through the procedural components of metacognitive activity concerning thinking features and problem-solving methods, which contribute to an individual's metacognitive awareness (Saribeyli, 2018).

For diagnosing 2nd-year students ($N = 52$, average age 19 years), 5th-year students ($N = 52$, average age 22 years), and pharmacists ($N = 51$, average age 39 years, average work experience 17 years), we utilized the "Evaluation of Metacognitive Knowledge and Metacognitive Activity" questionnaire (Y.V. Poshekhonova, M.M. Kashapov). This questionnaire comprised 39 statements, and respondents were asked to choose between "agree" or "disagree" for each statement. This methodology assessed metacognitive knowledge and activity, wherein metacognitive knowledge refers to an individual's acquired knowledge about their cognitive processes, including knowledge about learning processes, task types, requirements for task fulfillment, and metacognitive strategies for task solving. Metacognitive activity encompasses information acquisition, selection, control, transformation, and metacognition planning. The questionnaire evaluated metacognitive characteristics like concentration, information acquisition, selection of main ideas, and time management (Motycka et al., 2010).

We utilized the "Self-Reflection and Insight Scale" (A. M. Grant) to diagnose 2nd-year students ($N = 46$, average age 19.5 years), 5th-year students ($N = 45$, average age 22 years), and pharmacists ($N = 41$, average age 38 years, average work experience 15 years). This questionnaire consisted of the self-reflection scale for analyzing one's own experiences and inner desires and the socio-reflection scale for assessing awareness of others' experiences. Each scale included 10 direct and opposite statements, rated by respondents on a six-point scale based on their level of agreement, where one indicated "absolutely disagree," and five indicated "absolutely agree." This methodology aimed to evaluate the level of reflexivity of individuals with different orientations. Reflection involves the subject's attention to oneself and one's consciousness, as well as the reevaluation of one's activity. It encompasses analyzing one's own thinking and communication with others, providing an understanding of oneself and others' perspectives (Lobczowski et al., 2021).

The study comprised two stages. The first stage involved assessing the metacognitive awareness of second and fifth-year students and pharmacists who underwent advanced training programs. In the second stage, we compared the metacognitive awareness of pharmacists at different levels of professional education. Statistical analysis of the data was conducted using Statistica 8.0. We employed the Mann–Whitney U-test to evaluate differences between independent samples regarding quantitatively measured traits, along with descriptive statistical methods. The U-test is nonparametric and does not require the assumption of normal distribution in samples. Much accurate results and greater statistical power may be achieved in 30 or more observations in each group (Veeraraghavan and

Shetgovekar, 2016). However, in our study we used about 50 participants in each group.

3 Results

We assessed the levels of metacognitive awareness among 2nd and 5th-year students and pharmaceutical industry specialists. These levels amounted to 192.8, 202.1, and 211.1 points, respectively, out of a maximum possible score of 260. Subsequently, we conducted a comparative analysis using the Mann–Whitney U-test to examine indicators such as metacognitive awareness, metacognitive knowledge, metacognitive activity, and the level of reflection expression and direction among 2nd and 5th-year students.

By the fifth year, students demonstrated a significant increase in total metacognitive awareness and metacognitive knowledge. However, no significant differences were observed in indicators related to declarative knowledge, procedural knowledge, conditional knowledge, planning, information management, monitoring, error control and evaluation, socio-reflection, and self-reflection (refer to Tables 1–3).

Declarative knowledge in the professional realm of a pharmacist signifies an understanding of professional competencies associated with the development, production, quality control, and distribution of medications. Procedural knowledge illustrates specialists' ability to apply acquired professional competencies in practical settings within various organizations within the pharmaceutical industry. Conditional knowledge reflects the capacity to solve complex problems based on acquired knowledge, skills, and abilities and to apply them in non-standard professional scenarios.

Furthermore, we compared the indicators mentioned above between 5th-year students and pharmacists using the Mann–Whitney U-test. Although we did not observe significant differences in total metacognitive awareness between fifth-year students and pharmaceutical industry specialists, pharmacists demonstrated superior performance in terms of declarative knowledge, procedural knowledge, error control, and evaluation. Additionally, pharmaceutical professionals exhibited higher metacognitive knowledge, metacognitive activity, information acquisition, and time management (refer to Tables 4–6).

4 Discussion

The study investigated the metacognitive awareness of pharmacy students across various stages of their educational journey. Results revealed a progressive increase in metacognitive awareness scores as students advanced through their professional pathways. Interestingly, while most metacognitive awareness scores among pharmacy professionals surpassed those of final-year and 5th-year students, self-reflection scores were more pronounced in the latter group, with no statistically significant difference observed. However, the cumulative metacognitive awareness indicators of 5th-year students were higher than those of junior students.

The empirical data analysis indicates that pharmaceutical professionals require metacognitive awareness in addition to traditional competencies to identify and acquire additional knowledge and skills. Research by Tarabukina and Dremova (2021) suggests that highly qualified pharmacists should possess additional professional competencies such as critical thinking, flexibility of mind, development and implementation of professional projects, teamwork and leadership, communication and customer focus, intercultural interaction, self-organization and self-development, and health and life safety (Ivashov and Sergienko, 2013).

Positive changes in the level of metacognitive awareness are observed at the initial stage of education, as evidenced by significant differences in metacognitive knowledge between second and fifth-year students. During university education, students develop an understanding of their individual intellectual resources. Subsequently, pharmaceutical industry specialists, following their professional path after university, become adept at assessing their individual intellectual qualities and are prepared to employ techniques to enhance their cognitive abilities.

We hypothesize that significant changes in the metacognitive awareness of specialists occur due to accumulated professional experience. While metacognitive activity is essential in pharmacists'

TABLE 1 Comparison of metacognitive awareness scores of second-year and fifth-year students by Mann–Whitney U-test.

	Mean		*U*	*Z*	*p*-value
	2nd year students	5th year students			
Declarative knowledge *(knowledge of one's intellectual resources)*	29.7	30.7	963.500	−1.05891	0.289643
Procedural knowledge *(knowledge of how to apply learning strategies)*	14.9	14.9	1.100500	−0.02269	0.981897
Conditional knowledge *(knowledge of when and for what purpose to use education methods)*	18.6	19.5	932.500	−1.29338	0.195881
Planning *(setting goals, allocating resources before starting the learning process)*	25.9	27.6	869.500	−1.76989	0.076747
Information management *(skills and strategies used in the learning process to effectively process information, organize learning material, summarize, select relevant information)*	37.3	39.3	898.000	−1.55432	0.120109
Monitoring *(ongoing monitoring of how instructional strategies are used)*	26.6	27.7	959.500	−1.08916	0.276084
Error control *(strategies used to monitor errors during learning)*	19.7	20.5	983.000	−0.91142	0.362077
Evaluation *(overall assessment of the extent to which learning objectives have been achieved)*	20.2	21.9	869.000	−1.77367	0.076119
Total	192.8	202.1	834.000	−2.03839	0.041511

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TABLE 2 Comparison of second-year and fifth-year students' metacognitive knowledge and metacognitive activity scores by Mann–Whitney U-test.

	Mean		*U*	*Z*	*p*-value
	2nd year students	5th year students			
Metacognitive knowledge	10.4	12.1	1.038000	−2.03812	0.041539
Metacognitive activity	8.8	9.0	1.340500	−0.07151	0.942989
Concentration	2.4	2.6	1.225000	−0.82240	0.410850
Information acquisition	5.3	6.1	1.109500	−1.57329	0.115653
Selection of main ideas	6.5	6.5	1.290500	−0.39657	0.691683
Time management	3.9	4.5	1.165000	−1.21247	0.225333

TABLE 3 Comparison of self-reflection and socio-reflection scores of second-year and fifth-year students by Mann–Whitney U-test.

	Mean		*U*	*Z*	*p*-value
	2nd year students	5th year students			
Self-reflection	44.7	46.6	843.0000	−1.52013	0.128480
Socio-reflection	35.4	35.6	966.5000	−0.53978	0.589346

TABLE 4 Comparison of metacognitive awareness scores of fifth-year students and pharmaceutical industry specialists by Mann–Whitney U-test.

	Mean		*U*	*Z*	*p*-value
	2nd year students	5th year students			
Declarative knowledge	30.7	33.8	615.000	−3.45545	0.000549
Procedural knowledge	14.9	15.8	802.000	−1.99518	0.046024
Conditional knowledge	19.5	20.5	839.000	−1.70625	0.087962
Planning	27.6	28.0	985.500	−0.56224	0.573951
Information management	39.3	40.6	876.000	−1.41732	0.156390
Monitoring	27.7	27.6	1.026500	0.24208	0.808721
Error control	20.5	21.8	625.000	−3.37736	0.000732
Evaluation	21.9	23.5	781.000	−2.15917	0.030838
Total	202.1	211.1	820.500	−1.85072	0.064211

TABLE 5 Comparison of metacognitive knowledge and metacognitive activity scores of fifth-year students and pharmaceutical industry specialists by Mann–Whitney U-test.

	Mean		*U*	*Z*	*p*-value
	5th year students	Pharmaceutical industry specialists			
Metacognitive knowledge	12.1	13.8	1.006500	−2.10416	0.035366
Metacognitive activity	9.0	10.9	914.000	−2.71429	0.006642
Concentration	2.6	3.2	1.054000	−1.79084	0.073320
Information acquisition	6.1	6.9	1.026500	−1.97223	0.048584
Selection of main ideas	6.5	7.2	1.179000	−0.96633	0.333881
Time management	4.5	5.8	908.500	−2.75057	0.005949

TABLE 6 Comparison of self-reflection and socio-reflection scores of fifth-year students and pharmaceutical industry specialists by Mann–Whitney U-test.

	Mean		*U*	*Z*	*p*-value
	5th year students	Pharmaceutical industry specialists			
Self-reflection	46.6	43.4	684.5000	2.053508	0.040024
Socio-reflection	35.6	35.0	865.5000	0.488519	0.625183

professional activities, it is notable that although indicators of planning and monitoring may not increase significantly over the course of their professional path, specialists exhibit enhanced levels of error control and evaluation. However, it is worth noting that changes in metacognition often occur through trial and error rather than formal learning methods.

Despite general trends in metacognitive awareness, specialists from different industries exhibit unique subject-specific features (Antipenko, 2016). While metacognitive awareness typically increases linearly with a specialist's level of education and professionalism (Persky et al., 2019), this may not always be the case (Bazanova, 2022).

Kashapov and Zheltkevich (2018) demonstrated that cognitive activity is a crucial element of effective interaction among business communication participants and serves as a fundamental characteristic of professional competence, which in turn influences the development of metacognitive processes.

Of particular interest is the dynamic of the metacognitive awareness reflexive indicator. Our findings revealed no significant differences in the level of socio-reflection among pharmacists. Similarly, we observed no increase in socio-reflection indicators during higher education. However, there was a decline in self-reflection indicators following graduation and throughout the professional journey.

Self-reflection enables individuals to comprehend professional situations and consciously engage in productive actions. Through self-reflection, individuals observe themselves from an external perspective, analyzing past situations. At the university level, a high degree of self-reflection may hinder the implementation of unique (creative) solutions, as excessive analysis may instill fears of unsuccessful innovative solutions (Serafimovich et al., 2021; Medina et al., 2017).

Excessively high level of self reflection may lead to negative consequences, such as decreased success in activities, rumination, hyperpersonal control, illusory control, introspection and quasi-reflection. Thus, hyper self-examination can harm professional performance, especially for pharmaceutical workers who regularly encounter challenging communication situations. Reflecting on numerous situations, often beyond the pharmacist's control, can lead to negative consequences such as heightened self-awareness and excessive anxiety. A low level of reflection in some cases may be positive, as it can enhance metacognitive abilities. It is reported that low self-reflection values may implicit learning, intellectual behavior of experts, secondary control, selective mindfulness, creative process. One may conclude that reflection and a reflection manifest splitting effect. Both excessively high and low reflection indicators may demonstrate positive and negative effects in professional activity, probably optimal self-reflection level lies between the poles (Kholodnaya, 2022).

Self-regulation based on high levels of involuntary control characterizes the intellectual activities of competent individuals. Accepting circumstances can yield positive outcomes when one achieves high control and confidence in navigating situations beyond control (Sizikova et al., 2016). Conceptual thinking is an intermediary linking intellectual (metacognitive regulation of cognitive activity) and personal reflection (meaningful integration of motivational and demanding aspects of personality). This tendency holds for pharmacists who accept circumstances without striving to alter them, positively impacting their psychological well-being.

During our investigation into pharmacists' metacognitive awareness across different stages of the educational continuum, we observed that the cognitive component of metacognitive awareness, crucial for knowledge acquisition, undergoes active development during higher education. By the fifth year, pharmacy students demonstrate the ability to discern acquired knowledge based on their accumulated experience. They can also identify and address knowledge gaps, facilitating their professional growth.

Cognitive and regulatory indicators of metacognitive awareness develop consistently across all educational stages. In competitive professionals, metacognitive awareness, exemplified by efficient time management and error control, aids in navigating challenges encountered in both learning and professional endeavors.

Reflexive indicators of metacognitive awareness initially increase during higher education but decline to levels comparable to the initial stages during the professional trajectory. This decline in self-reflexivity among pharmaceutical industry employees presents a barrier to professional advancement and impedes the identification of educational gaps. However, experienced pharmacists can adjust the degree of reflection expression depending on the situation, leveraging their combination of high metacognitive abilities and reflexive indicators. In situations resistant to change, individuals with high metacognitive abilities can accept circumstances without attempting to alter them.

5 Conclusion

The findings underscore the need for targeted development of reflexive skills among pharmacy students and the importance of individualized approaches for experienced pharmacy professionals to identify, document, and enhance their metacognitive skills. Simulation training, increasingly integrated into pharmacy education, should be coupled with reflective practices to foster metacognitive awareness while minimizing potential risks to patients. Similarly, other innovative educational methodologies, such as flipped classrooms, team-based, and problem-based learning, necessitate subsequent reflection.

Exploring the motivational component of metacognitive awareness across all educational stages holds promise for further research. This component serves as a trigger, eliciting specific emotional responses. Constructive events that evoke positive emotions among pharmacy specialists appear crucial for fostering sthenic emotional states.

Implementing educational technologies like the flipped classroom (Khodaei et al., 2022), team-based learning (Ijirana et al., 2022), and problem-based learning (Gholami et al., 2016) has enhanced students' metacognitive awareness. The authors of this article intend to delve further into various interventions within the educational framework of pharmacy students and other biomedical disciplines to enhance academic quality, viewing the conducted study as a step in this direction. Additionally, future investigations could examine the role of individual differences, such as personality traits and learning styles, in shaping metacognitive processes and their impact on educational outcomes. Furthermore, longitudinal studies tracking the development of metacognitive skills from entry to practice could provide valuable insights into the long-term effectiveness of educational interventions.

However, despite numerous interventions in study process (Wessels et al., 2019; Isaacs et al., 2022; Walker et al., 2023),

metacognition disciplines have not still widely introduced in pharmaceutical education programs. Introduction of metacognition disciplines in the study process in pharmaceutical universities might improve quality of education and help graduates in professional activities.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Institute of Pharmacy, Sechenov First Moscow State Medical University. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

SZ: Conceptualization, Investigation, Methodology, Project administration, Software, Writing – original draft, Writing – review & editing. MM: Data curation, Investigation, Methodology, Software, Validation, Visualization, Writing – review & editing. SS: Formal analysis, Investigation, Software, Writing – review & editing. GB: Formal analysis, Methodology, Validation, Writing – original draft. MK: Conceptualization, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. LK: Methodology, Supervision, Writing – review & editing. AE: Data curation, Software, Visualization, Writing – review & editing. ES: Project administration, Resources, Supervision, Writing – review & editing.

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The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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