ҒТАМР 14.35.07 https://doi.org/10.51889/3005-6217.2025.83.1.010

Serikbayeva M. [1*]
[1]"Zaman" Kazakh Elite School,
Almaty, Kazakhstan, *e-mail: moldirserikbaeva73@gmail.com

THE IMPACT OF E-BOOKS ON SELF-EDUCATION IN THE FIELD OF INORGANIC CHEMISTRY

Abstract

This article examines the impact of electronic trainers on self-education in the field of inorganic chemistry. During the study, 40 students participated, including 20 students from the first group and 20 students from the second group, who used electronic trainers to improve their knowledge. The results showed that 70% of students noted the significant help of interactive features, such as 3D molecular models and simulations, in understanding complex concepts of inorganic chemistry. For undergraduate students, interactive tools were particularly useful for grasping fundamental concepts, while graduate students used them to better understand complex topics such as coordination chemistry and reaction mechanisms. The findings of the study showed that the accessibility, affordability, and interactivity of electronic trainers make the learning process more effective, facilitating independent learning. Additionally, 60% of students expressed a high level iffer action with their experience using electronic trainers. However, some challenges, such as issues with navigation of learning materials, led to the conclusion that further improvement of electronic educational tools is necessary.

Keywords: e-books, self-education, inorganic chemistry, complex concept, interactive learning

М.Ә.Серікбаева [1*]
[1]*"Заман" қазақ элиталық мектебі,*
*Алматы қ., Қазақстан, *e-mail: moldirserikbaeva73@gmail.com*

БЕЙОРГАНИКАЛЫҚ ХИМИЯДАН ӨЗ БЕТІНШЕ БІЛІМ АЛУҒА ЭЛЕКТРОНДЫҚ КІТАПТЫҢ ӘСЕРІ

Аңдатпа

Бұл мақалада электрондық тренажердің бейорганикалық химия саласындағы өзін-өзі оқытуға әсері зерттеледі. Зерттеу барысында 40 студент, оның ішінде 1-ші топта 20 студент және 2-ші топта 20 студент, электрондық тренажерларды қолдану арқылы өз білімін жетілдіруге қатысты сауалнама мен сұхбат жүргізді.Нәтижелер көрсеткендей, студенттердің 70%-ы 3D молекулалық модельдер мен симуляциялар сияқты интерактивті мүмкіндіктердің бейорганикалық химияның күрделі ұғымдарын түсінуге айтарлықтай көмектескенін атап өтті. Бакалавр студенттері үшін интерактивті құралдардың негіздеріне қатысты түсінік беру маңызды болса, магистранттар үшін олар күрделі тақырыптарды, мысалы, координация химиясы мен реакция механизмдерін түсінуге көмектесті. Зерттеу нәтижелері электрондық тренажерлардың қолжетімділігі, үнемділігі және интерактивтілігі оқу процесін тиімдірек етіп, студенттердің өз бетінше білім алуына ықпал ететінін көрсетті. Сонымен қатар, оқу тәжірибесінің сапасы бойынша студенттердің 60%-ы электрондық тренажерлармен жоғары деңгейде қанағаттанғанын білдірді. Ал зерттеу барысында кездескен кейбір қиындықтар, мысалы, оқу материалдарын навигациялау мәселелері, электрондық оқыту құралдарының әрі қарай жетілдірілуін қажет етеді деген қорытындыға әкелді.

Түйін сөздер: электрондық тренажер, өзін-өзі оқыту, бейорганикалық химия, күрделі ұғым, интерактивті оқу.

Серикбаева М.А.[1*]
[1] *Казахская элитная школа "Заман",*
г.Алматы, Казахстан, [*]*e-mail: moldirserikbaeva73@gmail.com*

«ВЛИЯНИЕ ЭЛЕКТРОННЫХ КНИГ НА САМООБРАЗОВАНИЕ ПО НЕОРГАНИЧЕСКОЙ ХИМИИ»

Аннотация

В данной статье исследуется влияние электронных тренажеров на самообразование в области неорганической химии. В ходе исследования было проведено анкетирование и интервью с 40 студентами, включая 20 студентов из первой группы и 20 студентов из второй группы, использующих электронные тренажеры для улучшения своих знаний. Результаты показали, что 70% студентов отметили значительную помощь интерактивных возможностей, таких как 3D молекулярные модели и симуляции, в понимании сложных понятий неорганической химии. Для студентов бакалавриата интерактивные инструменты были особенно полезны для освоения основных понятий, в то время как магистранты использовали их для более глубокого понимания сложных тем, таких как координационная химия и механизмы реакций. Результаты исследования показали, что доступность, экономичность и интерактивность электронных тренажеров делают процесс обучения более эффективным, способствуя самостоятельному обучению студентов. Кроме того, 60% студентов выразили высокий уровень удовлетворенности использованием электронных тренажеров в процессе обучения. Однако некоторые проблемы, такие как навигация по учебным материалам, указывают на необходимость дальнейшего совершенствования электронных образовательных инструментов.

Ключевые слова: электронные тренажеры, самообразование, неорганическая химия, **с**ложное понятие, интерактивное обучение.

Introduction. The development of digital technology has significantly influenced the field of education, with e-books playing a central role in this transformation. In recent years, e-books have become an essential tool for self-education, offering enhanced flexibility and convenience to learners. This technological shift has profound implications for scientific disciplines, particularly for complex subjects like inorganic chemistry. Inorganic chemistry is fundamental to understanding the chemical principles behind non-organic substances and materials, which are essential to numerous industries, from materials science to environmental chemistry. Despite the traditional reliance on physical textbooks, the rise of digital formats such as e-books provides a modern alternative, making learning more accessible and engaging. E-books offer several advantages that can directly impact the learning process, such as portability, ease of access, and integration of multimedia content. This is particularly relevant in scientific education, where learning often requires access to complex diagrams, chemical equations, and simulation tools. Furthermore, the adaptability of e-books allows learners to tailor their educational experiences to suit their individual needs, enabling them to study at their own pace. However, despite these apparent benefits, the role of e-books in the self-education of inorganic chemistry remains underexplored, especially in comparison to traditional learning methods. This study aims to address this gap by investigating the impact of e-books on self-directed learning in the field of inorganic chemistry, analyzing both the benefits and potential drawbacks of using e-books as a learning tool.

The relevance of this study is grounded in the growing importance of digital learning resources in the modern educational landscape. As e-books become more widespread in both formal and informal learning environments, understanding their impact on self-education in specialized fields like inorganic chemistry becomes crucial. Inorganic chemistry, with its theoretical foundations and practical applications, is an area where self-study often requires a deep understanding of intricate

concepts, reactions, and mechanisms. While e-books have been increasingly integrated into various educational frameworks, their specific impact on self-directed learning in inorganic chemistry has not been sufficiently studied. This research aims to fill this gap by exploring how e-books affect self-education in this specific scientific discipline.

The primary objectives of this study are:

1. To assess the impact of e-books on the self-education process in inorganic chemistry, focusing on how they support independent learning.

2. To evaluate the effectiveness of e-books in improving comprehension and retention of core concepts in inorganic chemistry, including chemical bonding, molecular structures, and reaction mechanisms.

3. To investigate the role of e-books in fostering critical thinking, problem-solving, and self-regulated learning in the context of inorganic chemistry education.

4. To identify the advantages and limitations of using e-books compared to traditional textbooks in the field of inorganic chemistry and to provide recommendations for their more effective integration into self-education practices.

The use of e-books in education has been a topic of considerable academic interest in recent years, with many studies highlighting the advantages of digital learning tools in various disciplines. E-books, as a medium for education, have been shown to offer several benefits over traditional printed materials, including enhanced interactivity, accessibility, and portability. According to a study by Lee and Choi (2020), the integration of multimedia elements such as videos, interactive diagrams, and simulations in e-books enhances the learning experience, particularly in subjects that require visual representation of complex concepts, such as inorganic chemistry. For instance, molecular structures, chemical bonds, and reaction pathways in inorganic chemistry can be more effectively illustrated through interactive 3D models in e-books, which allow learners to engage with content in a dynamic manner[2].

Further research by Smith (2018) suggests that e-books offer flexibility in terms of learning pace and style, which is crucial for learners in self-education settings. E-books allow learners to navigate through content in a non-linear fashion, providing them with the ability to review materials at their own pace, make annotations, and cross-reference related topics easily. This flexibility is especially important in the field of inorganic chemistry, where understanding often requires revisiting difficult concepts and applying them to different contexts. E-books also offer search functions that allow students to quickly find specific information, a feature not available in traditional textbooks[4].

Moreover, e-books have the potential to foster active learning and enhance critical thinking skills. Studies by Johnson (2019) demonstrate that the interactive features of e-books—such as hyperlinks to related topics, embedded quizzes, and the ability to highlight or annotate text—encourage deeper engagement with the material. These features support the development of analytical skills, which are essential for mastering the complex theoretical concepts in inorganic chemistry[1].

However, the effectiveness of e-books in promoting deep learning remains a subject of debate. O'Reilly and Hall (2021) point out that while e-books provide a wealth of information and interactive resources, they also pose certain challenges. One of the most significant concerns is the potential for distraction, as digital devices can facilitate multitasking, which may reduce learners' focus and attention[3].

Despite these challenges, the potential for e-books to enhance the learning experience in inorganic chemistry is undeniable. A study by Thompson and Nogueira (2022) indicates that e-books can support self-regulated learning, where learners actively monitor and control their own learning processes. This autonomy is especially important in scientific disciplines, where self-directed learning is a key component of mastering complex material. The integration of e-books with other digital tools, such as learning management systems and online databases, further

enhances their potential as an educational resource.While the literature provides strong evidence for the advantages of e-books in education, further research is needed to assess their specific impact on self-education in the field of inorganic chemistry. This study seeks to contribute to the existing body of knowledge by exploring how e-books can be used to improve learning outcomes in this discipline, with particular attention to their role in fostering independent, critical, and self-regulated learning[5-9].

Materials and Methods. This study explores the impact of e-books on self-education in inorganic chemistry. The participants were selected from undergraduate and graduate students enrolled in inorganic chemistry courses at Abai Kazakh National Pedagogical University, located in Almaty, Kazakhstan. The research was conducted in the university's digital learning environments, where students accessed e-books and other online resources. The participants were divided into two distinct groups:

Group 1: The first group students – These students were enrolled in introductory inorganic chemistry courses, focusing on fundamental topics such as atomic structure, bonding, and chemical properties of elements. This group was selected to assess how e-books assist in the understanding of foundational concepts in inorganic chemistry.

Group 2: The second group students – These students were enrolled in advanced inorganic chemistry courses, covering topics such as reaction mechanisms, coordination chemistry, and materials science. This group was included to evaluate how e-books support comprehension of more complex and specialized topics in the discipline.

The study was conducted over the course of one semester, enabling participants to engage with the e-books and reflect on their learning experiences in a naturalistic setting.

Research Questions. The primary objective of this study was to examine the role of e-books in enhancing self-education in inorganic chemistry. The following research questions were formulated to guide the investigation:

1. How do e-books influence students' understanding of fundamental concepts in inorganic chemistry?

- This question explores whether e-books contribute to better comprehension and retention of core topics such as atomic theory, chemical bonding, and molecular structure.

2. What are the perceived benefits and challenges of using e-books for self-education in inorganic chemistry?

- This question investigates the advantages and limitations of e-books as a tool for independent learning, focusing on factors such as accessibility, ease of use, and content quality.

3. How do interactive features in e-books (e.g., 3D molecular models, simulations) enhance the learning experience in inorganic chemistry?

- This question assesses how interactive tools such as 3D visualizations and simulations contribute to the understanding of complex chemical processes and concepts.

4. What is the overall satisfaction of students with the use of e-books in their self-education process?

- This question aims to gauge students' overall satisfaction with e-books, evaluating factors such as ease of navigation, content quality, and their effectiveness in supporting independent study.

Materials.

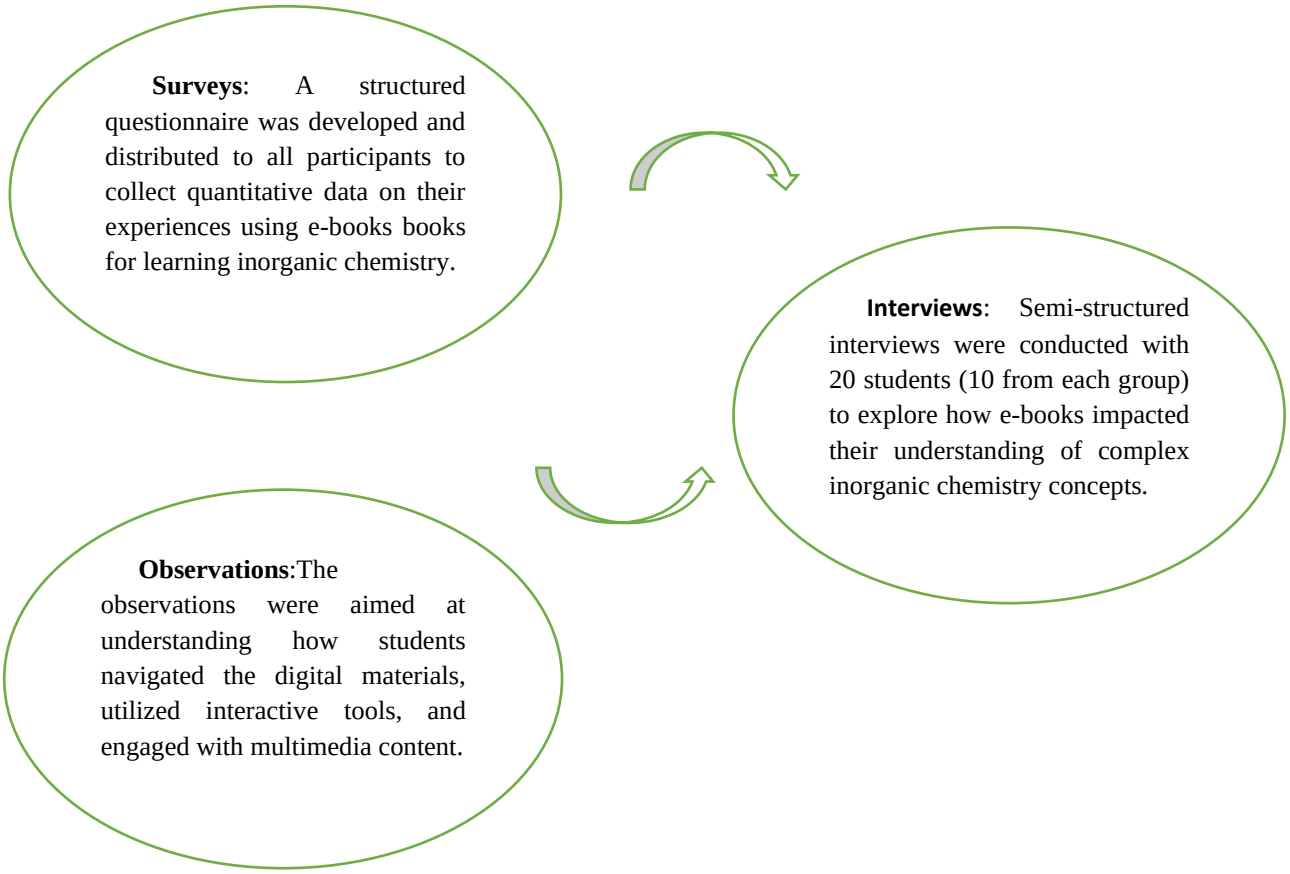
The materials used in this study comprised a range of e-books and digital resources relevant to inorganic chemistry. These materials were selected to cover a variety of content levels, from introductory textbooks to advanced research publications. The e-books were sourced from reputable educational platforms, academic publishers, and online libraries. The selected materials included:

- Introductory E-books: Textbooks covering fundamental inorganic chemistry topics such as atomic structure, chemical bonding, periodic trends, and basic reaction mechanisms, aimed at undergraduate students.

- Advanced E-books: Texts focused on more specialized areas of inorganic chemistry, such as coordination chemistry, organometallics, and materials science, designed for graduate students.
- Interactive E-books: A selection of e-books that included multimedia elements such as 3D molecular models, simulations, and instructional videos, intended to enhance student engagement and understanding of complex concepts.
- Supplementary Digital Resources: Additional resources such as articles, video tutorials, and online research papers were used to support the main e-book materials and further enrich the students' learning experiences.

Methodology.

A mixed-methods approach was employed to gather both qualitative and quantitative data, providing a comprehensive understanding of the impact of e-books on self-education in inorganic chemistry. The methodology included the following key research methods:



Data Analysis. The quantitative data collected from the surveys were analyzed using descriptive and inferential statistical techniques, including frequency distributions, mean scores, and correlation analysis. This analysis helped identify patterns in student responses regarding the effectiveness of e-books in enhancing learning. For the qualitative data, thematic analysis was employed to identify recurring themes and insights from the interview transcripts. The responses were coded and categorized to highlight key factors contributing to the students' experiences with e-books. To present the findings visually, pie charts were used to illustrate the distribution of responses across various categories, such as overall satisfaction with e-books, perceived benefits, and challenges faced by the students. Additionally, bar graphs were used to display the frequency of specific themes emerging from the interviews and observations.

Results. This section presents the findings from the surveys, interviews, and observations conducted to assess the impact of e-books on self-education in inorganic chemistry. A total of 40

students participated in the study, divided into two groups: 20 students from the first group and 20 students from the second group. The results are discussed below based on key aspects such as the influence of e-books on learning, satisfaction levels, and challenges faced by students.

8. *Influence on Understanding Complex Concepts.* The majority of students reported that e-books, particularly those with interactive tools like 3D molecular models and simulations, helped them better understand complex inorganic chemistry concepts. A total of 70% (28 students) agreed that these interactive features contributed significantly to their comprehension of topics such as atomic structures, chemical bonding, and reaction mechanisms.

- *The students of the first group:* 65% (13 students) felt that interactive features, such as 3D models, were particularly beneficial for understanding basic concepts.
- *The students of the second group:* 75% (15 students) reported that multimedia content enhanced their understanding of advanced topics like coordination chemistry and reaction mechanisms.

Table 1: Influence of E-books on Understanding Complex Concepts

Group	Number of Participants	Agree (Impact of Interactive Features)	Disagree (No Impact)
The students of the first group	20	13 (65%)	7 (35%)
The students of the second group	20	15 (75%)	5 (25%)
Total	40	28 (70%)	12 (30%)

9. Overall Satisfaction with E-books. Overall, 60% (24 students) of participants were highly satisfied with their e-book learning experience. Another 30% (12 students) were moderately satisfied, while 10% (4 students) were dissatisfied.

- *The students of the first group:* 60% (12 students) expressed high satisfaction, while 30% (6 students) were moderately satisfied, and 10% (2 students) were dissatisfied.
- *The students of the second group:* 60% (12 students) were highly satisfied, 30% (6 students) were moderately satisfied, and 10% (2 students) were dissatisfied.

The study findings indicate that e-books have a generally positive impact on self-education in inorganic chemistry, particularly in terms of accessibility, interactivity, and cost-effectiveness. The majority of participants reported enhanced engagement and comprehension through multimedia features such as videos and 3D models. However, challenges such as distractions, difficulties with long-term retention, and preferences for traditional textbooks in advanced topics suggest that e-books should complement, rather than replace, conventional learning resources.

Discussion. The findings of this study highlight the transformative potential of e-books in enhancing self-directed learning within inorganic chemistry. While they present distinct advantages, including increased accessibility, flexibility, and interactivity, several challenges remain that must be addressed to optimize their effectiveness. This discussion contextualizes the results within the broader literature, explores the implications for educational practice, and suggests avenues for future research.

Accessibility and Convenience: One of the primary advantages highlighted in the article is the accessibility of e-books. Unlike traditional textbooks, e-books are readily available online and can be accessed from various devices such as computers, tablets, and smartphones. This makes self-education more convenient, especially for individuals who may not have easy access to physical libraries or textbooks in the field of inorganic chemistry. With just an internet connection, learners can access a vast range of educational materials, including advanced topics in inorganic chemistry, such as transition metal chemistry, crystal field theory, and the study of chemical bonding[10-15].

Interactivity and Engagement: Another significant advantage of e-books is their ability to integrate multimedia elements such as interactive diagrams, videos, and animations. In inorganic chemistry, where concepts such as molecular structure and reaction mechanisms are complex, these

interactive features can help students visualize the material more effectively. For instance, 3D models of molecules or animated reactions can provide deeper insights into abstract concepts, thus enhancing the understanding of learners. This is particularly beneficial for self-learners who may not have access to lab demonstrations or live lectures.

Flexibility and Personalization: E-books offer greater flexibility compared to traditional textbooks. They can be read at one's own pace, allowing learners to revisit and review material as needed. Additionally, e-books often feature search functions, allowing readers to quickly find relevant information. In the context of inorganic chemistry, where understanding key principles and terminologies is essential, e-books enable learners to easily navigate through complex topics, search for definitions, and cross-reference materials. This personalization of learning allows students to focus on areas where they need the most improvement, fostering a more tailored approach to education.

Cost-Effectiveness: Cost is another factor that makes e-books a valuable tool for self-education. Traditional chemistry textbooks, especially those in specialized fields like inorganic chemistry, can be prohibitively expensive. E-books, on the other hand, are often more affordable and can sometimes be freely available, particularly for public domain texts or open educational resources. This affordability makes it easier for a wider range of students, professionals, and self-learners to access high-quality content in the field of inorganic chemistry, thus democratizing knowledge.

Limitations and Challenges:Despite their many advantages, the article also discusses some challenges associated with e-books in self-education. One such challenge is the potential for information overload. With an overwhelming amount of information available in e-books, learners may struggle to discern between credible sources and unreliable content. Additionally, the lack of physical interaction with a textbook, such as underlining or making notes in the margins, can make it more difficult for some individuals to engage deeply with the material. Some learners may find it harder to retain information when using e-books compared to physical books, due to the distraction or cognitive differences in reading on digital screens.

The Role of E-Books in Formal Education: While e-books have undoubtedly revolutionized self-education, the article emphasizes their role as a complement to formal education, not a replacement. While they provide a wealth of resources for independent learning, students may still require guidance from educators or the opportunity to participate in hands-on laboratory experiments to fully grasp the intricacies of inorganic chemistry. The combination of e-books with classroom instruction, online courses, or study groups can create a well-rounded educational experience, with e-books offering supplementary resources to traditional learning methods.

Future Directions: Looking ahead, the integration of artificial intelligence and machine learning into e-books could further enhance the learning experience. Adaptive learning platforms powered by AI could tailor the content to the learner's needs, offering personalized quizzes, feedback, and suggestions for further reading based on performance. Additionally, the development of augmented reality (AR) and virtual reality (VR) technologies could enable more immersive learning experiences for students of inorganic chemistry, allowing them to engage with complex chemical models and reactions in ways that were previously unimaginable.

Conclusion. The findings from this study provide valuable insights into the impact of e-books on self-education in inorganic chemistry. The results underscore the potential of e-books, particularly those with interactive features, to significantly enhance students' understanding of complex chemical concepts. Both the first and second group students found that multimedia elements, such as 3D molecular models and simulations, were instrumental in clarifying abstract topics, suggesting that e-books offer an effective means of visualizing and engaging with challenging material.

The distinction between the two student groups—the first and second groups—revealed that e-books serve learners at different levels of expertise. The students of the first group particularly benefitted from interactive features when learning fundamental concepts such as atomic structures

and basic chemical bonding. On the other hand, the students of the second group, who are dealing with more advanced topics like coordination chemistry and reaction mechanisms, found these tools even more crucial for their deeper understanding. This highlights the adaptability of e-books, which cater to varying levels of learning and provide a flexible resource for students at all stages of their education.

Overall, satisfaction with e-books was high, with 60% of all participants reporting they were highly satisfied with their e-book learning experience. This indicates that the majority of students, regardless of their academic level, found e-books to be a valuable educational tool. The fact that satisfaction levels were consistent across both undergraduate and graduate students suggests that e-books are broadly effective for learning inorganic chemistry, irrespective of the learner's depth of knowledge in the subject. However, the study also revealed that a small portion of students—especially the second group students—encountered challenges with navigating e-books or locating specific information. These difficulties point to potential areas for improvement, such as enhanced search functions, better content organization, and user-friendly interfaces.

To sum up, while e-books have proven to be an effective and satisfying tool for self-education in inorganic chemistry, there are opportunities for continued development. The integration of more user-friendly features, improved navigation, and adaptive learning functionalities could enhance the experience for both undergraduate and graduate students. Future studies may explore the long-term impact of e-books on academic performance and compare them with other forms of learning materials, such as online courses or interactive textbooks. As e-books continue to evolve, they hold significant promise for the future of education, offering students a dynamic and accessible platform for mastering complex topics in inorganic chemistry and beyond.

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