

## Research Article

Assel Akhmetova\*, Zhanat Karmanova, Shnar Demissenova, Nurgul Sadvakassova, Kanat Koshkumbaev

# Pedagogical Technologies and Cognitive Development in Secondary Education

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### Abstract

**Introduction** – The model for implementing pedagogical technologies to the develop cognitive processes of secondary education students is highly significant in the present era.

**Objectives** – The purpose of the study is to substantiate and practically test some pedagogical technologies used in the process of secondary education.

**Methods** – To investigate this issue in more detail, theoretical research methods were used, namely: analysis, generalisation, synthesis, structural and functional methods, and empirical research methods such as testing, survey, and experiment.

**Results** – The main result of the study is the proof of the fact that pedagogical technologies for the development of cognitive abilities in students affect their success in learning and their level of productivity.

**Discussion** – The experimental part of the study showed that it is necessary to introduce such teaching methods as game techniques “In search of the truth,” “Perceive the date,” “Naughty numbers,” and “Black Box” in the development of chronological knowledge in history lessons, since the use of such techniques at any age contributes

to the development of stable associative connections, as opposed to direct memorisation. Moreover, such training promotes the development of imagination, logical thinking of students, and memorisation mechanisms and effectively affects the development of cognitive abilities of the individual. The practical significance of this study is that all the materials can be used in educational institutions by teachers, students, and other researchers.

**Keywords:** educational activity, chronological knowledge, non-standard training, game techniques, cognitive abilities

## 1 Introduction

The topic of cognitive development is relevant among the scientific community and lies in the fact that through the use of special pedagogical teaching methods aimed at developing the cognitive sphere of the individual and overcoming the difficulties of teaching subjects at school, students have the opportunity to get positive results in the learning process and improve their level of performance. Most knowledge seekers do not enjoy learning because they consider it too difficult and boring. According to the research by Austerberry et al. (2022), this is conditioned by the development of cognitive abilities of the child, which are necessary for processing a large flow of information. Accordingly, methods and practical exercises contribute to the development of the necessary abilities and positively affect the productivity and success of the individual.

Cognitive abilities of a person are innate, but it is important to pay significant attention to their development from the very birth of the baby and throughout life. Bulgakova and Voloshenko (2022) note that in the elderly, cognitive abilities begin to fade, so constant training is necessary to stay sane. Normal human development involves interest, curiosity, and a desire for development, so it is important to maintain this development and be in a state of constant interest in the environment (Torybaeva, 2013). The main task of parents is to develop the cognitive sphere of their child from birth. Some cognitive

\* **Corresponding author: Assel Akhmetova**, Department of Preschool and Psychological-Pedagogical Preparation, Karaganda Buketov University, Karaganda, 100024, Republic of Kazakhstan, e-mail: akhmetovaa284@gmail.com

**Zhanat Karmanova:** Department of Preschool and Psychological-Pedagogical Preparation, Karaganda Buketov University, Karaganda, 100024, Republic of Kazakhstan, e-mail: zhanatkarmanova@outlook.com

**Shnar Demissenova:** Department of Pedagogy and Psychology, A. Baitursynov Kostanay Regional University, Kostanay, 110000, Republic of Kazakhstan, e-mail: S.Demissenova@proton.me

**Nurgul Sadvakassova:** Department of Special and Inclusive Education, Karaganda Buketov University, Karaganda, 100024, Republic of Kazakhstan, e-mail: nurgul.sadvakassova@hotmail.com

**Kanat Koshkumbaev:** Department of Fine Arts and Design, Karaganda Buketov University, Karaganda, 100024, Republic of Kazakhstan, e-mail: K.Koshkumbaev@proton.me

skills are innate, but most of them are acquired in the learning process. According to Kyyakbaeva, Iniyatova, and Shirinbaeva (2021), in cases where the development of cognitive skills does not occur properly at one of the stages, this causes problems to arise at the next dependent stages, and as a result, cognitive insufficiency occurs, which negatively affects the learning potential.

According to the study by Ibraimova and Ermentaeva (2020), currently, there are many teaching techniques, but the most effective pedagogical technology is cognitive, aimed at improving the cognitive abilities of the individual and having a positive impact on the child's performance. In general, such technologies are based on the provisions of cognitive psychology. The main task of cognitive psychology is the development of an individual's intellectual sphere during the educational process. Cognitive psychology investigates the processes of obtaining information, its transformation, storage in memory, and how this information will affect a person's future behaviour and attention (Ortynskyy, Varii, Ortynska, Humin, & Terletska, 2018). In the conditions of cognitive technology, the educational process is aimed at cognition of the relations between subjects and not at the absorption of information. Such informed learning contributes to the effective development of mental activity (Sarsekeyeva, Gorbunova, Zhekibayeva, & Sarsekeyeva, 2019). However, according to Nurkhozhayeva and Begaliyeva (2021), most modern educational institutions do not pay enough attention, money, and time to develop abilities since teachers must submit educational material at a pace that is difficult to restrain such children. Moreover, additional workloads, homework, and inadequate attention to the development of these abilities aggravate the student's frustration and the problem with mastering new knowledge (Pak, Kheday, Akkasynova, Bidaibekov, & Kamalova, 2021).

Thus, the main purpose of this study is the theoretical substantiation of pedagogical techniques for the development of cognitive abilities, as well as experimentally testing the technique in educational institutions. The main objective

of this study is to consider the basic concepts such as "cognitive psychology," "cognitive abilities," and "cognitive technologies," analyse current pedagogical technologies for the development of the cognitive sphere, and experimentally test cognitive teaching techniques in history lessons in educational institutions of Kazakhstan.

## 2 Materials and Methods

To investigate this issue further, theoretical research methods were utilised, including analysis, generalisation, synthesis, and structural and functional approaches. Empirical methods such as testing, surveys, and experiments were also employed. The structural and functional approach provided the foundation for examining the core concepts "cognitive techniques," "cognitive abilities," "cognitive psychology," and "cognitive schemas." The developmental stages of an individual's cognitive sphere were analysed. This study examined how the level of cognitive development impacts learning success and productivity in adolescents. In addition, the skills and abilities comprising the cognitive system were analysed.

The teaching techniques focused on improving students' memorization of chronology in history (Table 1).

These games were incorporated into the standard history curriculum topics studied by the 7th-grade students aged 12–13 over a 1-month period. The exact topics were aligned with the standard Kazakhstani 7th-grade history curriculum.

During the study, an experiment was conducted based on four educational institutions in Karaganda. The directors of the educational institutions gave written permission for the experiment to be carried out. The experiment involved altering the teaching methodology for history. It is worth noting that the students were interviewed and tested before and after the experimental period. The primary aim of the research was to determine the change in

**Table 1:** Cognitive game techniques

"In search of the truth"	Students were given a short history text with missing words or incorrect information that they had to correct and complete. This tested their knowledge of historical facts.
"Perceive the date"	Dates were encoded in pictures, riddles, etc. that had to be deciphered. This helped the students memorize dates through different forms of encoding.
"Naughty numbers"	Students were given sets of numbers that they had to arrange into historical dates. This game improved memory and familiarity with key dates.
"Black box"	Students drew cards with historical dates, events, and keywords from a box, the significance of which they had to explain. This method tested memorization.
Competitions to write down timelines	It required students to write the most dates on the board from memory. This helped reinforce memorization through active recall.

students' understanding before and after the implementation of this approach. To this end, empirical methods such as surveys and tests were used in this phase of the study (Table 2).

The participants were tested to determine their level of knowledge. This phase of the experiment lasted 2 h. The methods were utilised to establish the knowledge levels of 7th-grade students' (12–13 years) before and after the experimental period. The article placed considerable emphasis on logical techniques, particularly analysis and synthesis. Using the initial approach, theoretical data were summarised, and the results of a pre- and post-experimental survey of students were analysed. It is crucial to note the significance of generalisation and comparative analysis, which were influential in shaping the overall results of the experiment and scientific research. With the assistance of the second method, synthesis, the collected information was organised into a logically structured document.

To carry out the experiment involving 7th-grade students of both genders, the authors of the article devised techniques and activities. The surveys were intentionally designed to be highly accessible and straightforward, ensuring that students in grades 12–13 could easily manage them without feeling any undue pressure.

The authors informed the participants (their parents) about the anonymous and voluntary participation, and the participants (their parents) provided their consent.

### 3 Results

Such an academic subject as History is a rather complex system of influence on the cognitive sphere of a student. It consists of the construction of educational material, teaching methods, the organisation of educational and cognitive activities, and other aspects. Knowledge of history accumulates not only information about specific facts but also emotions associated with them, the essence of events and the logic of their development (Vlasova, 2016). They are the basis for the transition to the theoretical level of knowledge when a student can independently explain facts from history. The broader the understanding of facts, the more

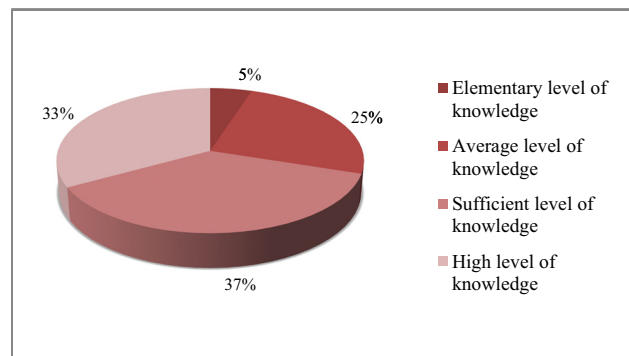
meaningful the system of concepts. According to researchers, it is a mistake to believe that the use of game techniques during training is effective in the development of the cognitive sphere only at an early age. The game is a serious mental game that develops all kinds of human abilities. The use of such techniques at any age contributes to the development of stable associative connections, as opposed to direct memorisation.

By the beginning of the experimental period, all the students who participated in the experiment had passed a small survey and testing, which took only 2 h. The main purpose of this stage was to determine the level of knowledge of students. The results of this part of the experiment were as follows: most of the respondents claimed that it was quite difficult to study history, especially for students of gymnasiums and lyceums. This was attributed to the broader curriculum and higher academic demands in such institutions. However, testing indicated that students from gymnasiums and lyceums generally had better history knowledge compared to regular school students. According to the criteria for assessing students' academic achievements in history, there are four levels of academic achievements in the general education system: elementary, average, sufficient, and high. Thus, most of the interviewed students had a sufficient level of knowledge of history. Specifically, students from School No. 1 and School No. 2, as well as School No. 3, primarily attained a high level, while some achieved a sufficient level. However, at School No. 4, only a small number of students reached a high level, whereas others were categorised as sufficient or average. A minority of the students surveyed demonstrated an elementary level of knowledge (Figure 1).

Successful study of history is impossible without mastering chronology. According to scientific research, almost 87% of students aged 11–13 have problems with studying chronology (Kievit, 2020). The factors influencing such statistics should be analysed. Attention should be paid to the

**Table 2:** Survey questions

1	Are you fond of studying history?
2	Is it easy for you to study this subject?
3	Do you attend additional classes?
4	Would you like to change something?



**Figure 1:** Test results before the experimental period.

regulatory role of various psychological properties that determine productivity. This factor can have a negative impact on different levels of mental functioning, namely: perception, processing, and analysis of the received material. Cognitive development is objectified in different indicators. Cognitive development is objectified in different indicators (Table 3).

When planning the lesson, educators should prioritize the methods they'll use to teach skills and abilities to students, rather than simply focusing on the content they'll present (Rashidov, 2022). In this process, the place is occupied by cognitive abilities – the general skills of the child, which allows the individual to independently study the presented material in the acquisition process. The presented material consists of the fact that the student can reproduce the learned material, use learning elements in solving typical tasks, and apply the base of acquired knowledge to assimilate new material and solve problems in new conditions. The development of chronological knowledge is impossible without the basic cognitive abilities of the individual, namely attention, thinking, memory, and perception since they are all interconnected and activated in the process of cognition, proceed in accordance with all psychological laws, and therefore need to be developed (Maletska, 2013). The effectiveness of the perception of the material is influenced by the type characteristic of each individual and the amount of material entering the brain. The more channels through which this information gets to a person, the more complete the idea of the subject that is formed in the individual's mind, and as a result is better remembered (Peng & Kievit, 2020). Thus, the following types of perception are distinguished: visual, auditory, tactile, and combined type.

In the process of cognition, memory plays an important role, since it acts as the main source of skills and knowledge necessary to obtain new material, and is a mechanism for preserving already acquired skills and knowledge. According to research by psychologists, memory is a process of receiving, processing, storing, and reproducing what has been received (Immordino-Young & Knecht, 2020).

The effectiveness of this process lies in the ability to use the laws of memory. The basic laws of memory are the law of return, the law of the volume of knowledge, the law of installation, the law of conscious perception, the law of first impression, the law of associations, the law of the length of the information series, the law of human throughput, the law of forgetting, and the law of information overlay (Austerberry et al., 2022). In the case when a person does not know how to use these laws, the labour productivity of not only students but also teachers decreases. Students face the problem of the formation of chronological knowledge in the study of history in general.

To avoid the appearance of such difficulties in the learning process, it is necessary to apply various techniques of cognitive development of 7th-grade students in the process of studying chronology in history lessons. In some exercises, you can use the technique “In search of the truth.” The student is offered a small text on history, where the missing words should be supplemented and all errors corrected. For example, the teacher offers such a fragment: “Counting the years from a certain event is called chronology, that is ... era. One million years ago, the counting of years was gradually established in society, which is still used today. The time from the first year to today is called our date (our era). Every... (100) years is called a century, or ... (century). A thousand years is ... (a millennium). The first century of our era begins in the 1st year and ends in the 101st year (100th)”, and the student must correct the mistakes here and insert the correct word or phrase instead of the colon (Maletska, 2013).

In other classes, students were asked to use the “Perceive the date” technique in the lessons. The essence of this lesson is that through a variety of ways and different encoding characters, the content of information can be changed. For example, this technique is very effective in studying the dates of the appearance of primitive people on the territory of Kazakhstan. A teacher can draw a picture of this event and disguise the corresponding meaning in it, as well as determine the content of the hint and how to find it. Then

**Table 3:** Indicators of cognitive development

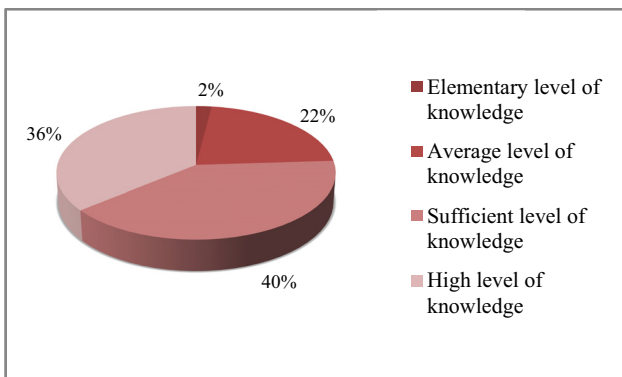
A systematic transfer of learned material	The ability to apply learned knowledge to new situations and problems
The use of mental operations	Analysis, synthesis, criticality, classification, abstraction, concretisation, and comparison. These mental operations are used to process information and solve problems
The qualities of reason	This includes criticality, independence, depth, flexibility, and age dynamism. These qualities are used to reason and think critically in new situations
Learning as receptivity to learning	The ability to learn and acquire new knowledge and skills
Intellectual initiative	The ability to take the initiative to learn and solve problems independently

make a riddle about the event, finding some words that can be used to describe the event.

Another effective technique that will help remember dates is the game “Naughty numbers.” The teacher offers a set of numbers, and students should make them up and get some historical dates. For example, the teacher offers the following figures: 8; 1; 4; 7; 3; 6; 2; – 1824–1864 years. The national liberation struggle of the Kazakh people, 1837–1841. The uprising of Kenesary Kasymov. Or the “Black box” game, which consists of the fact that students extract a card with historical dates (event description, keywords, and questions) from the box and have to explain these dates. The technique “Who can write the most dates on the board for the topic” will help the students to increase their memory capacity. In turn, the teacher calls several students and holds competitions between them, and those who do not participate in the competition check the correctness of the dates.

During the month, teachers in history lessons used a variety of game techniques aimed at improving the memorisation of chronology. At the end of the experiment, the participants were interviewed and tested again, as at the beginning of the study. As a result of the survey, the majority of students were satisfied with the new way of remembering dates. According to the test results, the level of knowledge of some students has improved significantly, and it has become easier to remember new information (Figure 2).

The key shifts were a small increase in the high and sufficient levels and a decrease in the average and elementary levels. The cognitive learning techniques have helped move some students from lower levels of performance to higher levels. Specifically, the elementary level declined as some of those students improved to average. The average level declined as some students transitioned to sufficient. Consequently, there is a positive trend, but the increase



**Figure 2:** Test results after the experimental period.

was conditioned by not only the study of chronology but also the systematic assimilation of basic theory. It is also important to note that testing takes place without considering new material. Testing at the beginning of the experiment and at the end took place on the same topics. The increase in the level of knowledge is quite insignificant, since the period of application of cognitive learning technologies is quite short, and therefore, to achieve significant results, cognitive learning technologies should be systematically used with students in the classroom. It can be concluded that in the process of studying history, such chronology study techniques should be introduced since the use of game techniques contributes to the development of imagination, logical thinking of students, and memorisation mechanisms and effectively affects the development of cognitive abilities of the individual. More extensive research is needed to further validate and quantify the impact of these techniques on student performance.

The present study is susceptible to various potential confounding factors that may exert an influence on the outcomes. Initially, the brief period of 1 month may restrict the capacity to formulate conclusive inferences. Students necessitate ample time and repetition to genuinely attain new knowledge and skills. Furthermore, the study was carried out within a restricted geographical region and with a relatively small number of participants. These factors diminish the ability to apply the findings to a broader population.

To tackle these concerns, forthcoming investigations should employ extended experimental durations spanning an entire academic year or multiple years. Furthermore, conducting multi-site experiments across diverse regions and utilising larger sample sizes would enhance the reliability of the results. Incorporating control groups and comparing them to groups receiving cognitive teaching techniques is essential. This aids in isolating the influence of the independent variable. To further reduce bias, it would be beneficial to blind the research assistants who are collecting data.

In addition, there could be discrepancies in the implementation of instructional techniques among various educators. Measures should be implemented to standardise training procedures to guarantee consistent application of game techniques. Furthermore, it is challenging to exert control over extracurricular activities and personal circumstances that impact students, but it is important to consider and acknowledge other factors that influence student performance.

To summarise, although this preliminary study demonstrates encouraging outcomes, it is imperative to conduct more extensive and comprehensive experiments with

rigorous controls over an extended period to ascertain the influence and applicability. To obtain more conclusive evidence on the effectiveness of cognitive teaching techniques, it is necessary to address limitations related to the duration of the study, sample size, geographic scope, control groups, standardised instruction, and accounting for confounding variables. Consistently enhancing research practices will aid in overcoming the current complicating factors.

## 4 Discussion

During adolescence, a person undergoes active cognitive development. Development begins in subtle forms, both for the child and for their environment. According to the research by Immordino-Young and Knecht (2020), during this period, there is a development of thinking and memory, there is a holistic awareness of what is happening around, and the imagination expands. Such features of cognition are the basis for the rapid accumulation of new knowledge. Cognitive development in a child is characterised by the development of abstract thinking, logic and memory, and the use of metacognitive abilities. Metacognitive abilities are such skills of an individual that are interrelated with the development of a style of intellectual activity (Dzhubaliyeva, Mynbayeva, & Assilbek, 2021). All these factors especially influence the development and content of opinions and the ability of a teenager to make moral judgments.

According to Klahr and Wallace (2022), one of the main concepts of pedagogical technologies for the development of the cognitive sphere of students is the concept of cognitive schemes. Perception involves actively gathering information through the use of specific cognitive frameworks that develop throughout an individual's lifetime. In cases where these schemes are absent, the information received is not perceived or is perceived as distorted. Accordingly, experience, skills, and knowledge affect the completeness of perception. The presence of cognitive schemata in the student's mind is important so that new information held can be combined with old information. It is necessary to agree with the conclusions of the researcher, since incomplete or distorted information causes incomplete or distorted perception of information, which complicates the socialisation of the individual. Therefore, it is important to consider the educational process as a way of forming cognitive schemes.

Swiss psychologist, researching this topic, found out that the development of the human cognitive sphere is a gradual process consisting of several stages, at which new

cognitive abilities are formed and old ones are improved. The intellectual development of a child occurs in the process of constantly searching for a balance between the knowledgeable and what a person still seeks to understand. Having analysed the theory of cognitive development, it should be concluded that the main task of a teacher in history lessons, during the development of chronological knowledge, is to help a child in search and to be able to keep a balance between what a student knows and what they should still learn. Later, based on the theory of cognitive development, Bruner (1997) formulated a cognitive theory of learning. The main provisions of this theory of cognitive learning are as follows: the student should be an active participant in the educational process, during which all their individual characteristics should be considered; the educational process should be socially conditioned, i.e. the teacher and students should participate in the process of understanding each other; and an integral part of the learning process is the development of thinking. The theory of cognitive learning is aimed at the intellectual development of the individual and all mental abilities, which facilitates the learning process and the perception of new material (Baikulova, Ibrayeva, Shalabayeva, Abdigapbarova, & Mynbayeva, 2017).

In adolescents, the development of the cognitive sphere is based on the ability to think and make important decisions. All cognitive abilities begin to form from the moment of birth. However, as denoted by Heeringa and Berglund (2020), during adolescence, the development processes become somewhat more complicated based on the changes that have already occurred. Adolescents should learn to apply their existing abilities. During the experiment, it was found that most of the students had a sufficient level of intellectual and mental activity, but they could not use these skills correctly in the classroom. Thus, the authors add that persons aged 12–18 years should be able to put into practice the skills and abilities they received during their childhood. A significant factor affecting performance and success in learning is adolescence. It is concentration and the level of distraction that depend on age. According to the study by Wijaya and Supartini (2020), each individual can apply their own invented method of memorising new information and manage their own memory and thinking processes, but at the same time, it is difficult for adolescents to manage themselves as a whole. Academic failure may be due to the fact that a teenager has an interest in a new occupation or because of their own emotions or emotional instability. The authors agree with the conclusions of these researchers, since most of the students in the survey claimed that with the start of attending various clubs and sports sections, interest in the learning process decreased.

As noted by Simmons et al. (2021), adolescents are also characterised by the development of theoretical thinking and their mental activity becomes more active and independent. As a consequence of the development of the cognitive sphere of a teenager, the appearance of narcissism and egocentrism contributes to a change in worldview, and as a result, students are more likely to treat the content of the material and teachers critically. This period is characterised by the configuration of ideas about the interest of the subject. That is, high school students are not interested in what they are studying but in the method of presenting information (Balykbayev, Bidaibekov, Grinshkun, & Kurmangaliyeva, 2022). The more unusual the way of teaching, the more enthusiastic the students will be. Another feature of adolescents is the attraction to generalised principles and patterns (Moshura, 2023). It is necessary to agree with the researcher because, in the process of interviewing the participants of the experiment, it was found that it is easier for children to remember when the teacher explains the basic information in an accessible and short way, whereas memorising large and difficult rules and theorems is difficult.

Hanımoglu (2018) analyses various literature focusing on the roles that technology has played in high school education over the years. The study highlights that the integration of IT in the learning process requires practical skills and access to technological tools for teachers. The study also suggests that the adoption of technology in high school education leads to an overall improvement in reporting and 7th grade. The use of technology in high school can help break down boundaries, as it does not limit the lesson period, and creates an authentic learning continuum between home and school due to empowerment in the latter (Meruyert, Aigul, Aidyn, Laura, & Esenbaevna, 2022). The study concludes that access to technology can improve the quality of education and student attainment, promote self-learning, and develop new skills. Kulmagambetova, Iskındirova, Kazhiakparova, Bainiyeva, and Pandya (2016), in their study, provided a comparative analysis of pedagogical technologies used in higher educational institutions, their strengths, weaknesses, and development prospects. It was concluded that the correct application of pedagogical technologies greatly simplifies and improves the quality of the educational process. Choosing poor or outdated teaching technology causes the inability of higher education institutions to provide high-quality professionals for the labour market (Moldazhanova, Dzhumazhanova, Amanova, & Kokoraeva, 2019). The comparison of pedagogical technologies provides their detailed description and the ability to select the most appropriate methods and approaches based on the requirements of relevant disciplines that will

meet the highest quality standards for students and teachers. The study conducted by Hennessy et al. (2007) investigated the interaction between teachers and their students and searched for mechanisms in the pedagogical context related to teachers' use of technology. The authors found that teachers who effectively integrate technology into their teaching have well-developed and articulated pedagogical thinking about integrating technology use. It was concluded that understanding the strategies that teachers employ to promote effective teaching with new technologies is crucial to the successful integration of technology into teaching and learning.

In conclusion, the use of cognitive teaching techniques, such as games and competitions, can have a positive impact on students' cognitive abilities and academic performance. The experiment demonstrated that the use of such techniques in history lessons can improve students' engagement and knowledge of chronological events. However, while the results indicate a positive trend, the experiment was carried out for a short period and with a limited sample size, thus the generalisability of the results may be limited.

## 5 Conclusions

Currently, there are many teaching techniques, but the most effective are cognitive teaching technologies, since they are aimed at improving the cognitive abilities of the individual and have a positive impact on the student's performance. They are based on the provisions of cognitive psychology, which studies the human mind and thinking, as well as the mental processes associated with them. When determining the course of the lesson, the teacher should remember that the basis of their work is how they will teach students skills and abilities, since students are attracted to non-standard methods of presenting information. The more unusual the way of teaching, the more enthusiastic the students will be. A significant factor affecting performance and success in learning is adolescence. During adolescence, the development processes become somewhat more complicated. This may be conditioned by the fact that the teenager has an interest in a new occupation or because of their own emotions or emotional instability. Consequently, most students are disappointed with the learning process, because they consider it too difficult and boring. However, this is due to the lack of proper development of cognitive abilities necessary for information processing. During the study of this topic, an experiment was conducted to investigate the influence of pedagogical techniques for the development of cognitive

systems on the success of students in history lessons in the development of chronological knowledge. If, before the beginning of the experimental period, students were dissatisfied with learning, then after the end of using a variety of game techniques, namely “In search of the truth,” “Perceive the date,” “Naughty numbers,” and “Black Box,” the level of students’ educational knowledge improved significantly.

The scientific originality of this study consists in the fact that for the first time, pedagogical technologies for the development of cognitive processes of 7th-grade students that affect their academic performance in learning, namely history lessons, were investigated. Further research with larger samples, longer duration, and broader geographic areas is necessary to validate the results and quantify the impact of cognitive teaching techniques on students’ performance. In addition, future research should focus on the development of the cognitive abilities of secondary school students and the identification of effective pedagogical approaches in various academic subjects. The study highlights the importance of incorporating innovative teaching practices that engage students and enhance their cognitive abilities.

**Author contributions:** A.A., Zh.K., and Sh.D.: conceptualization, methodology, data curation, writing-original draft preparation. N.S.: visualization, investigation, and supervision. Sh.D. and K.K.: software, validation, writing-reviewing, and editing. All authors read and approved the final manuscript.

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**Data availability statement:** The authors confirm that the data supporting the findings of this study are available in the article.

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