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Engineering Approach to Creating a Cutting-Edge Children's Additional Education Establishment

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Abstract

Intellectual activities conducted at an early age play an important role in the formation of a well-rounded personality in modern society. Games, including chess, are an extremely effective way to engage in such activities. The paper proves the equivalence of the engineering approach and the principles of quality management in the education of children of preschool and primary school age. As an example, an organization that teaches children to play chess has been chosen. The findings allow other similar organizations of additional education to effectively build their short-term and long-term work to increase the competitiveness of both the educational organization and the students who have completed their training. The study employed a qualitative methodology of educational engineering based on the application of quality management system principles. Additionally, along with this, the following tools for management, analysis, and quality engineering were used: SWOT analysis, methods for describing business processes, and statistical quality management tools. Furthermore, to enhance the motivation of learners and their parents for systematic studies and to further digitalize the educational process, a startup project based on the use of artificial intelligence has been described.

Keywords: engineering approach; quality management system; quality education; SWOT analysis; business process; digitalization; artificial intelligence; supplementary education institution; chess.



1. Introduction

It is no secret that today's children are more intellectually developed than their predecessors. Their abilities in cognition of the complex modern world begin to manifest themselves very early - already by 3-4 years of age. The fourth information breakthrough, which began in the last quarter of the 20th century, has played and continues to play a significant role in this development [1, 2]. Formation of a well-rounded personality of a modern person is a very complex and multifaceted process. Intellectual activities in the learning process, especially during the time when a growing individual was still a child, occupy an important place in this development. Without such activities, introducing children to the scientific picture of the world can later prove to be a very difficult process. Therefore, in order to make the transition from child perception to adult understanding as fruitful and effective as possible, a child's intellectual development should be prepared in advance.

Such training can be done in a variety of ways. One of them is teaching the game, in particular, teaching to play chess. Playing chess is both a game and a sport. Moreover, chess serves as a serious test of intellectual abilities. At the same time the game of chess is a training and development of these abilities [3]. Being an intellectual training, it directly influences the development and formation of the child's entire personality. The game of chess has always been one of the important elements in the development of history, theory and philosophy of intellectual culture not only of a single person, but also of the whole human community.

Teaching to play chess is a complex set of different methods formed by centuries of human history. However, all of them, to a greater or lesser extent, are aimed at developing a comprehensively developed and harmoniously integral personality of the learner [4, 5]. Teaching to play chess allows developing a whole range of human abilities, such as:

- developing intellectual abilities;
- improving mental processes;
- enhancing attention;
- improving memory;
- developing logical thinking;
- fostering imagination;
- promoting the development of stress resilience;
- encouraging the development of willpower and volitional behavior.

In contemporary Russia, teaching children to play chess mainly takes the form of supplementary education: chess clubs, chess sections, the "Chess in School" project [6, 7], as well as numerous websites offering both free [8] and paid online courses for teaching children how to play chess [9-11]. It is worth noting that a vast number of such courses aim not so much at achieving a certain (preferably



maximum!) sports result but at ensuring the intellectual and overall personal development of the child.

However, teaching to play chess cannot be reduced to just one creative process of teaching a child to play the game according to their age and gender characteristics. It is also, in fact, the organizational structure itself, which implements educational activities.

In this regard, an important task is to create a competitive organization aimed at ensuring quality education for children and the development of their personalities. This, in turn, requires addressing a range of issues concerning the provision, management, and, undoubtedly, the continuous improvement of the quality of educational services offered. This can be realized, primarily, by implementing the principles and methods of quality management systems. Secondly, it can be achieved through the implementation of specific provisions in the field of quality. These can include, for example, meeting consumer requirements regarding the provision of educational results with widely recognized stable characteristics, such as knowledge of chess terminology; application of tactical methods and conducting combinations; formation of a mathematical mindset, and so on. These methods can be effectively realized based on the use of traditional technologies and standardized quality tools.

However, in order to attract and retain consumers it is necessary to form fundamentally new competences of the learner (for example, cognitive interest and creative approach to solving various problems; the ability to independently acquire knowledge; the need for further self-development and realization of one's own personal potential). This urgently necessitates the development and implementation of new technological developments (including digitalization of educational activities).

Such developments should have a significant impact on the development of children's mental processes, so should clearly be based on an individualized approach, on continuous improvement and on a process-oriented approach.

Their implementation will help solve a variety of pressing issues faced by supplemental education institutions in the field of chess today: increasing the competitiveness and prestige of the educational institution; combating the loss of interest in chess among children after the first year of classes or subsequent years of training; the lack of professional growth among educators; the need to establish a system for exchanging experiences among supplemental education institutions, and so on.

Parents carefully consider the choice of educational options. Competition, especially in large cities, is great. Thus, for organizations engaged in teaching



activities, ensuring the quality of education and consequently raising the competitiveness of specific teaching methods is crucial.

Nowadays, education is not only one of the fundamental human rights ensuring the quality of life, but also becomes a key factor of sustainable development of the whole society. The concept of "quality of education", as compliance with educational standards [12, 13], is a very multifaceted concept [14, 15]. Undoubtedly, it cannot be simply identified with the single issue of the quality of graduates' training [16, 17].

In this context, this work applies an engineering approach to the development of a universal quality management system [18-20] of the work of institutions of additional education on the example of an organization that teaches children the game of chess [21, 22]. These proposals are based on the introduction of a quality management system [23], which will contribute to improving the system of training young chess players and, in turn, will undoubtedly contribute to increasing the competitiveness of institutions of additional training (education).

2. Materials and Methods

For decades, the modern Russian chess school has been one of the world's leading chess schools, a position it continues to occupy. Continuing the best traditions of the Soviet chess school, modern Russian chess players continue to remain on the chess Olympus, occupying the first places in the world chess qualification. Naturally, in this connection, the methods of teaching young chess players developed by Russian [24] and Soviet chess players [25-28] have gained worldwide recognition. Undoubtedly, of particular interest are the methodological recommendations [29] written specifically for teaching chess to children aged 4-6 in kindergartens.

Both a sports coach and a general school chess teacher teach children to play chess. In their work, they rely on well-known didactic principles - awareness and activity in the learning process, accessibility of the acquired knowledge, individualization of learning, systematic learning, and scientificity. However, the learning process itself is based on different target objectives, which naturally leads to different teaching methods.

A sports coach is orientated towards a sporting bias [25-28]. Therefore, he endeavours to develop in a novice chess player primarily sporting qualities, such as: determination to win, theoretical knowledge of openings, middlegame, etc., mental stability and endurance.

A chess teacher is orientated towards the general educational bias, putting the achievement of high sporting results on the back burner [6, 7]. Therefore, he



endeavours to develop first of all intellectual qualities in a beginning chess player. At the same time, he must take care that this development does not prevail over the development of other aspects of personality, but contributes to the formation of a harmoniously developed person.

Nevertheless, a chess teacher should not forget about the prospective task of training a qualified chess player. Therefore, in his work he must also take into account the basic principles of sports training [30].

The main mission of the pedagogical process is to transfer the acquired experience and accumulated knowledge to the next generations. Naturally, this puts a certain imprint of conservatism on the pedagogical process, because [31]:

- Old knowledge is transmitted, which becomes obsolete with each new day;
- The methods and forms of knowledge transfer are also subject to rapid obsolescence.

For centuries, the path of human development (growing up) (child → schoolchild → adult) remains still the same linear path: kindergarten → school → college → university.

According to the results of a sociological survey [32], the main problems of introducing a chess educational program in preschool and additional school education are: children's lack of motivation for lessons; insufficient material and technical support; and parents' lack of proper interest in their child's education (Figure 1).

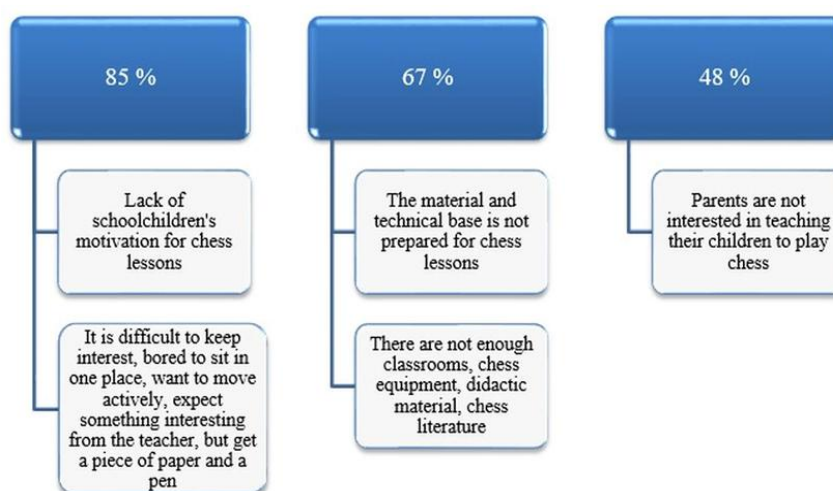


Figure 1. Results of the sociological survey



The identified problems can and should be solved in different ways [33]. For example, films, crossword puzzles, chess-themed puzzles, stories, fairy tales and even theatre plays can be used to keep children's attention and develop motivation in chess lessons [34]. To arouse children's interest and motivate them to come to the next lesson, the narrative should be interrupted at the most interesting point. Dynamic games, physical fitness warm-up in the break also stimulate children, allowing them to switch their attention.

However, computer programs, the Internet and social networks occupy a crucial place in the lives of modern children. Therefore, digitalisation and computerisation of the chess teaching process through the use of existing training programmes and mobile applications should be given much more attention.

Educational engineering [35], unambiguously raises the level of this concept. In modern conditions, educational engineering aims the teacher to create, master, implement and disseminate new innovative educational products. Based on the principles of educational engineering [36, 37], it is necessary to approach all elements of the educational process: developing lesson plans; writing teaching and learning support; creating computer-based educational programmes; developing author's innovative educational technologies, etc. The project nature of pedagogical activity, the need to bring modern educational products to the stage of implementation, the need for training of new-type personnel for educational organisations also contribute to the widespread introduction of educational engineering principles into everyday pedagogical practice [38]. The main engineering process in the work of a teacher is the creation and promotion of an educational product, which is the result of scientific and pedagogical labour [39]. According to [40], a modern educational product should have the following properties: undoubtedly, it should be in demand; it should have clear features of planability; it should be aimed at achieving the set goal, etc.

In this paper, in order to improve the competitiveness of an educational institution and the effectiveness of training young chess players within the framework of an integrated approach to the construction of the educational process, including educational engineering and compliance with all the principles of quality management, the quality of education is considered in at least three aspects:

- the quality of external and internal conditions created for the implementation of educational activities;
- the quality of the educational process itself, i.e. the quality of the educational activity itself, achieved in various ways, including through digitalisation;
- the quality of the results of educational activities, i.e. the quality of training of graduates of educational institutions.



An important way to improve the competitiveness for institutions of additional children's education is to develop, create and implement a quality management system (QMS) in the practice of daily work [41-45]. Such a quality system should operate within the organisation, i.e. it should be an internal system. The fundamental principles of such a system are: customer orientation; process-oriented approach; continuous improvement; leadership of managers and involvement of employees, etc. QMS implementation is a transition to a higher level of management culture, which requires careful attention and control from the management. QMS implementation should be carried out in a quality and professional manner, because if some elements or individual events are missed, the results obtained will not meet the original objectives.

The purpose of this study is to develop the elements of QMS to the educational process on the example of the chess school – Ladia Chess Club, located in one of the Russian cities with a population of about one hundred thousand people [46]. The age group of students participating in the educational process is 5-10 years old.

The Ladia Chess Club has been functioning since 1985. The club has proven itself in successfully teaching thousands of children to play chess. Experienced teachers of the club have a high level of knowledge of chess, regularly take refresher courses, take part in sports competitions, confirming their professional level and sports qualification. Pupils of the chess club also show high results at regional and all-Russian competitions, taking prize-winning places.

3. Results

One of the fundamental principles of QMS is "customer orientation". As it is known, in the conditions of competition in the market of additional education services, the success accompanies the companies that best meet the needs of consumers. To this end, at the first stages of QMS implementation it is necessary to take such actions as:

- Understand and assess the needs and expectations of consumers;
- Ensure that the organisation's goals and objectives are in line with these needs and expectations.

The stages of complex engineering, in turn, include:

- Defining the need or problem;
- Defining the system objectives;
- Researching existing problems;
- Generating new ideas;
- Developing the concept of change.



The first three stages of integrated engineering echo some of the QMS principles (customer focus, systematic approach to management, continuous improvement).

To address the questions posed, a "portrait" of the target consumer of the chess club was formulated (Figure 2).

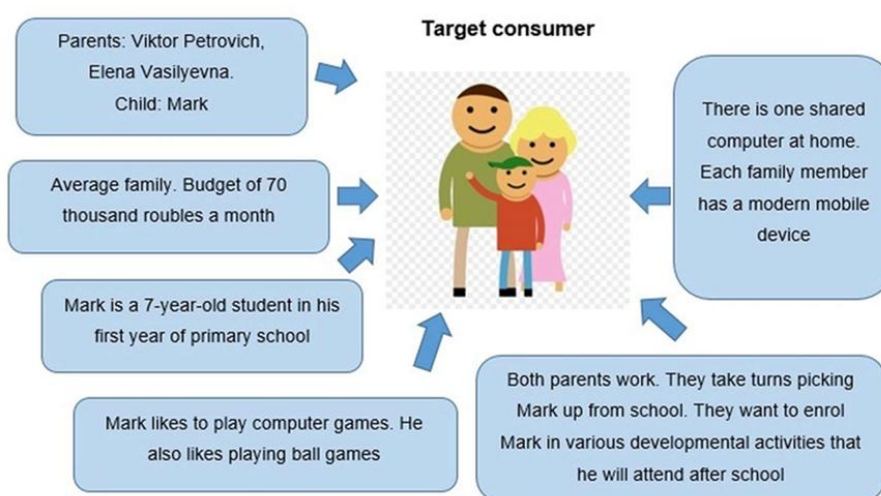


Figure 2. Portrait of the target consumer

The analysis of the formulated "portrait of the target consumer" (Figure 2) showed that the main consumer of the service is a child. However, due to age restrictions (at the age of 5-10 years old a child is completely incapable or partially capable), so he/she cannot make independent decisions. In this regard, parents are included in the "portrait of a potential consumer".

In addition, it should be emphasised that the results of chess learning depend to a large extent on a systematic approach to attending lessons, doing homework, and the child's emotional state at lessons. The responsible attitude of parents to all these aspects of the lessons is also important for achieving high learning results.

The organisational chart of the Ladia Chess Club is shown below in Figure 3 shows the organisational chart of the chess school – Ladia Club.

The performed analysis shows that the organisational scheme of the chess school – Ladia Chess Club (Figure 3) is acceptable and does not require significant modernisation.



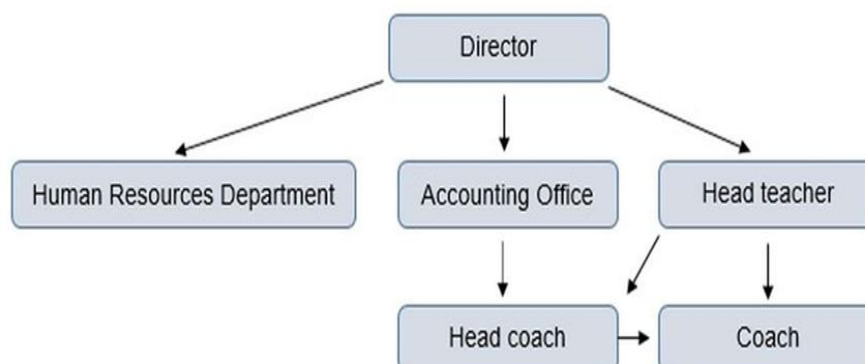


Figure 3. Organisation chart of a chess club

The next stage of marketing research was carried out in accordance with the requirements of the existing Russian standard on the implementation of sustainable management in small and medium-sized enterprises [47]. For this purpose, the SWOT analysis was applied in the work to select the marketing strategy and organisational development of the club [48, 49]. This analysis was carried out in relation to all the most important areas of the company's activities [50-53], where both internal and external factors operate and where it is important to make the right decisions.

The application of a SWOT analysis to the operations of a chess club will enable the identification of the following: the competitive advantages of the club (strengths); potential areas for improvement (weaknesses); opportunities for expansion (development opportunities); and factors that may create problems (threats). This will assist the club to develop effective strategies to eliminate weaknesses. And also to develop effective strategies for its further development and the achievement of its immediate goals and ambitious future goals.

At the initial stage of the SWOT analysis a specific goal was formulated - to improve the quality of education of young chess players through the introduction of quality management system in the institution for additional education of children. Achievement of this goal will undoubtedly contribute to the competitiveness of the educational institution itself. The results of the qualitative analysis are presented in Table 1.



Table 1. SWOT Analysis Matrix.

Strengths	Weaknesses
Free access to group classes	Potential shortage of professional staff
Participation in tournaments with the possibility of fulfilling the requirements for awarding sports titles	Outdated form of education with insufficient implementation of digital technologies
Convenient location of the chess club in the city centre	Low level of staff motivation and engagement
Lack of other chess clubs in the city with qualified coaches	
Pedagogical team aimed at innovative activities	
Positive image of the school in the eyes of parents, its competitiveness	
Professionalism and high competence of each member of staff and of the teaching staff as a whole	
Availability of a competent administrative and management corps	
Equal opportunities for students and teachers for self-realisation and self-development	
Regular, ongoing and comprehensive monitoring of the quality of learning	
Careful preservation, further development and multiplication of school traditions	
Adequate provision of modern teaching and learning facilities	
Opportunities	Threats
Introduction of new innovative technologies in training	Organisational passivity of the parent community
Opening of branches in other cities of the region	Unwillingness of sponsors to invest in education development
	Some deterioration in the socio-economic situation in the region
Self-realisation through participation in sports competitions	Lack of initiative by existing public organisations to establish partnerships with educational institutions
Attracting university teachers to work at the school on a part-time basis	Some lack of prestige of pedagogical specialities, making it difficult to attract teachers
Expanding relations with public organisations and the media	Decrease in children's interest in learning
Attracting sponsorship	Pedagogical burnout of the teaching staff



As the qualitative analysis (Table 1) has shown, there are much more strengths than weaknesses for the Ladia Chess Club under consideration. Pupils participate in team competitions, which helps to significantly strengthen team spirit and co-operation between players. In the chess club there is an opportunity to play table tennis (between theoretical lessons), which helps to diversify leisure time and "reset the brain". In the warm season, there is a practice of going to sports grounds where students play football.

It should be especially noted that the demand for the Ladia Chess Club among consumers is quite high. This is facilitated by the absence of similar institutions in the city, convenient location, as well as the existing modern "fashion" for chess lessons for the development of intellectual abilities of a child. Good advertising for recognisability and image of the school are the graduates of the school, their successes and obtained grades. In addition, the club coaches systematically conduct developmental classes (electives) in secondary schools. This method advertises the chess club and chess in general very well. Experience has shown that many children who have attended these elective classes before are engaged in the chess club.

Among the weaknesses (Table 1) is especially the lack of possibility to give each student proper individual attention in lessons.

Organisational problems include the fact that most chess tournaments are held on Saturday and Sunday mornings. In this regard, children who study on Saturday in the first shift at a comprehensive school have difficulties due to the need to miss classes at school.

Weaknesses also include insufficient funding to organise travel to competitions held in other cities.

Today, the pace of development of information and communication technologies (IT technologies) continues to be very high. A modern teacher makes very active use of information technologies in his/her daily activities - from multimedia boards and projectors to computers with specialised software. A successful combination of traditional (chalk-board) and new ways of teaching helps the teacher to develop and maintain the child's interest in learning. An analysis of the potential of the Ladia Chess Club (Table 1) has shown that IT-technologies need to be more widely introduced into the daily work of the school.

However, it should always be remembered that chess is a game, and therefore it should be learnt by playing. And providing this integral component of the learning process is a very important task. In this regard, the authors of this study set themselves an ambitious prospective goal to develop a new original game platform for teaching children and adolescents up to 16 years old to play chess [54, 55]. To this end, a startup project has been developed to create software and target



the B2C and B2B market. The project is based on Chess Artificial Intelligence (Chess AI) [56-58] developed specifically for web applications. The created software is oriented first of all on teaching chess to children and teenagers. It has a number of significant differences from existing analogs. In particular, the software has the following capabilities:

- to adjust to the level of play of a particular user in order to develop skills and thinking in a step-by-step manner;
- to communicate with the user through the modern format of a game mobile application;
- is able to encourage the user through the development of its own virtual base for its progression through the levels of difficulty in the chess game.

Artificial intelligence adapts and self-learns based on the games played and adjusts to the initial abilities of the individual user.

Another very promising area of the club's development is the opening of branches in other towns in the region. In this connection, it is worth noting that the Ladia Chess Club is currently funded by the state as a municipal educational institution. However, it may happen that when branches are opened in other towns, such funding will simply become unavailable. In this case, the club will have to switch to self-sufficiency, which will eventually and inevitably lead to the fact that the education process will no longer be free of charge.

As the analysis has shown, in order to reduce the potential shortage of professional staff, it is possible to attract university teachers to work at the club. However, experience shows that, as a rule, on the contrary, universities try to attract coaches of the Ladia Chess Club to conduct classes with students.

The analysis of the identified factors and their trends made in this paper allows us to conclude that the Ladia Chess Club is a quite stable organisation, even despite the influence of various economic factors. At present the club has 250 students. However, even under favourable circumstances, in order to increase the competitiveness and active activity of the club, it is necessary to constantly monitor, improve and modernise the quality management system of this institution.

It is well known that successful companies are those that have been able not only to set specific ambitious, but also realistic goals, but also to develop ways to achieve them. In management, this is called strategy. The results of the SWOT analysis and internal environment of the studied Ladia Chess Club allowed us to formulate a tree of desired business directions within the framework of its future strategic development (Figure 4).



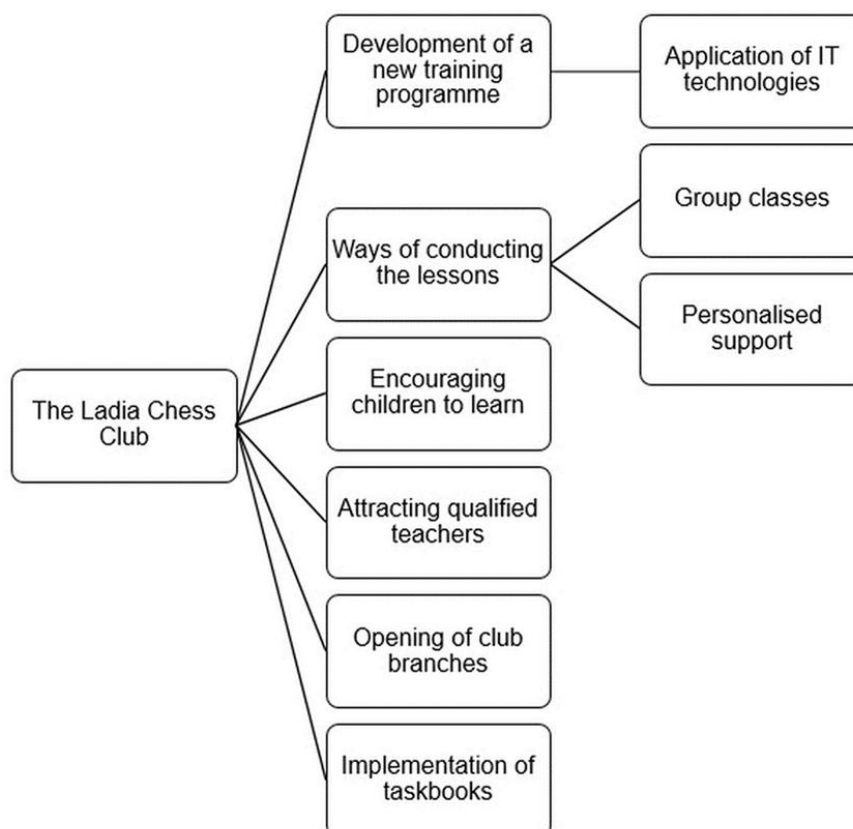


Figure 4. Business area tree

As can be seen from the presented scheme (Figure 4), in order to improve the competitiveness of the club it is advisable to develop a new training programme through the development of a digital platform for teaching chess; to implement author's problem books; to open branches of the club in other cities.

In order to develop the elements of the quality management system and implementation of the process approach in the organisation it is necessary to introduce a step-by-step process including design, action, control and analysis. Modern economic life convincingly shows that enterprises that have adopted a quality management system according to ISO 9001 [59, 60] have a significant advantage over competitors. To create such a system it is necessary to start with the development of business processes. The development and implementation of such



business processes in parallel will allow the organisation to solve some other daily and long-term tasks.

A business process (BP) is comprised of several fundamental elements. The aforementioned elements are presented in Figure 5.

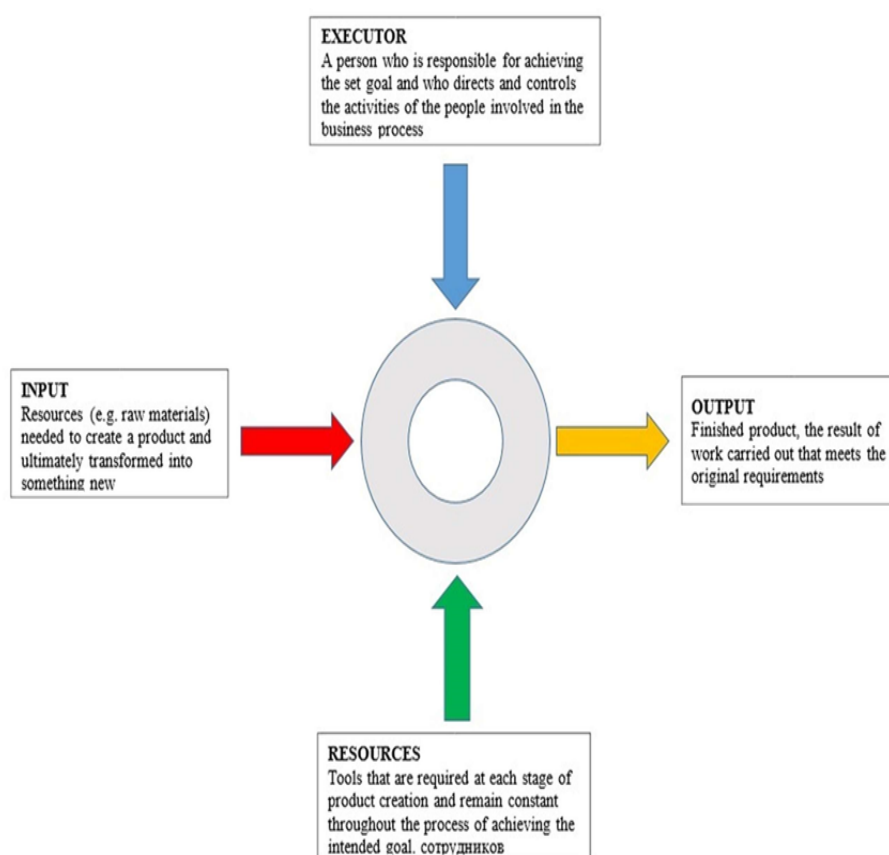


Figure 5. Components of a business process

There are always many types of business processes in any organisation. The most important BPs are end-to-end processes that create specific value for the customer.

According to the ISO 9001 standard and the principles of business process description [61], the paper described the BPs currently existing in the Ladia Chess Club (Table 2).



Table 2. Business processes of the Ladia Chess Club.

Process	Basic	Auxiliary	Upper level	Lower level
1. A search for apprentices	+			+
2. The training of chess players	+		+	
3. Maintaining training logs		+		+
4. The organisation and holding of chess tournaments	+		+	
5. The maintenance of contact with chess clubs in other cities		+		+
6. Developing a training plan		+		+
7. The internal control of personnel		+		+
8. The interaction between teachers and the parents of pupils		+		+
9. Search for investors for participation in away tournaments	+		+	

The next stage of the BP description is its modelling, corresponding to the levels of detail. This stage was realised on the example of one of the principal BPs, namely "Chess training". As a result of the conducted research, all its components were identified. These are visualised in Figure 4. Exactly:

- The clients of the process are the learner and their parents;
- The aim of the process is to teach children of the age category 5-10 years to play chess; to bring their level of play up to the 3rd junior level;
- The result of the process (the output of the process) is to obtain the 3rd junior category in no more than 12 months of study. This period was averaged over time, as this indicator depends largely on the individual characteristics of the learner. In some cases, a child can achieve a grade in as little as 3-4 months, and sometimes in much longer time;
- Process resources – a computer or tablet for using a computer programme for analysing chess games, chess textbooks, a chessboard with a set of pieces, homework, and so on;
- The implementer of the process is the coach.

Figure 6 presents the block diagram of the "Chess training" business process.



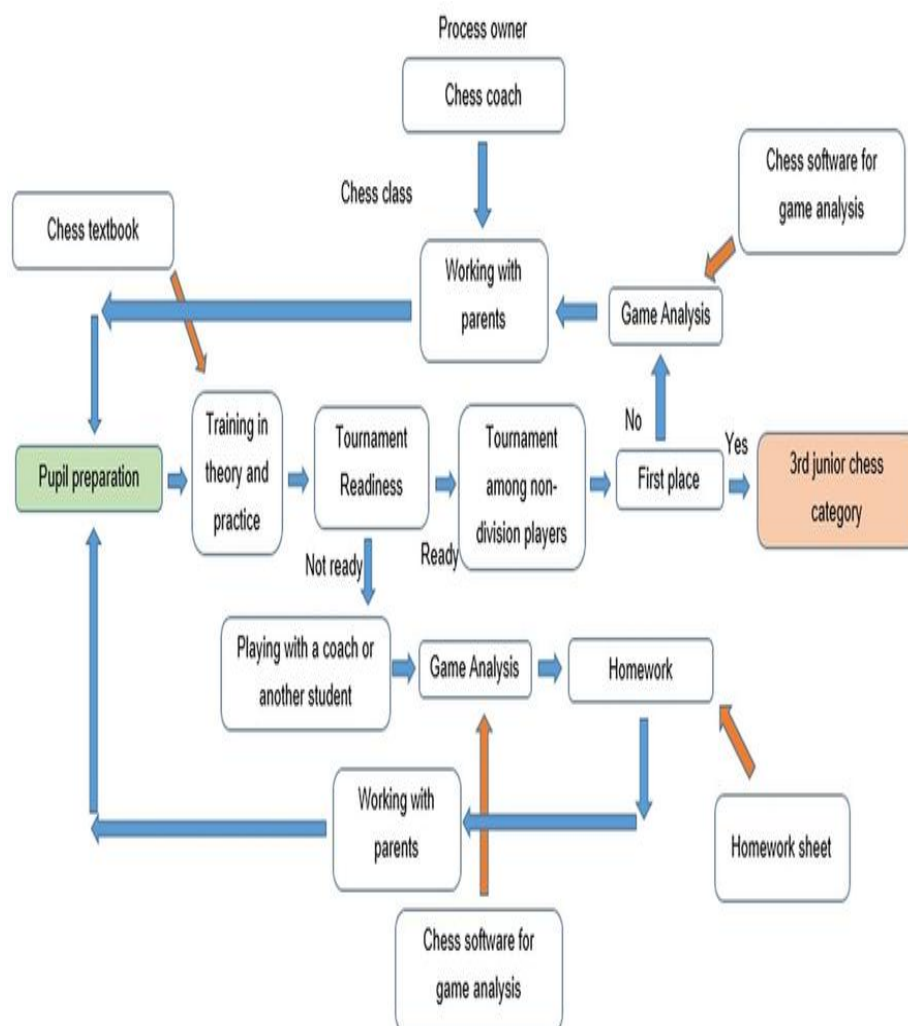


Figure 6. Block diagram of the "Chess training" business process

In order to address the issue of attracting new qualified teachers to the educational process (Table 1), the existing job descriptions of the staff were scrutinised. As a result, new job descriptions and required competencies were developed. For example, for a chess club teacher (this concept includes several positions) they are presented in Table 3.



Table 3. Job duties and required competencies for a chess club teacher.

Job title	A description of the employee's functions within the relevant business process	Knowledge	Skills	Personal qualities
Coach-teacher of group classes	- Organising group chess lessons; - Organisation of chess tournaments; - Co-operation with other chess clubs; - The maintenance of academic journals; - Interaction with parents.	- Rules of Chess; - Knowledge of openings, middlespiles and endgames; - Basic principles of tactics and strategy in chess; - Features of different pieces and their moves; - History and development of chess theories and ideas; - Methods of lesson planning and organisation.	- Pedagogical skills; - Experience of playing chess at a good level; - Level of play not lower than first sport category; - Organisational skills; - Ability to work with groups of different ages and levels; - Ability to motivate students; - Analysing and critical thinking skills; - Ability to explain complex chess concepts; - Ability to assess the knowledge and skill level of each student; - Skill in demonstrating and explaining moves on the board; - Ability to organise and run tournaments and competitions.	- Organisational Skills; - Initiative; - Patience; - Perseverance; - Responsibility; - Organisation; - Creativity of thinking; - Innovativeness in activities; - Attentiveness; - Accuracy of performance; - Flexibility and adaptability; - Ability to empathise and understand; - Communication skills; - Stress tolerance.
Coach-teacher of individual lessons	- Conducting individual lessons to students of different levels; - Creating your own training plan for each student.	- Knowledge of the rules of chess; - Knowledge of openings, middlespiles and endgames;	- Ability to assess the knowledge and skill level of each student; - Pedagogical skills; - Experience of playing chess at a high level;	- Empathy and understanding; - Patience; - Initiative; - Creativity; - Innovativeness; - Flexibility and adaptability;



		- Basic principles of tactics and strategy in chess; - Features of different pieces and their moves; - History and development of chess theories and ideas; - Methods of lesson planning and organisation.	- A level of play that is not lower than the first sport category; - The ability to motivate students; - Analytical and critical thinking skills; - The capacity to explain difficult to understand topics.	- Attentiveness.
Methodologist Instructor	- Drawing up a training programme; - Preparing the strongest students for qualified tournaments; - Accompanying and preparing students during qualified tournaments; - Counselling of coaches-teachers.	- Deep understanding of positional play; - Ability to apply various chess concepts; - Analysis of chess positions and games; - Knowledge of chess programs and computer analysers; - Extensive knowledge and experience in tournament practice; - Knowledge of chess history and culture.	- A rank of at least FIDE Master (ideally Grandmaster); - Ability to explain complex chess concepts; - Pedagogical skills; - Ability to organise and conduct tournaments and competitions; - Ability to motivate students; - Organisational skills; - Strategic thinking.	- Patience; - Perseverance; - Responsibility; - Organisation; - Attentiveness; - Accuracy; - Creativity of thinking; - Innovativeness; - Flexibility and adaptability; - Communication skills.



It should be noted that the formulated job descriptions and required competencies that have been formulated should be taken into account when hiring new employees and, of course, should be fulfilled in day-to-day work.

4. Discussion

This paper analyses various approaches to teaching chess to preschool and primary school age children, applied in institutions of extracurricular supplementary education.

As the research has shown, the traditional methodology [3-5] is mostly applied in the learning process everywhere. This methodology is based on the well-known didactic principles such as consciousness and activity in the learning process, accessibility of the received knowledge, systematic learning.

The teaching of chess can be carried out by different teachers – a sports coach and a school chess teacher. In this case, the sports coach puts the achievement of high sports results in the first place, pushing the achievement of general educational goals to the second place [26-28]. A chess teacher, on the contrary, puts the solution of general educational objectives in the first place, putting the achievement of sports results in a secondary position [6, 7].

Although different ultimate goals are pursued, the main mission of the pedagogical process remains the same – it is the transfer of accumulated knowledge. Despite the nobility of the goal, the way of its realisation at the moment remains rather conservative [31]. This leads to the weakening of children's motivation for lessons already in the first year of the beginning of lessons.

A second-order effect (but a very important one because of the child's incapacity) is a significant reduction in the parents' proper interest in their child's education.

The work systematises different ways of holding children's attention and developing motivation in children and their parents [32-35].

However, the interests of modern children, who spend a significant part of their time on the Internet, and their fascination with social networks and computer programs [34-38], should be taken into account when organising training sessions. Therefore, the implementation of digitalisation of the pedagogical process should be given the closest and much more attention.

To address this issue, the authors started to develop a startup project Chess Artificial Intelligence [55-58] for teaching children to play chess in the system of out-of-school additional education institutions. "ChessAI" is an author's development for the development of logical thinking and strategic planning through the format of chess duels with artificial intelligence. It adapts to the age and abilities



of the child, encourages him/her to increase the level of skill in the chess game. A comparison with already existing competing software products ("Lichess.org", "Chess.com", "Chess for Kids" and "Chessmaster") shows the following indisputable advantages and benefits of "ChessAI":

- The algorithm "ChessAI" is founded upon the principles of artificial intelligence (AI) and big data technology;
- Our development will take into account the player's mistakes and offers at the end of each game to solve chess problems to correct them or offers educational lessons to raise the level of play;
- Algorithm "ChessAI" is able to independently adjust to the level of play of the child and develop together with the child;
- A system of rewards in the form of a virtual base (dependent on the achieved level of play) stimulates interest in children and teenagers up to the age of 17;
- The application provides step-by-step training with the possibility of correcting mistakes, developing chess skills and subsequent growth in the level of sportsmanship.

At the moment, the startup project under development is in the following state [49]: the analysis of existing analogues has been performed; the distinctive features of the product to be created have been clearly outlined; the main software components have been determined; a business plan is being drawn up; the terms of implementation of individual parts of the project are being determined and specified.

Another important aspect of this paper is to improve the competitiveness of an extracurricular educational institution of supplementary education providing chess training services. As the analysis has shown, an integrated approach to the educational process, based on educational engineering and compliance with all the principles of quality management [41-45], will contribute to the increase of competitiveness.

For this purpose, the authors have analysed the work of the Ladia Chess Club [46], which is located in a typical Russian city and provides services in additional preschool education. The issues of developing the elements of the quality management system [59-61] are successively considered. The problems arising in the analysis are shown in detail and the most effective ways of their solution are determined. In the work: the analysis of the organisational scheme of the institution is performed; the portrait of the target consumer is formed. A SWOT analysis is applied to select the marketing strategy and organisational development of the club in relation to all the most important areas of activity; the strengths and weaknesses of the organisation's activity were analysed; the tree of planned business directions



within the framework of further strategic development of the organisation was built [47-53].

The analysis of the target consumer showed that the main "customer" of the service is a child (between the ages of 5 and 10). However, due to age limitations, he/she cannot make independent decisions. Therefore, parents were included in the portrait of a potential consumer of the service. It is shown that parents' attitude to the educational process should also be taken into account.

The SWOT analysis conducted revealed that the strengths of the work of the Ladia Chess Club are: increased team spirit; co-operation of students; effective use of methods to increase children's motivation by changing the form of activity (by using physical activity between classes); absence of similar institutions nearby; convenient location of the club; fruitful co-operation with secondary schools in the format of chess electives.

Nevertheless, the analysis revealed at the same time the presence of weaknesses. Therefore, in order to eliminate them and improve the efficiency of the club, the authors described the main and auxiliary business processes of the Ladia Chess Club (all nine business areas for the strategic development of the club are presented above in Figure 4). A number of recommendations are offered: improvement of the club's organisational structure; application of a competence-based approach to job responsibilities; the need for greater attention to advertising activities; expansion of work with sponsors, etc.

It is particularly noteworthy from a practical point of view that in order to apply a competence-based approach to job responsibilities, the competences of a potential club teacher that should be taken into account when hiring must be developed in detail.

5. Conclusions

This paper proves the equivalence of an educational engineering approach and quality management principles with regard to the organization of work of an extracurricular institution of additional education. The proven equivalence of the approaches will ensure:

- the necessary quality of the conditions created for the effective implementation of educational activities;
- necessary quality in the implementation of the educational process itself, i.e. the whole educational activity;
- obtaining high-quality results from all educational activities, i.e., ensuring the proper quality of graduates' training.

This work is particularly relevant because it provides practical recommendations for the development and improvement of the main business



process "chess training" for additional education organizations, as well as defines the job responsibilities and required competencies for chess school teachers.

A distinctive feature of the work is the use of artificial intelligence to increase the motivation of children and their parents to learn. The use of artificial intelligence also contributes to the digitalization and computerization of the chess teaching process. The authors have outlined the contours of a startup project under development using Chess Artificial Intelligence.

Consistent and comprehensive implementation of the above recommendations in the daily work of extracurricular education institutions will contribute to increasing the competitiveness and efficiency of these institutions. This will undoubtedly improve the quality of education for young chess players.

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