GAME-BASED EDUCATION IN THE 21ST CENTURY - INNOVATIVE EDUCATIONAL METHODOLOGIES IN THE SERVICE OF CURRENT EDUCATIONAL CHALLENGES

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Abstract

The teaching and learning needs of the 21st century have changed significantly from those a few decades ago. Changing economic conditions, new technologies, and labor market demands have changed the competency expectations.

There is an increasing emphasis on independent creative work, critical thinking and collaboration. The education of the younger generation, including vocational training and adult education, should support the achievement of these goals.

Competence development and effective education of both children and adults is a central issue in pedagogy. An appropriate tool for this are games, which is an internal learning method for people. Children play instinctively, it is a genetically encoded activity that does not need to be taught. Our research focuses on the methods of game-based education. Within this, the development of a new skills, development methodology and its practical applicability. In our work, we explored what effective teaching and development approaches are there through games and how cognitive skills can be developed. During our research, we develop and test various games, and we have concluded that at the present which are the games that perform best in competency development and individual development in general.

The research result to be presented is based on the Castle of Mind (COM) board game we have created, which also functions as an educational aid and development tool. Thanks to the unique gameplay of COM, the hit doesn't (necessarily) happen where the move is. That is, the consequences of actions during the game can occur in a location other than the move, which, in addition to developing attention, improves several abilities.

Based on our research results, playing with COM effectively develops concentration, logic, relationship insight, critical thinking, and problem-solving skills. The game is one way to develop competencies effectively and in a lifelike way through playing for both children and adults.

Keywords: *game-based learning, competence development, developmental tool, mental development, castle of mind, board game, educational methodology*

1. INTRODUCTION

The teaching and learning needs of the 21st century have changed significantly from those a few decades ago [1,2, 3]. Changing economic conditions, new technologies, and labor market demands have changed competency expectations [4, 5, 6, 7, 8].

But what is competence?

According to the European Council, **competence** is "*combination of knowledge, skills and attitudes*" appropriate to a context, "*the proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development*" [5,6,7,9]. The Dictionary of the American Psychological Association states that **competence** generally is "*the ability to exert control over one's life, to cope with specific problems effectively, and to make changes to one's behavior and one's environment, as opposed to the mere ability to adjust or adapt to circumstances as they are*" or "*one's developed repertoire of skills, especially as it is applied to a task*

or set of tasks." [10]. Another book defines **competence** as "*a set of mental processes related to creative and critical thinking to develop new strategies for solving challenges and processes*" [11].

Based on our research, we have come to the conclusion that competence is living with certain opportunities. These are partly the possibilities, aptitudes, inclinations someone is born with, partly the experience gained during environmental influences, and partly the opportunities learned or seen during development. If someone is competent in a certain topic or area, it means that they see opportunities in that area and are able to take advantage of them.

It is releaved that society and the economy do not need a workforce with huge lexical knowledge, but a flexible, creative, thinking workforce [4,6,7,9,12]. The importance of competencies is constantly growing, especially the skills related to cooperation [5,8,9]. Based on all this, the requirements of the rapid change of social and technological development in the field of education and training seem to be emerging. There is an increasing emphasis on independent creative work, critical thinking and human collaboration [13,14]. There is a need to strengthen the knowledge - based society and to ensure that the education of the younger generation, including vocational training and adult education, supports these goals [5]

Developing and effectively educating the competence of both children and adults is a central issue in pedagogy. Today, the development of competencies is also given a more prominent role in school education in order to ensure that the next generation already has the necessary competencies when they enter the labor market [5,13,15]. To this end, it is necessary to use teaching and training methods and aids that enable the development of abilities and skills in the most efficient way [15,16,17]. The appropriate tool for this is game, which is an internal learning method for people.

Methodological research shows that among innovative educational methodologies, game has proven to be an outstandingly effective development tool in many areas. [13,17,18,19,20,21]

Man plays instinctively, learns by playing. It is a genetically encoded activity that does not need to be taught and does not need to be encouraged in a healthy child. In the first period of a person's life, he develops his movement and nervous system through play, thus discovering the possibilities and limitations of movement, building and developing brain-nerve-muscle connections, and trying out his abilities [22]. The game is a practical learning process in which development appears naturally and lifelike [18,19,23].

From the age of 7-10, play increasingly shifts from the physical to the mental scene: the instinctive development of cognitive skills comes to the fore. Instead of developing brain-nerve-muscle connections, the focus will be on developing connections between different areas of the brain: logical, memory, and perceptual games become preferred [22,24,25]. In the game, the child learns how to communicate with their peers, what victory and defeat means and how to deal with tense situations. The child does not play a role in the games that create a competitive situation, his uniqueness and true self can come to the surface, to which he also receives feedback from his environment. The game has a framework and rules that need to be laid down and followed. These are important interfaces for conflict, conflict management, and cooperation between two or more children. In the case of offline games, in addition to all this, children are in a real space and see and perceive each other's reactions and behaviors, which have additional developmental effects [19,26,27]. With the game, the child can imitate and learn real-life situations, and can process the events happening around him or her in reality [14]. A clear example of this is the simpler board games with dice, which teach the child to wait for their own move, and the number of moves depends on the score of the dice, i.e., there are prerequisites for progress that must be met [13,15,26]. In humans, as in many other species, playfulness persists into adulthood and can have a similar developmental effect as in childhood. It should be noted that play is a practical activity, which means that whatever one plays, either as a child or as an adult, has an effect on him- or herself, it builds into his or her thinking and behavior [23,28]. This is especially true at the stage of his life when such stimuli reach him in certain periods of the development of thinking. So the kind of activity one does (e.g. watching TV or playing) is by no means negligible.

Knowing the above, the subject is addressed in many areas of the international literature and pedagogy, and the paramount importance of games as developmental tools in learning and teaching processes for

both children and adults has been recognized[13,16,19,21,29]. Games have started to play an important role in the school curriculum [1,2,3,8,16,21,29]. In addition, game-based education and learning with games have also proven to be a particularly effective development and teaching method among adults [1,13,14,16,21,29]. The study provides an overview of the interpretation of the role of play and the perception of play in each age. The study also looks at the role of play in development and how play can become an important pedagogical tool in school education.

Chess and bridge are also popular games in education [26,30]. In school education, these games are now widespread in many places, especially in Great Britain, the Netherlands, Belgium, the USA and Hungary. Observations show that the application of developmental, strategic, logical games can be started very early, already at the age of 8-10. Based on the experience of the professionals, the beneficial effects of bridge and chess games are also reflected in the development of intentional attention skills as well as in the better math and text interpretation results of the students [26, 27,30]. According to the observations of schools, developmental strategic and logical games are those that can be used to develop students' intellectual (planning, mental calculation, insight, analysis, evaluation, etc.) and social skills (foresight, scheduling, cooperation) in a playful way [13,21,26,27,30,31,32].

Developmental games can not only be part of the school curriculum, but also provide an excellent opportunity to spend after-school hours. By setting up various school play clubs, a framework for the organization of adult leisure culture and social life can be created at the same time [23,28]. Therefore, it can be said that the game can be one way to develop competencies effectively and in a lifelike way [33].

Most of the competency development methodologies and tools currently used in education are primarily based on the transfer and acquisition of patterns and templates (e.g. assertive communication, body language training, etc.)[1,2,3,23,34]. The disadvantage of pattern copying is that the individual learns template answers and solutions, but the mechanism of their operation is not known in most cases. The types of training that offer patterns, templates, initiate a pattern-based learning model based on movement pattern innervation through the above mentioned brain-nerve-muscle connections [22,24,25]. With a small number of repetitions, the individual can initiate the learned response; after a large number of repetitions, the pattern is fixed[25]. According to research, students typically have a very short attention span today. They reach their maximum information capacity very quickly, after which they are unable to acquire long-term knowledge. Without regular repetitions, participants in traditional training forget 90% of the information within 30 days. Attention problems in adulthood lead to additional problems such as lack of motivation, burnout, and problems with human relationships [27,35].

However, the patterns and templates can only be used in the given situations. The individual does not have an answer to a situation different from the ones he or she learnt. Instead, the emphasis needs to be on developing basic skills, key competencies, and attention: instead of developing patterns, develop thinking and its specifics: creativity, switching speed, and critical thinking [23].

Using the modern results of science, the Fontanus Research Center has set up a new, internationally innovative model for the functioning of consciousness, the human mind and the intellect [36]. Using the theory, a description and systematization of the conditions of the development process was developed [35]. All this knowledge and research results form the basis of the research background of the created capability development tool.

Taking into account the biological and physiological features of development, the basic conditions and moments of development have been elaborated. Attention is one of the central elements of the model [36], and the process of thinking is also an important part of it.

Research shows that developing attention and developing skills requires a completely different approach than “traditional” training. These areas to be developed cannot be treated as separate “subjects”. Competence development is not, or only to a very limited extent, effective if we treat it as a separate subject, as a separate element of the topic. (e.g., independent communication practice often triggers alienation, while if it appears during the teaching of a subject, such as in a game, it can be very effective.) Competencies can be developed in practice in real-life situations.

The research result presented here is the Castle of Mind (COM) board game we created as a development tool. The creation of the COM abstract strategy game was made specifically with the aim of developing the cognitive abilities of the game, while preserving the criteria and experiences of a game. Therefore, from the very beginning, the main purpose of development has been school use.

The long-term goal of our research is to make all people, including young people, leave the school system so that, in addition to the basic competencies, they also have the skills and competencies that underpin the acquisition of the qualifications required by the economy and lifelong learning.

Furthermore, the strengthening of the complex development approach in public education, vocational training and adult education, where the development of competencies and attention (motivation) is implemented as an integral part of curriculum transfer.

2. MATERIALS AND METHODS

A unique approach is needed to address today's new challenges. Which require the development of new, innovative forms of learning, the use of new teaching and learning tools and technologies. Complex methodological developments and a change of approach are needed. The key to an individual's learning and development process is motivation and its independent maintenance. Make learning and development attractive: all ages should see the value of knowledge, love the learning process itself. Teaching methods need to be updated. Recognizing this, our research also aims to create age-appropriate educational methods and tools adapted to the people and way of life of the 21st century, considering the development of technology. The link between theory and practice plays a key role in this: education must link theory with practice. The key is to see the connections: the basic task of education is to show the connections and to teach the individual the ability to see them on their own.

Based on our basic research, we have concluded that the game is an effective, innovative development tool, but it does not in itself lead to development. An appropriate tool is a game that effectively develops competencies and thinking.

The goal was to create a development tool based on methodological research that develops multiple competencies simultaneously, while adapting to the needs of users and the culture of the game. Considering the mechanics of games already on the market, we have taken a completely new approach. After the development of the basic gameplay and design, the gameplay was developed iteratively during and after the evaluation of test games, and then the manufacturable (reproducible) form was developed.

Based on the preliminary research, along the needs of the labor market, the selected, examined competencies, the impact of which was measured in the framework of testing prototypes are:

- decision making,
- strategic thinking,
- complex problem solving,
- spatial vision,
- creativity.

Therefore, we created several prototypes, from which we selected the most efficient tool, which is also the most popular tool for developing as many competencies as possible.

For all this research, in the experimental phase, we involved three different test groups along different criteria: age and education. Based on the results of the testing, the development game, which was later developed and marketed, was finalized.

As a result of the research, we have created a tangible, science-based development tool that fills a gap in both the gaming and educational environment, based on skills development, the renewal of related teaching and learning methods, and the practical introduction of new methodologies. In addition, it is fun, capable of community building, and provides an opportunity for several generations to relax

together. And regular use provides answers to many of the problems we find today, such as attention deficit, lack of concentration, loneliness, or the mental health problems that develop later.

Based on the development criteria and player preferences, the created tool has the following criteria:

- a colorful playing field in which colors also have practical significance,
- the devices used in the game (e.g., pieces, tokens) have been selected based on the testing of prototypes, user feedback,
- there are no dice in the game to minimize random elements, and to focus on tactics, thinking.

Based on the above research and results, COM specifically aims to develop key competencies, especially mental abilities.

3. RESULTS AND DISCUSSION

As a result of our research, the two-person Castle of Mind (COM) abstract logic-strategy board game was created. It is a new skills development methodology and learning support platform based on theoretical recognition and the practical applicability of the model developed based on it.

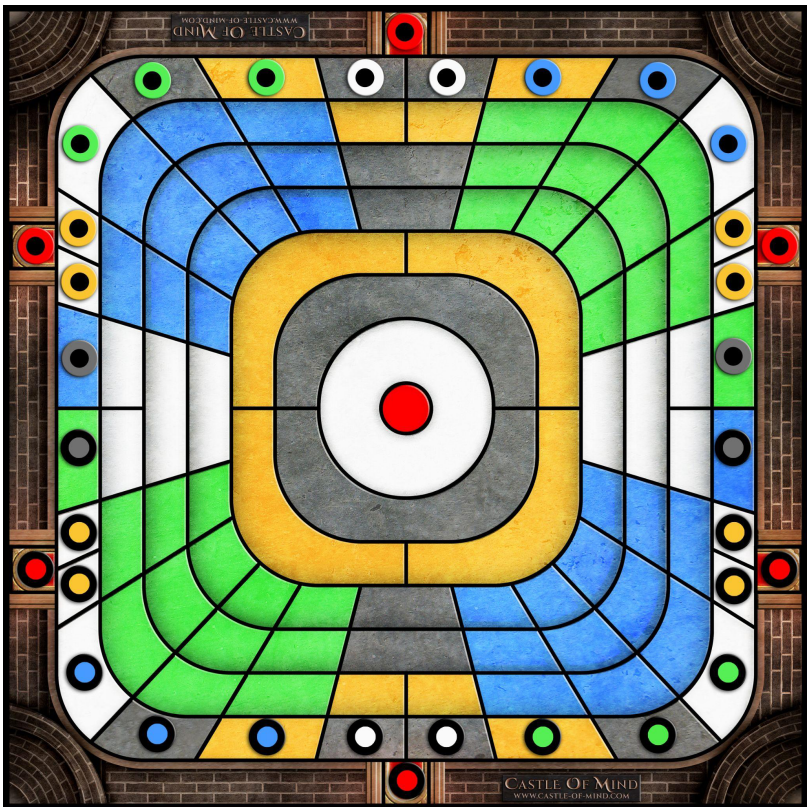


Fig. 1. Castle of Mind (COM) abstract logic-strategy board game
(a) Board: size: 30x30 cm, with 106 fields of different shapes and sizes, 6 different colors (12 yellow, 26 green, 26 blue, 7 red, 14 gray, 21 white fields). The layout of the fields is specific, one field is in contact with a variable number of other fields.
(b) Pieces: Per player: 4 yellow pieces, 3 green pieces, 3 blue pieces, 3 red pieces, 2 gray pieces, 2 white pieces (The pieces of one player are marked with a black circle on the outside and a dot of color inside; the pieces of the other player are marked with a colored circle on the outside and a black dot on the inside.)

A totally new, unique game mechanic has been created on which COM is based. Behind the unique mechanics are research activities that focus on developing an individual's combinatorial and cognitive abilities using playful methods. One of our research findings is that these skills and abilities can be developed regardless of age, mainly through the means of play, along the game mechanics in games. The practical basis of this game mechanics is that the "hit" doesn't always happen where the "move" is that creates the hitting situation.

The uniqueness of mechanics is determined by the combination of the following aspects, among others:

1) Structure of the playing field
    a) The board is colorful and the colors on the field, the arrangement of the colored fields, the relationship between them define the playing field, the frame of the game.
2) Properties of pieces
    a) Not two pieces of different colors (e.g., light and dark) are facing each other, but several pieces of different colors are available to players.
    b) Different pieces don't have different roles - they are all subject to the same rules, including when you move, hit, and even when your opponent takes down a piece.
    c) The pieces of one player have black circle on the outside and a dot of color in the middle, while the pieces of the other player have colored circle on the outside and a black dot in the middle.
3) The relationship between the appearance of the playing field and the pieces
    a) The colors of the pieces are the same as the colors of the fields.
4) The relationship between the playing field and the operation of pieces
    a) Players can decide how important are the different pieces and different fields during the game (and they can change this decision on the fly).
    b) The hit does not happen when the pieces meet, but when a piece enters in a field of the same color - then you can take one of the opponent's pieces that is also on a same-colored field.
    c) The piece taken by the batting player is independent from where the step into a same-colored field has taken place, the piece taken can be far from the location of the step.
    d) Possessing the fields still plays an important role in the game, as there can only be one piece on a field.
5) Relationship between the appearance of the fields and the pieces:
    a) The color of the piece is the same as the color of at least one field on the board.
    b) The color of the marked fields is the same as the color of one of the pieces.
6) The relationship between the appearance of the playing field and the pieces
7) The relationship between the operation of the playing field and the pieces

Based on the game mechanics described above, the game provides an opportunity to develop different abilities while also providing a gaming experience.

3.1. About the game rules

The game can be played by two people against each other.

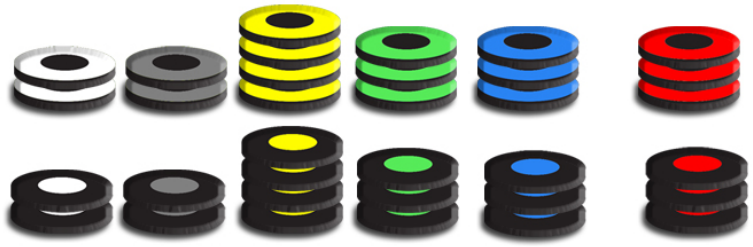


Fig. 2. Pieces: Per player: 4 yellow pieces, 3 green pieces, 3 blue pieces, 3 red pieces, 2 gray pieces, 2 white pieces (The pieces of one player are marked with a black circle on the outside and a dot of color inside; the pieces of the other player are marked with a colored circle on the outside and a black dot on the inside.)

Both players have 17-17 pieces at the start. The pieces of one of the players are black with a middle dot of color, while the pieces of the other player are colored on the edge and has a middle black dot. The color black refers only to the team, the color of the piece is the non-black color on the piece.

At the beginning of the game, players own two opposite halves of the board.

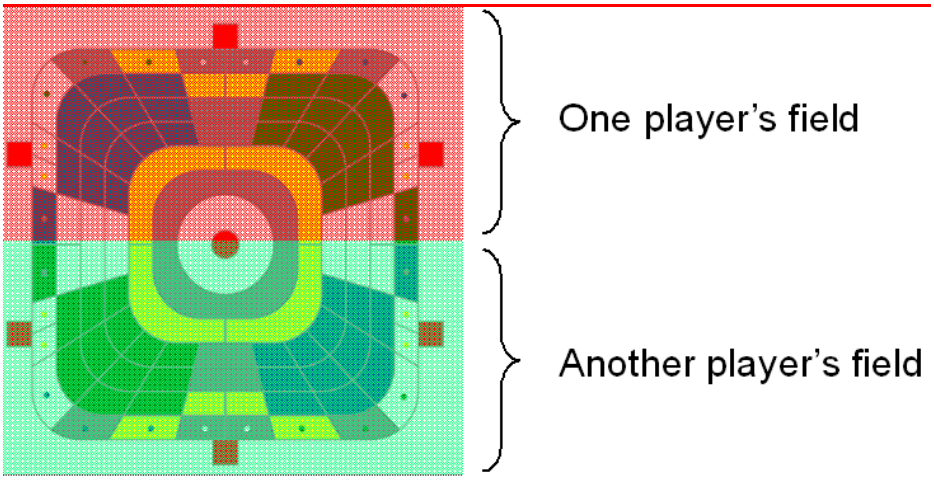


Fig. 3. The two opposite halves of the board at the beginning of the game.

At the beginning both players must place the pieces on the playing field according to the following rules:

- They can only put their pieces on the fields of the half of the board they own.
- A piece can only be placed on a field marked with a small colored circle in the color of the piece. This means that a green piece goes on the field marked with small green circle, a blue piece goes on the field marked with a small blue circle… and so on. If we put the pieces in this way, a piece will be placed on each marked field and all pieces will be placed on the board (so the placement is clear).
- The red pieces must be placed on the red squares on the edge of the board, these fields are called starting fields.

The two opposite halves of the board only matter at the beginning of the game, after which they lose their function (so there is no field that would be a player's field).

Steps

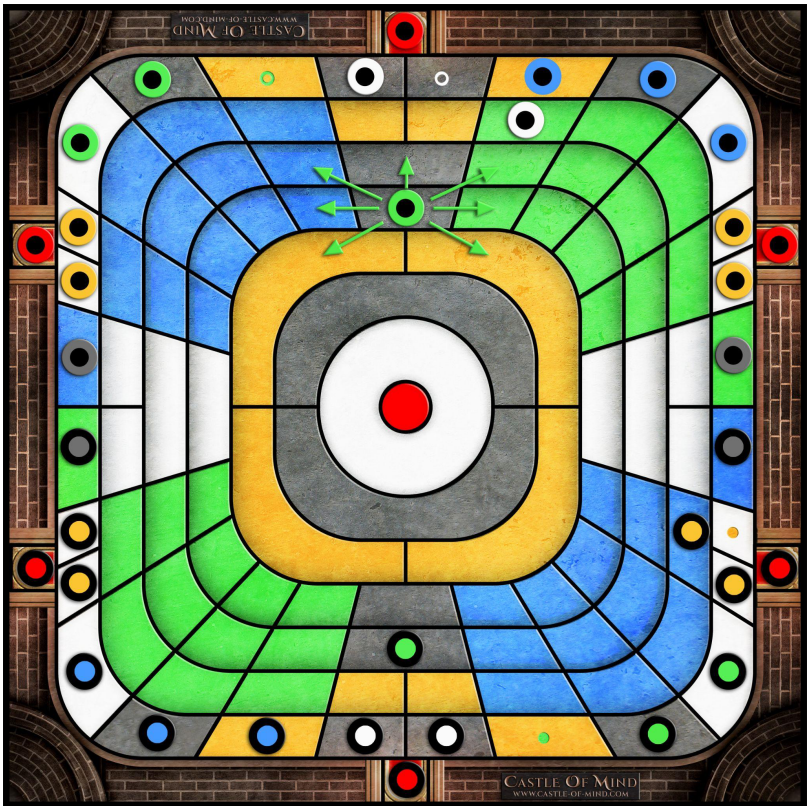


Fig. 4. The possible movements of the green piece are marked with green arrows.

Players take turns. The first step is a matter of agreement.

Each piece is in a field, and only one piece can be in a field.

From a field, the piece can be moved to adjacent field that that field is in contact with - the contact of the corners also matters.

If a piece is in a field of the same color as its own, you cannot move it to another field of the same color. (For example, if the green piece is in a green field, you can't move it to another green field from there.)

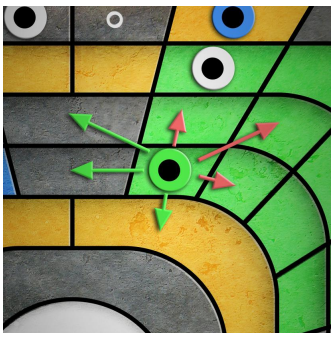


Fig. 5. The green piece cannot be moved to other green fields, but it can move to the adjacent gray or yellow fields.

The red pieces are on the starting field at the beginning of the game (the starting fields are the red fields on the edge of the board). Once they have left, they cannot return there during the game, and no other pieces of other colors can enter there.

The hit

If a piece moves to a field of the same color as its own, you can take one of your opponent's pieces that is also on a field of the same color. (For example, if a green piece enters a green field, you can take one of your opponent's pieces that is also on a green field.)

Taking a piece is compulsory - so if someone moves to a field of the same color as the piece, they must take a piece from the other player if the other player has a piece on a field of the same color.

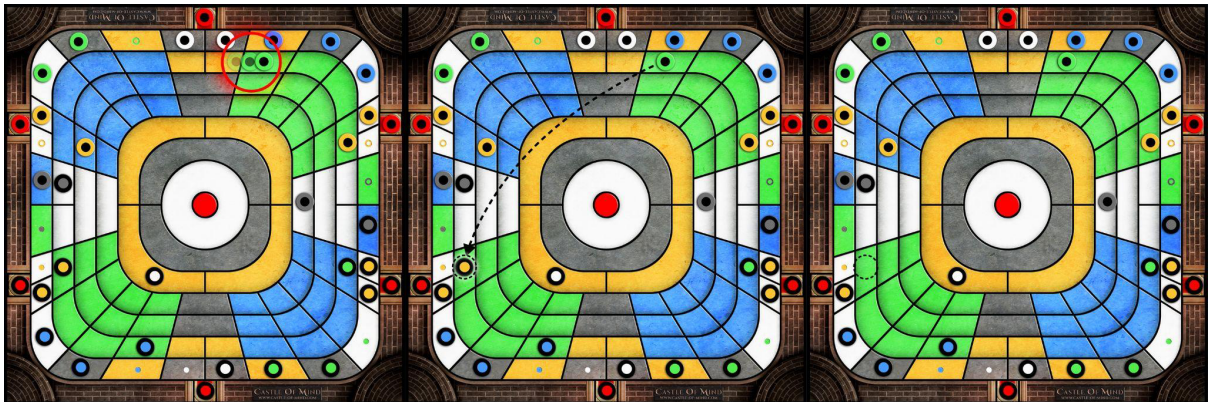


Fig. 6. The hit, taking a piece: As the green piece is moved to a green field, the player takes the yellow piece of the other player from a green field.

The purpose of the game

The object of the game is to move a red piece into the red field in the middle of the board. Whoever succeeds will win.

The end of the game

The game ends in the following cases:

- If one of the players can bring a red piece to the middle red field - in which case, he or she wins.
- If one player takes all three red pieces on the other player - in this case, the one who took the red pieces wins.
- If one player is unable to move with his pieces on the board because his opponent's pieces have locked him in - in this case, the one who locked in the other wins.

  Example of locking in: One player has only one piece left, which is red and is still in the starting field. This field, like all red fields, has two adjacent fields. If the opponent's pieces are on both fields, the player cannot go anywhere with the red piece, and since he has no other pieces, he is locked in and loses.

4. DISCUSSION

Based on our research, we have found that an educational methodology is effective when the development of an individual’s attention skills and abilities takes place simultaneously.

The COM game, as a tool in educational methodology, is a huge help in all of this. As explained earlier, the basis of the game's mechanics is that the "hit" does not always occur where the "step" that created

the hitting situation. As can be seen from the rules, the hit applies to the colored field and not to the piece itself. The size and shape of the fields are different and are designed so that one field can have up to ten adjacent fields and you can move to each one of them from the given field, according to the rules.

The colors of the pieces of the two players have been designed so that distinguishing them requires long-term concentration. The number of pieces varies by color, which is another factor in developing attention. As a result of the rules of the game, when a piece of a given color runs out for a player, the opponent can move around the squares of that color without any risk of being hit.

Each piece counts as equivalent. Thus, it is up to the player to decide what significance and value is assigned to each color. In order to win, it is essential to see the movements in the game and to oversee the whole board. The number of replays is endless. The unique structure of the board stimulates the brain to develop spatial vision and strategic thinking. In the game, the “hit” may happen far away from the location of the “move,” so the player learns to see through the entire board and the underlying relationships to play successfully. This requires the cooperative work of the right and left hemispheres, so the game develops the formation and strengthening of neural connections between the hemispheres. The player also learns the subsequent effects of a move on either the player's further game or the opponent's moves. The player learns the consequences of a decision and an action.

The mechanics of the game also support the development of logic. Logic is a discipline based on conclusions and evidence, and it is a learnable way of thinking. The mechanics of the game helps the player develop it unnoticed. However, as there can be so many options at once, the player can also make intuitive decisions in some cases to reach a quick decision.

Improving information processing: The wide variety of options and factors that appear in the game teach the player how to handle the many incoming stimuli at once, which is essential in today's world of accelerated information flow. It improves the perception of possibilities, the weighting and decision-making between them, and the game helps to see the situations of reality and to process the incoming stimuli in real time.

Our basic learning mechanism is based on patterns. At an early age, we learn movement patterns and then behavior patterns. Pattern learning is required to a certain extent, but then to continue developing it is necessary to detach ourself from the framework provided by the patterns and to work on our situational awareness. We rarely get this far in the formal school education. In the Castle of Mind game, due to the large number of possibilities, the player thinks about new solutions and tactics from the first minute, tries to analyze the given situation, the risks and how to make a decision in it.

5. CONCLUSIONS

In order for the next generation to be able to contribute many inventions and innovations for the advancement of the world, it is essential to emphasize the development of the necessary competencies and the value of ingenuity and creative thinking. The development of all these competencies contributes to the individual's ability to adjust to the many stimuli and information in his or her work and private life, to be able to oversee situations quickly and to respond to them in an appropriate way. In addition, one should be able to make decisions and see that decisions also have effects and consequences that often do not appear where the action took place.

There are currently no similar games on the market. Thanks to its unique development, the game can be widely distributed. One of the key target groups is young people wishing to enter the labor market, but the game can also help build family, school or workplace communities, develop workplace competencies, and help prevent and treat certain mental phenomena (such as attention deficit or dementia). With regular play and the application of its rules, the mental abilities and skills that the game develops will also appear in everyday life. The things you learn during the game can be applied in everyday life to a variety of situations in a rapidly changing, challenging world.

The COM game started out as a boxed board game, but in the meantime an online version of the game has been also completed and is being prepared for public launch.

Based on our research findings, playing with COM effectively develops concentration, logic, relationship insight, critical thinking, and problem-solving skills. One way to develop competencies effectively and in a lifelike way is through game, which is a very effective development tool. Thus, game-based learning is a feasible and effective method for both children and adults, provided that the basic rules of play are contained in the rules or framework of the educational method.

All in all, Castle of Mind not only develops competencies in creative creation, but as a popular game it also makes us attractive to think.

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