A NEW MATHETIC (THE SCIENCE OF LEARNING) AND DIDACTIC (THE SCIENCE OF TEACHING) CONCEPT

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ABSTRACT

The concept of Learngaming integrates Darwin's natural selection theory into a learning and teaching framework designed to prepare individuals for the demands of the 21st century. It focuses on entrepreneurial learning through play, fostering the development of key skills such as efficiency, flexibility, and creativity. In contrast to traditional educational approaches, which emphasise rote learning and exams, Learngaming promotes active, nonlinear, and collaborative learning environments that reflect the dynamic, digital context of modern life. The methodology uses digital "LEARNGames" to simulate real-world challenges, allowing learners to adapt and thrive in uncertain environments by encouraging risk-taking and instant feedback. This method proves particularly effective in teaching 21st-century skills, as demonstrated in projects with gifted children, where learners showed improved retention and engagement through play-based learning. By shifting from a teacher-centred model to a learner-driven, game-based approach, Learngaming enhances both personal and collective learning outcomes, preparing individuals to succeed in an ever-evolving society.

KEYWORDS

Learngaming, Mathetics, Didactics, Entrepreneurial learning, 21st century skills, Learning by playing, Natural selection, Non-linear learning, Digital learning environments, Game-based learning, Simulation games, Action Regulation Theory, Instant feedback, Gifted children

1. INTRODUCTION

To be best adapted to the 21st century environment a teaching and learning context is needed that "fits": a Learngaming context. This with a focus on entrepreneurial learning by playing to develop 21st century skills thereby creating a process of "natural selection learning".

Today's society is characterized by a global context full of turbulent real-time digital information and entertainment. Analogous to Darwin[1]: "If the context demands a different behaviour as a survival strategy, the animals do have to learn that. Humans are animals too."

Darwin in "The Origin of Species" shows that "survival of the fittest" is a struggle of species to adapt to the environment. According to Darwin all species arise and develop through the natural selection of small, inherited variations that increase the individual's ability to compete, survive, and reproduce. Humans are such a species too.

Learning is presented as an evolutionary process to be able to be effective, efficient, flexible and creative in a future context as an individual or as a group. Different competences and entrepreneurial behaviour have to be learned, to be successful in the 21thcentury environment, described i.e. in "The Entrepreneurship Competence Framework" (EU-Commission)[2].
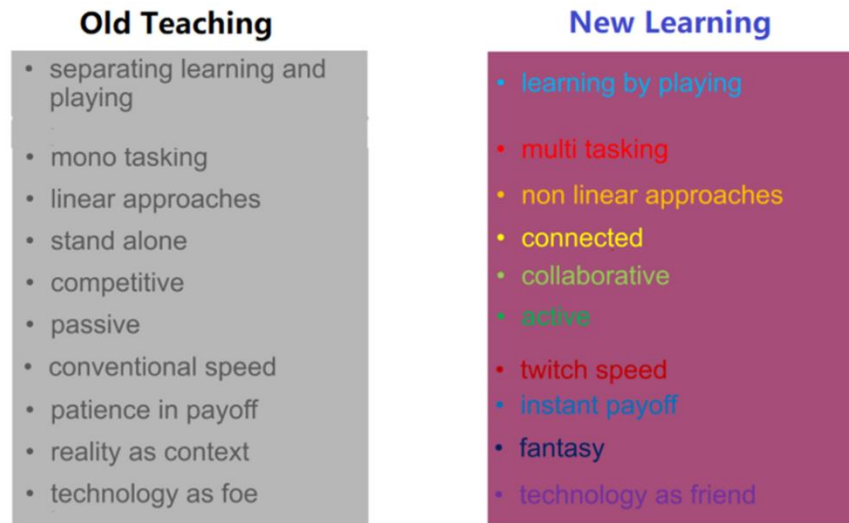
Old Teaching

- separating learning and playing
- mono tasking
- linear approaches
- stand alone
- competitive
- passive
- conventional speed
- patience in payoff
- reality as context
- technology as foe

New Learning

- learning by playing
- multi tasking
- non linear approaches
- connected
- collaborative
- active
- twitch speed
- instant payoff
- fantasy
- technology as friend

Figure 1: Traditional teaching versus Modern learning (Mark Prensky[3], modified version Henk Roelofs that starts with 'learning by playing')

Learning requires first of all **learning by playing** in an entrepreneurial learning context that is characterised by multitasking, non-linear approaches, connected, collaborative, active, twitch speed, instant pay-off, fantasy and technology as friend to create in this future context more effective, more efficient, more flexible and more creative persons. Michael Frese's Action Regulation Theory on the psychology of entrepreneurial development has identified three core characteristics in all phases of this development: proactive, self-starting and overcoming barriers. Learning 21st century skills requires such "entrepreneurial learning behaviour".

The "Learngaming " method, the didactic methodology behind LEARNGames in which the 21th century skills are achieved: effective, efficient, flexible and creative is presented. Examples are presented with digital "instant pay-off" of learning processes showing high retention rates resulting in "natural selection learning" of entrepreneurial behaviour that fits in future contexts of society.

2. WHY DO PEOPLE NEED TO LEARN?

Why do people need to learn? Because behaviour and actions must adapt to be successful in the future context. Competences that are needed change. A simple example: my mother (93) was proud she could finally SMS, but meanwhile WhatsApp had become the standard. Another example: the use of AI is quite normal now, like I practised in this document.

A future context changes and continues to change: Panta rhei (Heraclitus, Greek: πάντα ῥεῖ "everything flows", as a metaphor: "You can't step into the same river twice") . Learning nowadays should focus on adapting to the dynamic context of the 21st century. Darwin's principles of natural selection are relevant in this matter, because survival of the fittest is always

the survival of the best adapted, also regarding 21st century skills . The focus should be on the learning adaptations needed for this future! Learning is all about the future!

The idea to integrate Darwin's theory of natural selection in the learning process i.e. related to our LEARNGames and to the concept of Learngaming evolved from a visit to Redmond O'Hanlon[4]. He gave me his book "Joseph Conrad and Charles Darwin" and signed it for me. At the page of Acknowledgements the last sentence shows some evolutionary behaviour: *"...and Linda Hopkins has typed the final drafts and remained calm through the cataracts of contradictory corrigenda"*. She has learned to remain calm! The sentence also shows the inspiring telling style of Redmond, famous for many documentaries and books.

Darwin's principles of natural selection can also be seen in the learning context of the mid-19th century, where the rise of industrial society emphasised socialisation: for example being on time! (where peasant life had a very different perception of the concept of time), learning to count and to calculate, and learning a standard language to be able to understand instructions, and learning to write in that language. Later on the complexity of society required e.g. other languages needed for international trade.

In the 21st century, today's society is characterized by a global context full of turbulent real-time digital information and entertainment. Analogous to Darwin: "*Because this context demands different competences and different behaviour as a survival strategy, you have to learn that.*"

3. MATHETICS : THE SCIENCE OF LEARNING

Mathetics as **the science of learning** is a term coined by John Amos Comenius[5] (1592–1670) in his work Spicilegiumdidacticum, published in 1680. He understood Mathetics as the opposite of Didactics**, the science of teaching**. The word comes from the Greek word mathēmatikos, which means "disposed to learn". The mathetic approach can be summarised as "learning by doing by self-discovery". Linking new teaching to the organisation of new learning: changing the paradigm of "push teaching" by books to "pull learning" by "Learngaming ". Game-based learning is focusing generally on digital games, where human interaction is missing. Similar to Game-based learning, Learngaming also incorporates game characteristics and principles into learning activities. In Learngaming the focus is not on playing a game but on the learning aspect: learning by playing.

Just playing is not equivalent with learning

Figure 2: My grandson Aras on his first school day, Feb 2024, a little indignant; 'We weren't going to learn, just play".

I.e. regarding "instant pay-off" of the learning process, it is essential in **Learngaming** that information of each individual and collective learning process is available at the end of a LEARNGame session. It provides feedback for a process of self-discovery.

The principles of Learngaming are first of all **learning by playing** in a learning context that is characterised by multitasking, non-linear approaches, connected, collaborative, active, twitch speed, instant pay-off, fantasy, technology as friends.

This is provided in our LEARNGame: "Pull learning" in a joyful safe learning environment.

Figure 3: Internet versus Books

The old generation has a different perception of books than the young ones. We start from left above and finish right below (Arabic starts the other way around). Young people see it like a webpage as a "whole" because they are far more visually oriented.

The future of education should focus on the effectiveness of the learning context from the beginning, instead of the use of standard books as a starting method. Prensky[3], and Veen and Vrakking[6] showed that the current generation of students follow different study methods, because they are brought up with new technologies, learning in and by networks, using smartphones, learn by playing in learning contexts that encourage fantasy and exploration and are characterised by non-linear learning approaches.

The changes in the required "new" learning are partly due to the fact that the enormous flight of information and communication technology makes things like interactive and collective learning much more and better possible. Smartphones have greatly increased the pace of our daily lives. Knowledge is often based on fast communication and the ability to be in touch with everything and everyone. Sometimes this leads to hilarious situations: like the students who couldn't find the famous composer "Bag" (g in Dutch is ch, so Bach) on the internet! Nevertheless it is an example of using smartphones in teaching and learning and learning from making mistakes.

Figure 4: The traditional teaching focuses on exams at the end of a semester

An experienced event of traditional teaching in an exam hall :

- separate learning and playing: "silence please!"
- mono tasking: each course has its own part of a row ("mathematics is row four")
- linear approach: the linearity of the rows for each course exam ("this row is marketing")
- stand-alone : you do the exam alone ("copying is not allowed!", "don't crib answers from others")
- competitive: your individual score is the issue ("sign on the list, write your name on the paper and sign on the right place")
- technology : the only technology was a big clock ("15 minutes left to finish your writing")
- passive: ("sit down please", "raise your finger if you want to….")
- conventional speed ("time is allocated linear to de questions…","you have 90 minutes to complete your exam")
- patience in payoff: "the teacher takes the exams home to mark"
- reality as context: "no smart phones / no mobile phones are allowed"

The classical method of teaching is nothing more than one possible method and if you base the measures to change education on that classical method, you will achieve the wrong objectives.

Like John Maynard Keynes [7] in his one page (!) Chapter 1, The General Theory of Employment Interest and Money, a book that changed paradigms in economics: "*Moreover, the characteristics of the special case assumed by the classical theory happen not to be those of the economic society in which we actually live, with the result that its teaching is misleading and disastrous if we attempt to apply it to the facts of experience.*"
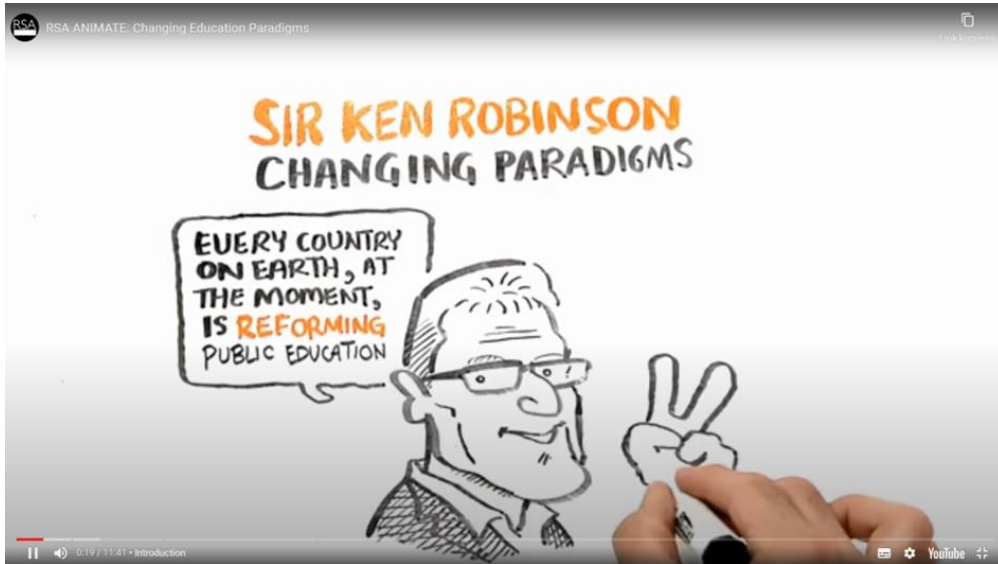
A change in paradigm visualised by Sir Ken Robinson [8] https://youtu.be/zDZFcDGpL4U

Figure 5: changing paradigms

A picture that outlines the cause: a need for a change in education paradigms, as this picture shows. "Boring stuff", "Blah blah, blah" with computers, iPhones, 100's of television channels etc. in the background.

Figure 6: Boring Stuff

See: Sir Ken Robinson at
https://youtu.be/zDZFcDGpL4U with RSA Animate - Changing Education Paradigms

4. THE "LEARNGAMING " METHOD

Figure 7: LEARNGame directions (design Hilka Schäfer)

Learngaming is the mathetic methodology behind LEARNGames, the way in which the 21th century skills are achieved. Learngaming implies that learning methods nowadays, taking the time dimension into account, should have features such as:

- **Effectiveness:** the **power** to achieve the learning objectives. To learn, one has to give meaning to information and communication, which can be achieved in the best way within networks where people communicate, cooperate and negotiate. In LEARNGames, being a role game simulation, participants operate in such a network, experiencing connectivity in their 'learning by doing'. Learning by doing is a very effective mathetic concept.
- **Efficiency**: the **power** to optimise inputs in order to realise the learning objectives. In LEARNGames we developed the concept of "minimal learning energy game". (Finalist at the European Conference of Game Based learning, ECGBL Odense). A very efficient mathetic concept to learn i.e. Cyrillic.

Figure 8 & 9: minimal energy learning of Cyrillic alphabet by using identical words.See: freelearngames.nl

- **Flexibility**: the **power** to adapt fast changes so that the effectiveness and efficiency in learning processes still can be achieved. Evolution implies continuous change , for the short term it implies the need for flexibility in learning processes themselves too. Each LEARNGame simulation is different and played in a different context. Sometimes new participants are added (or leave), groups are different: adults, students, (gifted) young children, refugees, etc. The dynamics of complex role game simulation is characterised by new elements in the game simulation which arise due to the creativeness of the participant. Many times these elements create explaining opportunities where metaphors can be used as teaching elements. A very flexible mathetic concept. See https://www.edupreneurial.com/ .
- **Creativity**: the **power** to bring in the changes which result in the future learning methods still will be effective, efficient and flexible. Evolution implies continuous change, for the long term it implies the need for creativity in learning processes. Creativity as an amoral process of natural selection for learning methods themselves, to create new learning opportunities. Also for LEARNGames, the better is the enemy of the good. "Technology as friend" implies continuous improvement. For example the availability of WIFI makes the integration of smartphones possible in LEARNGames which opens a lot of new mathetic concepts.

The non-availability (like in South-Africa with our LEARNGame where this is often the case) implies searching for creative solutions.

5. AN EXAMPLE OF LEARNING RESULTS OF LEARNGAMING : GIFTED CHILDREN

An example of learning processes using Learngaming were projects with gifted children. (Roelofs [9]) Here we used the entrepreneurial teaching method that applies to a receptive mindset of young gifted children (10-11 years). Specifically, learn a basic vocabulary of a totally unknown language (Russian, German) , so an easy to identify learning process. The learning results by Kahoot surveys: before LA-Game, after LA-Game and 1 week after LA-Game, are presented.

Gifted children specifically don't want to learn in the way of traditional teaching. According to specialists on education of gifted children like Linsen and Goethals [10] teaching to gifted children need to: avoid routine jobs; steps in learning should be large; a reasonable level of abstraction should be present; divergent thinking should be needed and creativity; internalisation should be as independent as possible. Bronkhorst[11] has similarly requirements for teaching gifted children: appeal their creativity; open assignments; high level of abstraction; high complexity; generate added value in relation to the regular learning content; activate an investigative attitude; evoke an attitude of reflection on operating; appeal to their meta-cognitive skills; provoke interaction; appeal to the self-dependence. We experienced that during the traditional

The perception of his "school-teaching " by a gifted child	The perception of learning processes by a gifted child
I don't want this	This is what I want
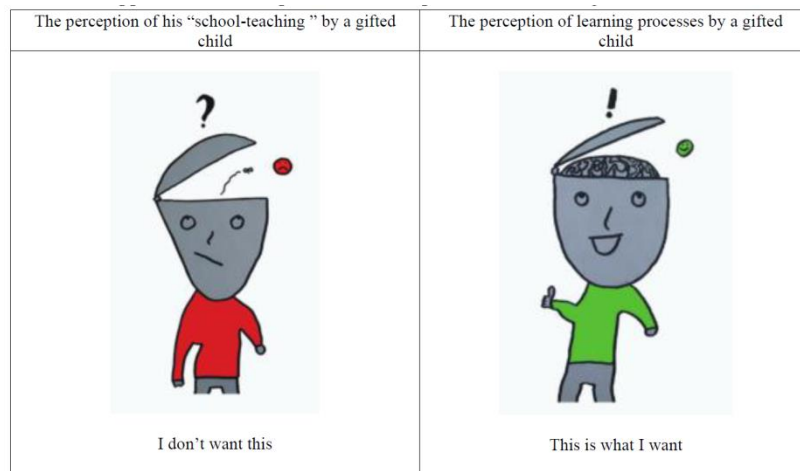
Figure 10: perceptions of "school" and "learning" visualized by gifted child Bart

teaching explanation of LEARNGame, several of the gifted children were in the passive "boring" mode, while turning into a very active "enjoying" mode a few minutes later.

When I asked several children to visualize the difference between "school teaching" and "learning", one of such a gifted child (Bart) made two drawings stereotyping the difference for him.

Gifted and talented children are those who possess or are capable of developing this composite of traits and applying them to any relevant area of human performance. As noted in the Schoolwide Enrichment Model, gifted behaviors can be found "in certain people (not all people), at certain times (not all the time), and under certain circumstances (not all circumstances)." (Renzulli[12]). Characteristics are: high reasoning ability, creativity, curiosity, a large vocabulary, an excellent

memory, able to master concepts with few repetitions, be perfectionist, often question authority, have trouble relating to or communicating with their peers.

Gifted children have abilities significantly above the norm for their age, generally these children learn more quickly, deeply, and broadly than their peers. Gifted behaviour occurs when there is an interaction among three basic clusters of human traits: above-average general and/or specific abilities, high levels of task commitment (motivation), and high levels of creativity.

Because gifted children request new learning methods, the teaching methods should be made applicable to the mind-sets of these gifted children. Teaching might otherwise lead to **mislearning**. For example, "instant payoff ". Illeris [13]: "*In education, at workplaces and many other situations, very often people do not learn what they could learn or what they are supposed to learn. Mislearning due to misunderstandings, lack of concentration, mental resistance, etc. Because young people are highly engaged in a process of personal identity development*". Illeris [14] means that *"young people fundamentally meet all learning initiatives with questions such as: What does it mean to me? Or: What can I use this for?*" - implying that it is only worth paying attention to if it is subjectively accepted as a usable contribution to the present demands of the identity process. Especially gifted children focus on a holistic approach: the so-called "top-down thinking". The meaning of the knowledge is essential for gifted children to store it as useful. The approach in school-education is generally bottom-up: stepwise built up with at the last step the goal and meaning. Top down learning implicates learning from the explicit level (generic, declarative level) to the implicit level (specific, procedural knowledge) and is analytic in nature (Sun, Merrill & Peterson[15])

Figure 11: communicate in Russian to buy LEGO material

We applied the Learngaming method for gifted children in which we used learning by playing a foreign language (i.e. Russian but also German) which was unknown by these children. Let them learn basic vocabulary, which is necessary to be able to communicate actively. For each language the basic vocabulary consists of circa 50-100 words, which can be compared with the first level of learning a language: "the Common European Framework A 1".

Acquiring a new language vocabulary does not necessarily require conscious study of theory, such as the study of grammatical rules. Learning a new language happens naturally (and

automatically) when you get lots of interesting and meaningful input, which can be provided by an authentic learning environment.

That a "learning" process exists is proved because participants in the LEARNGames learned the basic vocabulary of a totally unknown language starting from "zero". Then any increase in vocabulary is per definition a proof of "learning".

6. THE RESULTS OF THE TEST ON RUSSIAN

We tested a number of words of a basic vocabulary Russian. So colors, simple numbers, greetings etc. We tested by using Kahoot survey, before and after the LA-Game course. The results showed an increase of 52% in a few hours. Due to the chance element in testing (just gambling generates 25% good answers), the increase was even larger when corrected for this aspect. We repeated the same survey a week later: the results were even better: an increase of 61% correct answers

Figure 12: spreadsheet showing results

7. LEARNGAMING : WHERE MISTAKES AND ERRORS ARE "GOOD"

LEARNGame is a complex learning environment (a complex system is composed of many components which may interact with each other) where errors frequently appear. It is an entrepreneurial context in which opportunities arise or disappear. Making mistakes (Karl Popper [16]), even having fun about them is a positive element in the learning process of LEARNGame, because it is rewarding in terms of the entrepreneurial experience: "now I know that this doesn't work, let's try another way".

LEARNGame increases the quality of one's personal entrepreneurial abilities, due to the realistic dynamics of the simulation in which each participant is directly confronted with the consequences and rewards of their own entrepreneurial behaviour and actions (self-effectuation,

Roelofs [17]). It helps in changing the mindset towards entrepreneurship: learning by experiencing risk, experiencing aspects of sometimes flexible interpretation of moral aspects (even dishonesty) which is uncommon in education. We experienced in every LEARNGame session that participants create new elements in the process of market interaction; sometimes even new rules (shows "creativeness" of this learning/teaching method).

Moreover you also need success to learn to be successful. This type of learning is also effective by the experience of positive emotions: success drives success. Or Oscar Wilde's: "nothing succeeds like success". But how is "being successful" defined? As we showed in the article (Roelofs and Samplonius-Raut,[18]) on authentic learning environments, "being successful" implies an environment in which there is a "risk" aspect; with the dynamics to experience positive emotions of being successful by overcoming these risks, with the opportunity for each participant to create value and learning by successes of doing it, or not. This specific element of "risk" has been integrated as a key element in the LEARNGames.
First let's consider LEARNGame.

7.1. LEARNGame explained

LEARNGame is a synergy between games and simulations: is a simulation game. Games are very popular in today's world, also in educational systems. What differs games from the simulations? What are the similarities? Authors like Gredler[19] analysed the differences and similarities between games and simulation. Clearly the main difference between game and simulation is that you can win a game and you cannot win a simulation. For Gredler similarities between games and simulations are:

(1) Transport the participants to "another world";
(2) Participants control their own actions.

The first aspect of transporting the participants to another world is realised in LE-Game, **playing with LEGO** is reminiscent of many participant's childhood, the time in their lives when playing was the focus. The "other world" is also emphasised by the different coats (green, red and blue) for the different roles at the start of the LEARNGame, psychologically this is an element of "nudging" unconscious behaviour.
Also the second aspect is applicable, since each participant is challenged to guide his company in the best way and to make as much profit as possible, thereby participants controlling their own actions.

LEARNGame offers participants the chance to experience entrepreneurship in a safe and simulated environment. It is an authentic context for the learning process of entrepreneurship that focuses on two key characteristics: creating added value and pursuing opportunities. The participants develop their skills by using the market opportunities: a demand oriented learning method to develop entrepreneurial competences in an authentic learning environment. The experience acquired provides the confidence to bridge the uncertainty caused.

In LEARNGame, the objective is to learn entrepreneurship, but there is also a winning element: The one who earns the most profit, wins. The dynamics caused by the scarcity of money and time, and the competitors, create both linear and non-linear processes. Also in every LE-Game, we experienced that participants created new elements, sometimes even new rules, and it can be clearly shown that relationships between participants change over time. Sharing successes create positive emotions that support the learning of entrepreneurial competences.

The simulation role game, LEARNGame, is used in an entrepreneurial context to bridge the gap between theory and practice of entrepreneurship and education. Using LEGO to teach and learn entrepreneurship in a playful manner. In the simulation, several markets are created, where Lego products are traded. Participants buy and sell commodities, produce and / or trade Lego towers or Lego parts. The use of LEGO makes LEARNGame also quite sustainable: the same bricks are used > 20 years now.
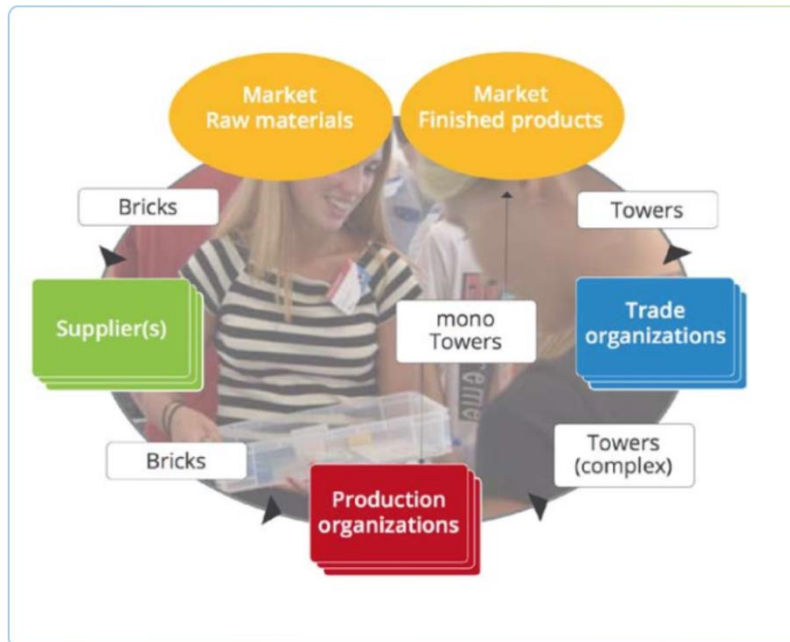

Figure 12: LEARNGame overview by Henk Roelofs (roles like VAT/Taxes, Bank, Export/Import can be added), payments can be digital using i.e. smartphones)

The essence of the simulation game LEARNGame lies in the conflict of interests among the different market players (see figure 12). In LEARNGame, participants are exposed to real uncertain market situations. The drive to participate actively is caused by real uncertain market situations in LEARNGame itself: complex, unpredictable, and creating a demand to participate. In LEARNGame the objective is learning, but there is also a winning element activated by making 'profit'.

The rules of LEARNGame are:

● Everybody is an entrepreneur in his/her role. In the simulation, several markets are created, where Lego products are traded. Participants buy and sell commodities, produce and / or trade Lego towers or Lego parts;
● There are three variations in the roles: Trading organisations, Production organisations and Supply organisations. The added value is created by the entrepreneurs by trading the raw materials, which can be bought at the Market Raw Materials and the finished products which can be sold at the Market Finished Products;
● The market consists of two types of products: mono-coloured towers (sold by Producers & Traders) and multi-coloured towers (sold only by Traders)
● Besides the entrepreneur roles there can be "supporting roles" like a bank, tax authority, in LEARNGame silver and export markets and currency issues in LEARNGame gold, depending on the simulation.

● All participants are limited in their resources, have a (small) competitive advantage in their stock and have the same starting capital: € 2500 in cash and in kind.

Participants experience market competition in combination with scarcity of resources: pressures of scarcity of money, time and competitors. So, being continuously exposed to the market transactions and the risk during the game. The dynamics caused by these pressures of scarcity create both linear and non-linear learning processes. Each participant is challenged to guide his company in the best way to make as much profit as possible. Success drives success

In LEARNGame each participant is an actor in the market: either as a supplier of LEGO bricks and / or plates, as a producer of LEGO-towers or as a trader of LEGO-Towers. All are "active agents". LEARNGame is a safe environment, where (faulty) actions can be conceptualised as learning devices and an enabler of developing a concept of the reality of entrepreneurship.

In the LEARNGames, each participant is self-employed and operates independently in a network of relationships (as a supplier, manufacturer or trader, with the world market of commodities (=LEGO-bricks and plates) and a final market (LEGO-towers). Such a game usually takes about 1½ hours. Interruptions often fail because the participants all go up in their role and context.

7.2. The Instant Pay-Off in Learngame Entrepreneurship

The earlier mentioned element "What's in it for me" is in Learngaming essential, and we developed software to make information available in LEARNGame (see Appendix 3) of each individual learning process and collective learning process at the end of a LEARNGame session. When possible we relate the development of "soft skills" (both individual and as a group) also to de performances of the LEARNGame.
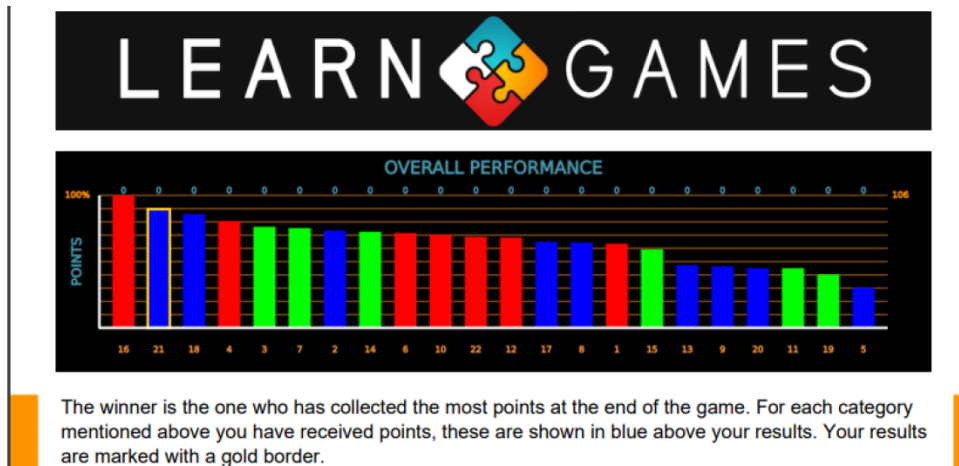
Figure 13: This participant was runner-up (2nd place)
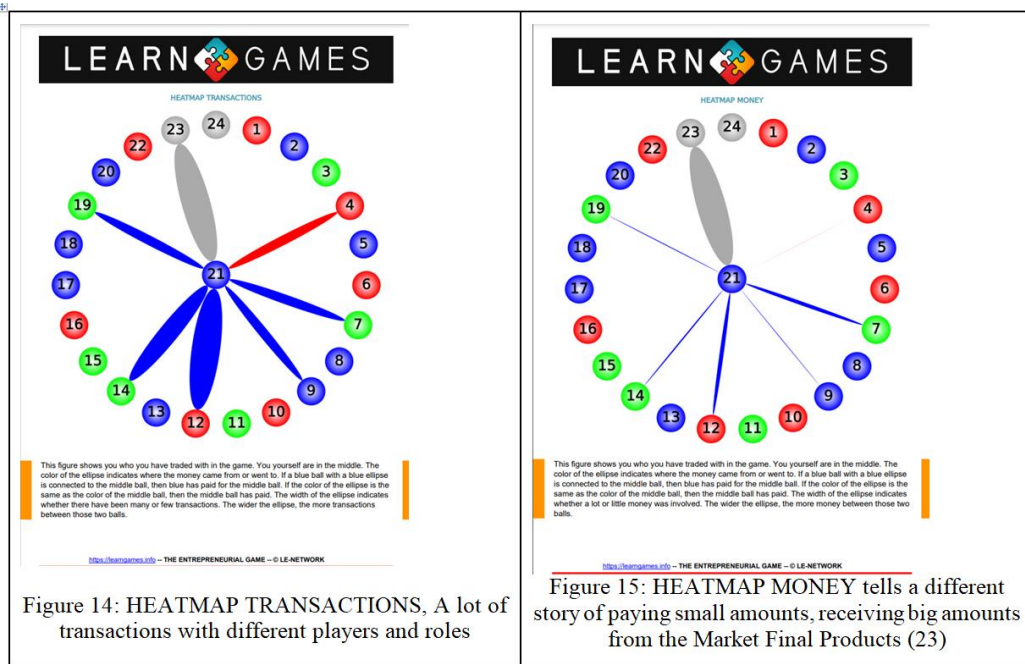
Figure 14: HEATMAP TRANSACTIONS, A lot of transactions with different players and roles

Figure 15: HEATMAP MONEY tells a different story of paying small amounts, receiving big amounts from the Market Final Products (23)

Appendix 3 shows an overview of the results, instant pay-off, after playing the digital version of LEARNGame Entrepreneurship.

Learning accomplishments in South Africa with the analogue LEARNGame don't have this digital registered feedback option. But the interviews presented in the video: https://youtu.be/9wNKI0IHNBI show the impact of this entrepreneurship learning by playing method.
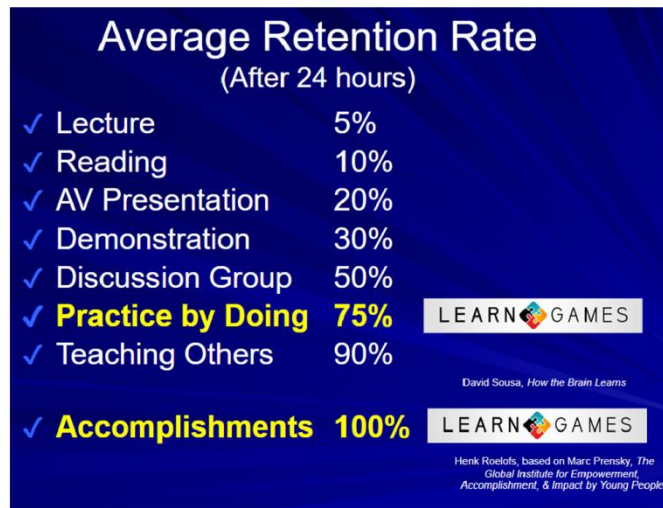
8. RESULTS AND IMPLICATIONS

Our educational system should change from a classical educational approach towards the use of effective Learngaming contexts where the characteristics of the mindset of the new generation are the standard. A learning environment with the dynamics that makes it possible to learn from making mistakes and experiencing successes.

The future of education should better focus on the effectiveness of the learning, instead of the focus on efficiency of learning, where books are standard. A method in education, in which games and simulations are the core element of learning, where textbooks are just supporting. This instead of the other way around where books are standard. Games simulations like LEARNGames will bring an action element in teaching & learning (See Appendix 1 showing the AI-based difference).

Teaching is different from learning. The teaching context has to evoke and challenge a preferred entrepreneurial, learning process. An effective, efficient, flexible and creative action learning environment, characterised by a learning process: self-starting, proactive and barriers to overcome. Where teaching regulates these learning processes, like the Dutch regulated their rivers with dykes and canalization. Indeed: "regulate", but "don't tell" (see Appendix 2 on "**how**" based on Action Regulation Theory[Frese, [20], Frese & Zacher [21] and Roelofs [22]).

A teaching method that fits in the mindset of this generation, where learning implies twitch speed, multi-tasking, nonlinear approaches, connected, collaborative, active, instant payoff (see Appendix 3), fantasy and technology as friends. Analogous to Darwin: "*Because the future context demands different competences and different behaviour as a survival strategy, you have to learn that.*" Survival of the fittest animals show how: by "learning by playing".
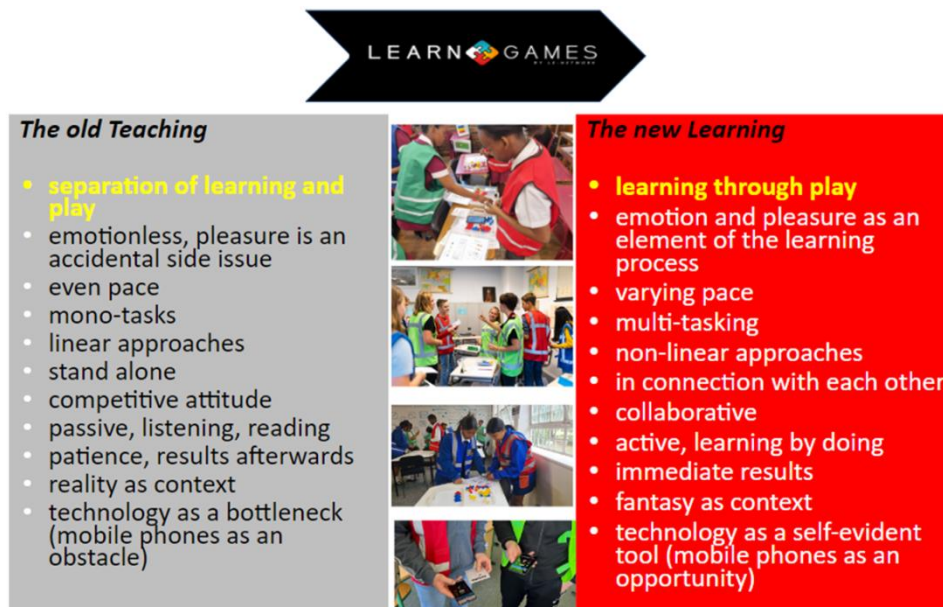
Figure 13: Overview LEARNGames characteristics, Henk Roelofs & Bert Dijenborgh

9. CONCLUSION

The Learngaming concept successfully integrates Darwin's natural selection theory into a modern educational framework, emphasizing entrepreneurial skills necessary for the 21st century. By moving away from traditional, linear learning models and promoting an environment of active, game-based learning, Learngaming enables learners to adapt and thrive in rapidly changing, digital contexts. This method encourages creativity, flexibility, and efficiency, preparing individuals to meet real-world challenges. The demonstrated success with gifted children and the focus on key entrepreneurial behaviors, such as self-starting and risk-taking, underscores the effectiveness of this approach. As educational paradigms shift, Learngaming provides a forward-thinking solution that aligns with the dynamic needs of today's learners.

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AUTHOR

Willem Schreuder stood at the basis of the development of the Internet in The Netherlands. He developed the software for the digital LEARNGame Entrepreneurship, the soft skills tests, the digital memory games (with sound) and the recent digital LEARNGame Operations Management (named "the Incompetence Game", were you can learn to be incompetent, because making mistakes is a very effective learning method).

Henk Roelofs , Academic in econometrics and in social geography. Developer of innovative learning processes,i.e. Regarding entrepreneurship learning. Passionate "edupreneur"(education/entrepreneurship) focusing on action learning, see https://youtu.be/y9egw-GuXEQ. I have been the chairman &project leader of three "ACTION" projects (2002-2009, a project to activate entrepreneurship at the Hogeschool Drenthe (now merged to NHLStenden university) and Drenthe College, financed by the EU. Also initiator of the project European Entrepreneurship.Wide experience in teaching economics, logistics, entrepreneurship, operations management, operations research, PBL, etc. Co-owner of the edupreneurial company LE-Network, https://le-network.nl/en/, where my passion for entrepreneurial education and role game simulations using LEGO is realized in the last >25 years. See www.learngames.info, www.le-network.nl, www.learngaming.info, www.edupreneurial.com

Worked for >30 years at a university of professional education (NHLStenden) and also some years as project advisor for an international EU-funded international entrepreneurial-educational project (http://www.c-alearn.eu/) at ROCvanTwente. Now CEO of LE- Network.

Developed several role game simulations using LEGO to learn in a more effective, efficient, flexible and creative way. Finalist with two learning games at ECGBL (LEARNGame & Minimal learning energy game) in Odense (DK).Played the LEARNGames all over Europe (SF, D, B, P, F, GB, NL), especially the "Legostics"-games. Recently our LEARNGame entrepreneurship has been played in Stellenbosch South-Africa. Using chrome books to register payments between the participants and with the Market Finished Products (=LEGO towers) and the Market Raw Materials (=LEGO bricks and LEGO plates)

Goal is the development of "learning entrepreneurship theory" . So not 'sec entrepreneurship' but the LEARNING of entrepreneurship. What can explain such learning? I.e. "Action Learning Entrepreneurship Regulation Theory"?By measuring during many pilots of our new digital (!) LEARNGame entrepreneurship we obtain data and we might find out using econometric modelling. :)

There might be a relation with i.e. the personal skills development (See: - www.softskillstest.com- where you can test your behaviour style, your conflict style or your leadership styles. All test are for free. See one of my papers for the unique methodology based on Prototype Theory and Fuzzy Logic Theory.

Finally: meanwhile we have also developed several digital memory games with sound that can be played on any device, also smartphone! The idea is using technology of today (smartphone & internet) to provide playful learning , preferably 'unconscious' learning (=minimal learning energy). I.e. Cyrillic alphabet, similar in Hindi and Arab. See www.freelearngames.nl

APPENDIX 1 : THE DIFFERENCE BETWEEN TEACHING AND LEARNING ACCORDING TO AI

Category	Teaching	Learning
Source of Information	**Externally driven:** the information comes from sources external to the students, provided by the teacher. **Teacher-provided:** the teacher delivers and imparts the knowledge and content to the students.	**Internally driven :** the learner seeks and acquires information through their own initiative. **Learner-acquired:** the student actively seeks knowledge and learns from various sources**.**
Active Participant	**Teacher, Instructor, Facilitator** Teacher: The instructor is actively engaged in leading and guiding the learning process. Instructor: The person responsible for facilitating the educational experience. Facilitator: The one who enables learning and fosters understanding. .	**Student, Learner, Participant** Student: The individual undergoing the process of education and acquiring knowledge. Learner: The person actively participating in the learning process. Participant: Engaging in educational activities and being involved in the learning environment
Focus	**Content delivery, Presentation** Content delivery: The primary focus is on presenting and conveying information to the students. Presentation: The act of showing and explaining content to the audience. Focus (Learning):	**Content absorption, Understanding** Content absorption: The main emphasis is on grasping and comprehending the presented information. Understanding: The process of making sense of the knowledge and concepts being learned.
Responsibility for Outcomes	**Shared, Collaborative, Supportive** Shared: Both the teacher and the student collaborate to achieve successful learning outcomes. Collaborative: Working together to attain the desired educational goals. Supportive: The teacher provides assistance and support to facilitate the student's progress.	**Individual, Personal, Self-directed** Individual: The learner is ultimately responsible for their own learning journey. Personal: Education is a unique and individual experience for each student. Self-directed: Taking initiative and responsibility for one's learning path.

APPENDIX 2: ACTION REGULATION OF (ENTREPRENEURIAL) LEARNING PROCESSES

Regulate, so: Don't tell		
sequence of actions.	**goal in the development of a personal entrepreneurial mind-set**	**monitoring and regulation**
Phase 0: the pre-phase,	➤ Change of unconsciousness to consciousness ➤ Switch the mind-set ➤ self-starting, proactive and overcoming barriers	create this change i.e. specific attributes, showing an example of a student that has made this change, show final presentations of other teams
Phase 1: Setting goals.	➤ Initiate actions to identify specific opportunities based on the provided value opportunity ➤ Initiate the mind-set ➤ self-starting, proactive and overcoming barriers	create a value opportunity i.e. a customer that want to pay for students' achievements (website, research, app-development)
Phase 2: Collection of information	➤ Activate personal networks, generate opportunities for specific useful info ➤ self-starting, proactive and overcoming barriers	monitor the information collection process, provide additional possibilities for info, suggest relevant additional sources
Phase 3: Plan and execute	➤ Do! Learn by doing ➤ Present intermediate results in progress events that are regularly organized ➤ self-starting, proactive and overcoming barriers	Allow making of mistakes, but keep on track, let experienced entrepreneurs (not managers!) monitor the process
Phase 4: Monitoring and feedback	➤ Experience successes (at the end) and failures (in between) ➤ Start again in Phase 2 if necessary self-starting, proactive and overcoming barriers	Rehearse, organize try-outs before presenting results to customer Ask whether they would pay for the service/product themselves
Phase 5: Assess the added value	➤ Experience creating added value (or not!) Added value might be zero or even negative ➤ self-starting, proactive and overcoming barriers	Celebrate achieving added value
Phase 6: Reflection	➤ Demonstrate and present learning process ➤ Teaching others is the most effective way of learning ➤ self-starting, proactive and overcoming barriers	Assess the entrepreneurial learning

APPENDIX 3: THE "INSTANT PAYOFF" FEEDBACK REPORT ON INDIVIDUAL AND COLLECTIVE PERFORMANCE AFTER LEARNGAME, INCLUDED A SOFT SKILLS TEST

LEARNGame report of personal results of the LEARNGame Entrepreneurship combined with the personal behaviour test (one of the possible soft skills tests)