Potential Development Using Thinking Tools

Potential Development Using Thinking Tools:

The Key to Flipped Teaching

By

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This book is dedicated to everyone in need of thinking tools.

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FOREWORD

Since the inception of formal schools, there were two clearly demarcated approaches towards teaching and learning, namely the constructivist and the behaviourist movements. Their proponents were, for example, the extreme behaviourist, John Watson (1878–1958), and the constructivist, Jean Piaget (1896–1980), who had different mindsets on teaching. They developed their philosophies at approximately the same time.

In teacher training programmes, those two approaches are taught parallel and intertwined. The theoretical part of the curricula addresses the more complex constructivist theories, while the behaviourist theories are employed during practical training. The reason why behaviourism gravitates towards the practical part is because it is easy to translate the principles of behaviourism into practices with easily observable and measurable strategies, plans and techniques.

The constructivist philosophies, on the other hand, contain complex concepts such as *zone of proximal development* (see Chapter 6), which, for the inexperienced, cannot be easily linked to observable teaching strategies, plans and techniques. This parallel teacher training continues notwithstanding the fact that the two philosophies have nothing in common and do not tolerate each other. It is interesting to note that the lessons to student teachers on both philosophies are offered in the lecturing fashion, which is based on the behaviourist theory. They are trained on theories they never practised, while their practical teaching is based on theories that could not stand the test of time. The latter is evidenced by the current status of education worldwide.

This ambiguity sheds light on why new teachers are insecure when they start teaching. It leads to senior teachers advising and guiding newly appointed teachers to not smile within the first three months, to let their "yes" be their yes and their "no" be their no, and to explain their class rules every day for the first month. In her book, *The Teaching Brain* (2014:4), Rodriguez shares her experience on this: "The senior teachers cautioned me against using too much passion in my classroom: 'Just read the books, ask them questions of comprehension, and have them write essays to prove that they've learned the appropriate theme of the book.'"

This means that new teachers receive on-the-job training from teachers whose training is based on informal self-generated in-house counterproductive practices. This leaves the stakeholders of teaching – of which the teaching fraternity is the professional partner – without a common language, except for a small number of superficial concepts such as *teach*, *learn*, *study*, *work harder*, *pay attention*, *look*, *listen, memorise*, *remember, revise, quiet,* and the most confusing of all: *THINK*!

Thinking tools emerged as thinking-based teaching sessions when parents approached me to offer courses on study methods to their children who were not progressing at school the way they should. To the surprise of both parents and children, these courses turned out to be critical thinking sessions. The result was that friction between the parents and children started to disappear and that the children started to flourish at school. The reasons were that, for the first time, progress on learning became communicable, visible and measurable. This spilled over to individual teachers, who noticed that some of their learners mastered the work better and faster. More and more teachers started to enrol for the six three-hour thinking tools sessions, which add up to eighteen hours.

Currently schools are enrolling their full staff complement for thinking tools sessions. My personal guarantee on these sessions is that if teachers do not learn more during the 18 hours of training compared to their approximately 4,800 hours of tertiary training, I will pay them back ten times their course fee. I have not yet received any claims. To the contrary, teachers have asserted that perhaps they should claim their wasted money back from the tertiary institutions where they studied. The thinking tools sessions are particularly accessible. Any teacher, regardless of their location, with access to the internet can attend a course, since all sessions are done using Zoom Conferencing.

In South Africa the sessions are registered with the South African Council for Educators, which is the standard regulating body for teachers. These sessions entitle teachers to 20 continuous professional development points – a requirement to maintain their registration as teachers.

Teachers who completed the sessions gave astounding feedback on my Facebook page, *Potential Development using Thinking Tools*:

Right through my teaching career I was always looking for strategies to make lessons interesting for my learners. I tried several strategies, but I did not really manage to find something that had a major impact, until I tried thinking tools.

During the September holidays of 2017 I did a course in thinking tools. I implemented thinking tools from October 2017 and it immediately made an impact in my classroom. My learners became more focused and engaged in activities. They were able to explain concepts without me explaining anything to them. They found the answers by themselves. They were able to identify their own mistakes and rectify it. As a result, their self-confidence, communication and language skills improved, and disciplinary problems became less.

Thinking tools had a positive impact on group work. During discussions and group activities they were focused on the task at hand. It did not matter what the activities were. They rose to the challenge and expectations. They knew how to analyse text, diagrams, graphs, or pictures, and they were able to write their own notes in Social Science. They were able to remember facts much longer, and as a result, their marks improved considerably.

Having a full-time job and doing part-time studies can indeed be a very big challenge. Implementing thinking tools in my own studies enabled me to not only meet all the assignment deadlines, but also to find the answers within myself and therefore maintain a very high academic record.
—Marionette Maart

As soon as you "get into it", it is amazing how fast and how much learners can discover and learn in a short space of time. Learners quickly grasp how thinking maps benefit them.
If all teachers and parents do the thinking tools course and use them on a daily basis, we will create a world where children can think for themselves.
—Karelien Kriel

I did the course during the March 2019 holiday. One has to test a new thing before being able to comment. Therefore, after almost four weeks of teaching the thinking tools way, I can confidently testify to the following:

- *My classes' discipline is now excellent.*
- *The kids work, and the chalk is left to rest.* 😅
- *Experiencing the joy when children achieve something they themselves did not think is possible.*
- *Parents are contacting me saying that their child can't stop talking about maths.*
- *The thinking maps are fantastic, and they love the hats … they regularly ask me: "The red hat too, teacher?"*
- *We're writing a test on Monday – I'm relaxed and my kids are ready.*

Thank you, Cas, a life-changing course!!
—Donnie du Plessis

> *Matric marks with thinking tools at the end of 2018: Mathematics class average 62% (up 11–27% from the previous three years). Physical Sciences class average 75% (up 25–40%) from the previous three years). I am so proud of my children*.
> —Carmen Henning

> *Thinking tools changed my mind on teaching. The discipline in my class improved because my teaching is driven by questions. Communication improved and learners started to contribute and speak their minds. Kids enjoy constructing their own thinking maps. No more copying from the writing board. They regularly use the thinking hats. Today when we did singular and plural a learner informed me that he used his green hat and wrote additional examples*.
> —Letitia Steyn

> *As a remedial teacher I cannot think of any reading, writing, maths and other subject remediation without using thinking tools. Using clever learning activities opened a whole new way of teaching for me. I discovered that learners are GREAT THINKERS. They want to engage in thinking and want to discover for themselves*.
> —Denise Zeeman

As part of my contribution to community development, I made an offer to a longstanding professional acquaintance, Dr Muavia Gallie, who is driving the School Turnaround Foundation (STF) to train teachers from dysfunctional schools. The foundation aims to turn around dysfunctional schools in the Worcester area in the Western Cape, South Africa. Eight teachers from five dysfunctional schools were nominated and trained on thinking tools. This is an extract of the final report, *Thinking tools as an important ingredient to achieving the shift from a teaching-focused to a learning-focused method* (Gallie, 2018:5):

> *In particular, the assessment results on the greater thinking method compared very favourably to the average of previous assessments on the same subjects, for example the electricity lesson results:*
> - *Increased by 20%;*
> - *The group's average increased by 24%;*
> - *The lowest score increased from 15% to 61% which is an increase of 46%; and …*
> - *No learner failed.*

In addition to the above, the report mentions the following:

This approach to teaching led to the following classroom management successes, which are important in the work of The School Turnaround Foundation, and is linked to the school turnaround methodology:

- *All learners were involved in the learning process;*
- *There were no disciplinary issues;*
- *Learners started to see themselves as "clever guys", which is important to self-affirmation;*
- *The learners enjoyed their new learning experiences; etc.*

The curriculum of the thinking tools paradigm blends seamlessly with the teaching methods set out in my book, *The DNA of Great Teachers* (2012), which are also discussed in Chapter 5 of this book. Thinking tools are the opposite of all traditional concepts and practices embraced by both teacher- and learner-centred teaching paradigms. This opens a whole new world for teachers as their original dreams of being role models for their learners, empowering them to learn and supporting them in building character, become a reality.

The prelude that follows sets the scene for the bigger picture and more details of the multifaceted paradigm of thinking tools concepts and patterns that will be explored in later chapters.

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PRELUDE

The *First Industrial Revolution* (1760–1850) – which is associated with coal, cotton and iron – took the textile industry's spinning and weaving processes to new heights. Primary education became compulsory and secondary schools focused on trades. Before that, education meant learning from a blacksmith to become a blacksmith. Most people were still working in old trades such as tailoring, shoemaking, baking, and unskilled employment. At that time, the hidden curriculum of the school system was to civilise the masses and included elements of obedience and respect, which were the work values treasured during those times.

The *Second Industrial Revolution,* which is associated with steel and electricity, started in the early 20th century, when Henry Ford designed the assembly line. It started the age of machine-manufactured mass production, and called for more schooling. The hidden curriculum of the school system mainly focused on following standardised procedures needed to maintain production standards.

The *Third Industrial Revolution* (1960 onwards) has so far had the largest visible impact on society. Administrative and management systems emerged alongside manufacturing systems, which gave rise to the concepts of "blue-collar factory" and "white-collar office" workers. Both types of workers follow standardised procedures to fulfil their duties. This called for even more advanced schooling. Education became a major role player in technological and economic progress, which resulted in academic, trade and business schools that provide educated workers for the growing economy. The hidden curriculum of the education system mainly focuses on the white-collar workers. Schools became information-age teaching factories aimed at duplicating masses of knowledge in learners' brains. The purpose of schools is to provide learners with standardised answers for standardised questions.

The *Third Industrial Revolution* is characterised by computer-based digitally programmed production lines and mass manufacturing by robots. These processes are closed-circuit systems and are controlled by internal regulators. For example, when a component overheats, the system is informed and stopped. Once such a closed system is built and running, it

goes unaccompanied or solo and is not influenced by external factors, except for workers who perform maintenance and quality assurance activities.

In the meantime, humankind entered the *Fourth Industrial Revolution*, which is characterised by a fusion of technologies that blurs the lines between physical, digital and biological systems. Closed linear digital systems are being replaced by open cyber-digital-physical-biological systems, which, in short, means that production or operations are influenced by pre-embedded sensors that monitor external digital, physical and biological factors. For example, a self-driven car's integrated motherboard will be connected to the passengers to be able to measure their pulse rate in order to determine their medical needs. This system will be linked to an external GPS system to direct the car to a hospital, as well as to a communication system via the internet to inform medical staff about the patient's status and arrival time.

While schools are stuck in their mass production teaching methods, the Fourth Industrial Revolution requires school-leavers to be critical thinkers. In his book, *The Fourth Industrial Revolution* (2017:6), Schwab summarises the challenge as follows: "These marked the transition from muscle power to mechanical power, evolving to where today, with the fourth industrial revolution, enhanced cognitive power is augmenting human production."

The initial focus of education was to teach learners over a limited number of years to read, write and do calculations. This was done to enable factory workers to read instructions, write down what must be recorded, and to determine and calculate machine settings. The purpose of teaching was to furnish learners with standardised sets of skills to enable them to fit into standardised industrial or information jobs.

Although education's main focus is on delivering white-collar workers, school curricula do not attend to competencies needed in the management and leading echelons where challenges change on an hourly basis. In these echelons, soft skills such as communication competence and emotional intelligence become more important. These skills are not covered by current curricula. With thinking tools teaching, these competencies are the drivers of learning, which is in accordance with Schwab's (2017:40) view on the requirements of future low-risk employment profiles: "In the foreseeable future, low-risk jobs in terms of automation will be those that require social

and creative skills; in particular, decision-making under uncertainty and the development of novel ideas."

Through the years the education system has defined itself by claiming that it delivers school-leavers who are ready for the world of work or for further studies. However, this doesn't seem to be in line with reality. At university level, students cannot be referred to textbooks, because they are clueless on how to access, organise and apply information. Employers are equally surprised when new employees do not meet the expectations indicated on the school-leaving certificate.

This dissonance between education systems and the competencies needed by the working world and tertiary education compares with how Kolind (2006) describes the crisis of Oticon, a hearing aid manufacturing company in Denmark, in his book, *The second cycle*. In the 1960s Oticon manufactured hearing aids of an acoustically high standard. Hearing aids in those days consisted of a box the size of half a hand carried in the pocket and connected to two ear plugs with two electrical cords, visually screaming out the reality of an auditory impairment.

Oticon perceived acoustical performance as the key criterion for choosing a hearing aid. To obtain a hearing aid, patients had little choice of what they needed, because these choices were made on their behalf by audiologists and hearing aid dispensers. Oticon believed it had the ready-made answers for all standard hearing problems. In the 1970s, the company took the lead in moving hearing aids from the pocket to behind-the-ear devices – a great achievement, from both a marketing and technological perspective. Customers, however, wanted customised hearing aids concealed in the ear canal. This was difficult, because the space in the ear canal is smaller than behind the ear, and the shape of the canal differs from person to person.

While the rest of the industry moved from mass production to customised in-the-ear-canal hearing aids, Oticon stuck to its behind-the-ears models and kept on defending these models for almost 10 years. Its view was that the market was wrong and that the whole thing would blow over. When the company lost about half of its equity in one year (1987), it finally realised that something radical had to be done and eventually Oticon moved to in-the-ear-canal devices.

Pardon the pun, but do you hear the echoes between the Oticon journey and what is happening in education? Education systems are still using industrial age teacher-centred lecturing methods that do not prepare school-leavers to

find solutions for problems that do not yet exist, while this is exactly what is expected in the Fourth Industrial Revolution: the ability to pioneer the future.

In attempts to mitigate the autocratic characteristics of the teacher-centred approach, learner-centred teaching models (more on this in Chapter 2) were developed to nobly include critical thinking. This gives teaching democratic properties, but does not individualise learning with the purpose of developing each learner's individual potential. Once institutions commence with their new teaching methods aimed at developing critical thinking, their vocabulary in terms of critical thinking fades.

I recently had a postgraduate teacher on a thinking tools session who confidently believed, as taught by the university, that the main role of the teacher in the classroom is to be an actor. It implies that this concept must be captured somewhere in that university's curriculum. The academic conflict and professional disharmony in this definition of a teacher is clear. Scientifically, one concept cannot be defined in terms of another concept. An electric light cannot be defined in terms of an apple; it must be defined in terms of what an electric light is. In the same vein, a teacher cannot be defined in terms of what an actor is.

This is an indication of a professional system with a deprived vocabulary that tries to describe teaching. Weaknesses in the system become clearer when we hear from graduated teachers what they have been taught:

- The teacher must be a leader in the classroom.
- A teacher can teach all the learners in a class simultaneously.
- The teacher determines the pace of teaching.
- Knowledge can be transferred.
- Bloom's Taxonomy serves as a benchmark for teaching and assessment.
- Worksheets are part of learning.
- Learning means studying textbooks and notes.

The education system has been misled by the mass production paradigm of the first three industrial revolutions, which was exacerbated by the information age that fuelled the belief that a teacher can teach many learners at the same time. Education needs an approach that can develop the potential of individual learners. This is not possible when the system is equipped with mass-oriented materials, physical and interactive writing boards, and overhead

and data projectors – all of which are used to convey masses of information to learners.

Mass-oriented materials are generic and aimed to inform the masses on specific topics. These materials can be newspapers, magazines, textbooks or information in electronic format such as e-books and internet web pages. Mass-oriented resources need to be digested and interpreted to make sense to the reader. In traditional education, it is expected from learners to master the material as provided.

Thinking is an individualised process. Mass-oriented materials such as textbooks are fit for rote learning, but unfit for individualised conceptual thinking, unless thinking tools are employed to enable learners to discover information, create knowledge, gain insight and solve problems themselves. The education system's counter-action is to enable teachers to digest the information on behalf of the learners and then repackage it in smaller chunks supported by diagrams, sketches, examples, notes and PowerPoint slides. Although teachers have all of this at their disposal, it still makes them feel like flying against the headwind when they teach. Teachers need to be equipped with the competencies to individualise learners' learning by empowering them to use thinking tools.

It is time to liberate education from factory floor-based learning and actively engage learners in learning with thinking tools. The hidden agenda of the thinking tools curriculum is to empower learners to be their authentic self, and to develop their critical thinking potential to become successful adults who make meaningful contributions to society.

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CHAPTER 1

THE THINKING BRAIN

Homo sapiens is destined to think, and thus all information on earth is created by human brains. The fact that the brain is a knowledge creator is acknowledged everywhere in the world, except in schools where learners' brains are turned into knowledge duplicators. This is in stark contrast with the meaning of "sapiens", which is "wise".

An education system's view on what learning is determines the system's view of what teaching is. The behaviouristic teacher-centred system defines learning as visual, auditory and kinaesthetic learning. Its teaching focus is to provide the senses with information. This is evidenced by teachers saying, "you must listen" when addressing the ears, and, "look at the sentence on the board" when addressing the eyes. They let learners perform "kinaesthetic" activities, for example, when they teach them to dance on a mnemonic to drill in long division steps. This assumingly assures the teacher that all eyes are focused, that the ears are accompanying the eyes and that body movements reinforce the memorising process. To the contrary, there are supporters of kinaesthetic learners who do not allow learners to use their fingers when counting. The system's interest in the brain stops at the sensory processing level, which is not helpful in describing what thinking is.

The focus of thinking tools is to determine how the brain behaves during thinking. The words "think" and "love" are both authentic to being human. Both are verbs and both are invisible. In the same way that we can make deductions about what *love* is, we can make deductions about what *think* is.

Observing learners engaged in thinking provides a plethora of observable patterns that can be used to make meaningful deductions about how the thinking brain works. It is possible to determine, by means of observations, what the brain is good at and prefers to do, and what the brain is not good at and dislikes. We can then use analogies and metaphors to express how we understand the brain's consistent behaviours. This information can be

used to align our teaching with how the brain behaves, and not with how we want to teach.

The brain is a wandering mind

Let's start by uncovering the brain's behaviour and how it handles information. No one can engage in listening to another person's step-by-step explanation, for example, of a recent holiday, without thinking about something else. We often catch ourselves losing the thread of a conversation because we are on our own thinking islands busy solving a household problem or planning an upcoming birthday party.

Our minds are wandering and cannot resist being distracted by ideas that keep popping up. You may be busy applying your mind to grasp what this chapter is about and then someone behind you say something about an umbrella that causes your mind to rocket to the umbrella. The brain gets even more distracted when it is forced to listen for a long period of time. The brain is a wandering mind.

It seems as if the brain does not think linearly in one long lane, but it takes detours and diverts in the same way as internet hyperlinks. This becomes prominent when we explore an idea. Sometimes after a while, we find it impossible to backtrack our thinking from our last or original idea. Hyperlinks enable leaps between thoughts, and may or may not happen haphazardly. These hyperlink leaps do not only happen when you are listening to another person, but also occur when you start thinking about an idea and seconds later you cannot recall how you ended up where you are. The same happens with a discussion between two people that goes out of logical control as they jump from one topic to another.

This phenomenon – that it is not possible for anyone to keep on paying attention to one thing for a period of time – has serious implications for chalk and talk teaching. Expecting from learners to make the impossible possible, namely to pay full-time attention, makes it clear why teacher-centred teachers' explanation methods do not render the expected results.

You and your brain

Over and above your senses, you have hands, a heart and a brain. All of them are to your disposal, or employed by you – consciously or unconsciously. Your heart works for you without you knowing, while you have more control over your hands. The brain is different and works in more

mysterious ways. Sometimes you talk to yourself as being your brain, when saying, “I am hungry and want to eat.” Sometimes you talk to yourself as if you are not your brain, when saying to your brain, “I wonder where my car keys are?” Your brain then responds, “Maybe in the dining room”, upon which you respond, “Let me go and look in the dining room.” When getting to the dining room, your eyes will inform you that they see the keys. You will inform your brain that your eyes detected the keys, which will put your brain at ease, and which, in turn, set you at ease.

The above example does not provide neurological information on the role and function of the brain, but provides the following valuable information to teaching and learning:

- There is something like inner speech that occurs all the time when you are awake.
- Sometimes you reveal your inner speech to other people as audible speech.
- Your brain is always available to you and ready to be employed when needed.
- You can request your senses to inform you and you can subsequently inform your brain, as in the case of finding your keys.
- When hearing a loud noise, your ears directly drop the sound into your brain, which then gives you a fright. It seems as if this shortcut from the ears to the brain only happens when you are not in control of the external environment.
- You can instruct your senses (your eyes and ears, as well as your taste, smell and tactile senses) to obtain information you need from the environment, which you provide to your brain for further processing.

From this, we can deduct that if teachers want voluntary access to learners’ brains, the route is via the learners and not via their senses. Addressing learners’ senses creates uncertainty in the brain, because the brain must rely on impulses of which the meaning is not always clear. This makes it difficult for the brain to channel and appropriately employ the information.

This necessitates a shift of the teaching compass away from addressing learners’ senses towards building relationships with the owners of the brains.

Think versus memorise

Because the brain is designed to think, we never get bored with our own thinking. We enjoy thinking things over and getting new ideas and solutions which, in turn, engage us in further thinking. Descartes (1596–1650) realised the prime function of the brain when he coined the phrase: "I think, therefore I am." He did not say, "I memorise, therefore I am", which seems to have become the credo of the current education system. In short, the brain has a preference to think, and dislikes memorising.

In the book *Developing critical thinking*, Olivier (2017:37) describes the thinking brain as follows: "The brain is a problem-solver, seeks answers to questions, and does not have natural 'copy' and 'paste' icons to replicate content from resources such as textbooks."

The brain is designed to think. To memorise subject content is its weakest faculty. This is how Alloway (2008:10) describes it in his book, *Working memory and learning*:

> *Visuo-spatial short-term memory can hold images, pictures and information about locations. If we studied a picture and then had to recall the physical characteristics and locations of the objects it contained when the picture was no longer in view, we would need to rely on visuo-spatial short-term memory. This part of working memory is in the right hemisphere, the opposite side of the brain from verbal short-term memory, and is a completely different system. Because verbal and visuo-spatial short-term memory are separate, a person who is very good at storing verbal material will not necessarily have excellent visuo-spatial storage abilities, and vice versa.*

In terms of memorising, it seems as if the brain is designed to work like a sieve that cannot securely grasp all that was observed via the senses. In other instances, it seems as if the brain has a specialised dilution ability to ensure that only a certain percentage of the information perceived can be recalled. In other cases, it seems as if learners cannot recall that a theme was memorised at all. However, on the other side of the continuum the brain has the ability to remember specific things for a very long time.

What becomes evident is that learners cannot predict which part of the studied content will be sieved out, diluted or fixed for a very long period of time. This means that a theme that was memorised can never be guaranteed to be secured in the long-term memory as the learner wants. This is enough evidence that the brain is not designed to memorise an overload of

information. This gave rise to the study method industry, which over the years did not prove itself to advance the education system.

The brain and words

When hearing someone say “chair”, one “sees” a picture of a chair in your brain and not the word “chair”. This phenomenon poses a further explanation challenge to the teacher, because the learners in the class each sees a different chair in their brains. It is impossible to have all the learners visualising the same image of a chair. When the teacher explains and some words do not make sense to learners, there are blank spaces or vacuums in their brains instead of pictures. This means that they are auditory blind for these words. This results in their picture stories being incomplete and they are not able to see the bigger picture.

When the teacher uses words to explain a sum and learners cannot generate a clear ongoing visual storyboard of the sum in their brains, they are auditory blind. The immense impact of this on the efficiency of an education system is incalculable and unimaginable, and lasts forever.

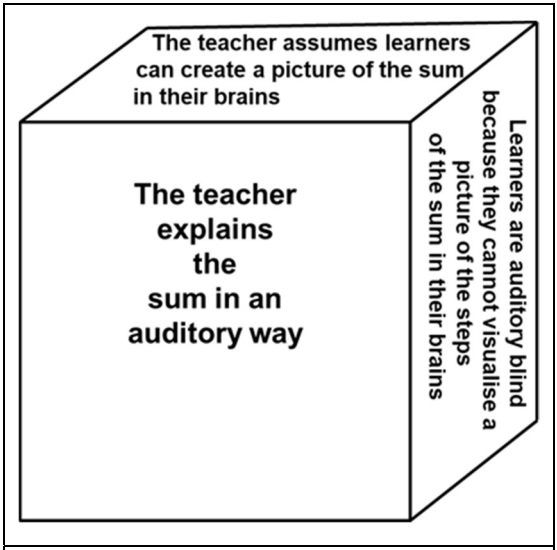

Figure 1 Illustration of auditory blindness

In the case of maths, it means that the teacher explains the story sum, but the learners cannot picture the sum, as illustrated in Figure 1. They are auditory blind for this sum, resulting in them saying that they do not understand and cannot do the sum. This applies to all subjects.

This is just the beginning of the teacher-centred explanation paradigm's problems. Problems multiply when they must explain words such as "nouns", "verbs", "adjectives" and "adverbs", which cannot be pictured. The same applies to the words "add", "subtract", "multiply" and "divide" in maths. Fortunately, there are words such as "square" and "rectangular" that can be pictured, but unfortunately they cannot save this aeroplane from crashing.

The brain and pictures

When teachers show learners an object that they know, such as a "cell phone" or a picture of a cell phone, the learners' brains' inner speech formulates the words "cell phone" to describe what was seen. These words are then audibly spoken. When the teacher shows learners a picture, diagram or graph and the picture does not make sense to them, their inner speech cannot generate words to express what is seen. When learners are shown pictures and they cannot connect meaning to the pictures, their brains do not resonate and echo inner speech words, which results in them being visually deaf. This means there is no clear storyline unfolding in the learner's brain.

The same applies when the language teacher shows learners a drawing of the relation between the past, present and future tenses and her drawings do not make sense to them – their inner speech is silent on the logic of tenses. Such learners will say that they do not understand tenses.

Visual deafness also occurs when the teacher provides learners with different types of geological maps, such as topographical and climate maps, and the maps do not make sense to them. Although they observe and see the maps, their inner speech is not able to explain the essence of the maps. The same applies to a sketch of the heart with arrows indicating the route of the blood flow. If the sketch does not sufficiently inform their brains to create an inner speech story, the learners are visually deaf.

When asking maths teachers, they will confirm that each sum they did on the board is a picture of the sum. When the learners do not see or grasp the "bigger picture" of the sum and they cannot compile their own story that

explains the logic of the plot and the dialogue of the sum, they are visually deaf.

In maths, when a learner is shown a picture of a straight line on an X- and Y-axis and the learner's brain cannot translate what is seen into words, the learner is visually deaf. The words that the learner's inner speech should formulate, if the straight line is understood, will contain elements of the equation for the straight line. The equation's mathematical auditory storyline is $y = mx + c$. Only knowing the equation is not enough, because the story contains more detail, such as the concepts "gradient", "coordinates" and "intercept". If the learner's brain does not respond with the storyline containing these words upon seeing the graph, the learner is visually deaf for the straight-line graph and does not understand the essence of the graph.

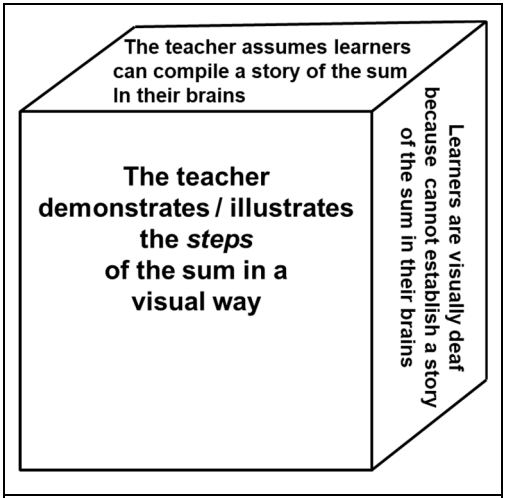

Figure 2 Illustration of visual deafness

When learners cannot create their own stories of the sum afterwards, as illustrated in Figure 2, they are visually deaf for this sum, resulting in them saying that they do not understand and cannot do the sum.

Being auditory blind during explanations and visually deaf when shown pictures spells double trouble for the learner. This clarifies why most people think maths is not only difficult, but incomprehensible.

This comes as a shock for traditional teachers, since they believe that their words become strings of sentences in the brains of learners – as close as possible to the paragraphs in the textbooks they are quoting from. They are also under the impression that when they show learners pictures, the pictures are deposited into their learners' brains as replicas of the original pictures. This is, however, not the case in practice. Without them realising it, this is what causes huge frustrations for teachers. This is why they sometimes intuitively feel as if they are talking to the desks and chairs, and not to the learners occupying them.

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