SIYAVULA EDUCATION

SIYAVULA

Passionate scientists enabling and creating innovative, technology-powered learning experiences.

"I am passionate about the way education can shape and change someone's behaviour and approach to life...
That moment a student realises he/she has applied something they thought impossible to grasp at first. "
Nadia, Educational Technologist

"I enjoy **tackling large and seemingly unsolvable problems and learning a lot in the process of solving them**. I also have fun making sweet treats to help team morale."
Heather

"I am enthusiastic about education because **it is a tranformative and empowering process. Education improves societies.** I am also keenly tuned in to maths, which is unique in its pristine elegance and provides numerous surprises."
Eric, Educational Techonologist

"As someone who is not originally from South Africa, I am passionate about **making a positive impact in this country, which has been so good to me.** I like being surrounded by people of different talents and seeing these gel together. Gina, Project Manager

"I really love the energy that comes from a group of us **collectively finding a better way to do things more effectively**."
Richard, Senior Developer

"Chemistry opens up a whole other way of seeing things, a different way of understanding the world around us. That fascinates me, and I'd like to pass on this interest in understanding the world we live in."**
Kate, Educational Technologist

"I think what I like most about Siyavula is the **deep sense of personal fulfillment that I get from working with a technological product that assists young learners**. That and the fact that every day, I feel I can be challenged to do better in some way."
Rebecca, School Accounts Manager

"I am passionate about assisting the youth from disadvantaged backgrounds reach the highest standards in education ...Making them **see obstacles as stimulants to succeed** and give back to their communities ."
Nandi, School Liaison

"I love the fact that the work I do is in some small way contributing to improving society. **I believe change has a ripple effect.**" Hannelie, School Accounts Manager

"I am fascinated by how we (as individuals and groups) think, learn, create and communicate."
Nicky, Product Manager

"I have an opportunity to make an impact on thousands of students scattered in several countries. It's a responsibility that I take seriously. "
Saymore, Educational Technologist

"I'm dead passionate about striking a balance between purely academic knowledge, practical experience and creative endeavours."
Ewald, Senior Developer

"Physics described in the language of mathematics is immensely powerful, but also beautiful. Teaching others so that they can harness the power that physics knowledge grants, as well as appreciate the intrinsic beauty of the subject is one of my greatest passions."**
Adam, Educational Technologist

"I am passionate about education and believe it should be accessible to all, no matter their circumstances and backgrounds. **I care deeply about helping people reach their full potential** and think that education is a tool for true empowerment."
Kosma, EdTech Production Coordinator

"I am fascinated and enthralled by the experience and **possibilities at which maths, science, art, design and curiosity collide."**
Megan, Instuctional Designer

"I believe that science is really about learning how to ask and answer questions about the surprising, fascinating world in which we live. I love being part of a team that tries to show scholars just how amazing the world really is."
Melanie, Educational Technologist

"My passion is to get things done. My role is mainly in the administration and financial management side of the company. I spend my days compiling financial reports for the shareholders, paying suppliers, managing budgets, banking, ensuring that everyone in the company gets paid on time, preparing for statutory audits, tax compliance and BBBEE compliance."**
Thembile, Accounting Officer

"I love being surrounded by people who challenge and push me to better myself." Cynthia, Office Manager

ABOUT US

Siyavula Education is a company with a mission to make **high quality education** as **accessible** as possible to every learner and teacher.

We believe in working with the **community** on a small and large scale, drawing on the strengths and experiences of others to make sure what we do is relevant and has a broad impact.

We believe in investing time and research into building **technology** that facilitates deep learning experiences, specifically in Mathematics and Science.

We believe in **openness**, a key principle in our philosophy that every learner and teacher should have access to high quality educational resources as a basis for long-term growth and development.

We are passionate, dynamic and each is invested in using our diverse skills and backgrounds to revolutionise the way we teach and learn.

SIYAVULA
TECHNOLOGY-POWERED LEARNING

si·ya·vu·la
/ˌseeyaˈvooˌla/

phrase
Common to the Nguni languages of Southeastern Africa

We open.
We are opening.

HISTORY

The Free High School Science Texts project begins publishing Open Educational Resources (OERs).

Off the back of the FHSST work, Siyavula is born as a fellowship project within the Shuttleworth Foundation.

With help from PSG Group Ltd and the Shuttleworth Foundation, Siyavula Education is spun out as a company.

With an investment from the Silicon Valley-based group, Siyavula becomes part of the Omidyar Network.

2002 **2007** **2012** **2014**

SHUTTLEWORTH FOUNDATION

PSG GROUP LIMITED

OMIDYAR NETWORK™

MAKING ACCESSIBLE EDUCATIONAL RESOURCES

We believe, quite simply, that everyone should have access to the basic resources that they need to achieve their education. In pursuit of making education accessible, Siyavula has produced book titles spanning Mathematics and Science subjects from Grades 4-12. These are high-quality, curriculum-aligned **Open Educational Resources**.

WHAT HAS THIS ENABLED?

- **Free access:** Learners and teachers have free access to the school textbooks they need.
- **Multiple formats for accessibility:** Content is available in print, EPUB3, on the web and importantly, on mobile phones.
- **Cost savings:** Hard copies are much cheaper to procure as there are no royalties to pay. Millions of copies of the books have been printed and distributed across South Africa.
- **Open collaboration and transparency:** Content is produced through continuous engagement with a large community of contributors and volunteers from diverse contexts and backgrounds.
- **Contextualisation of content and sharing:** Openly-licensed content is permanently unlocked for redistribution, reuse, revision and remixing by anyone to meet their specific needs.
- **Longevity of content:** Maintenance, adaptation and continuous revision of the content is more easily achievable.
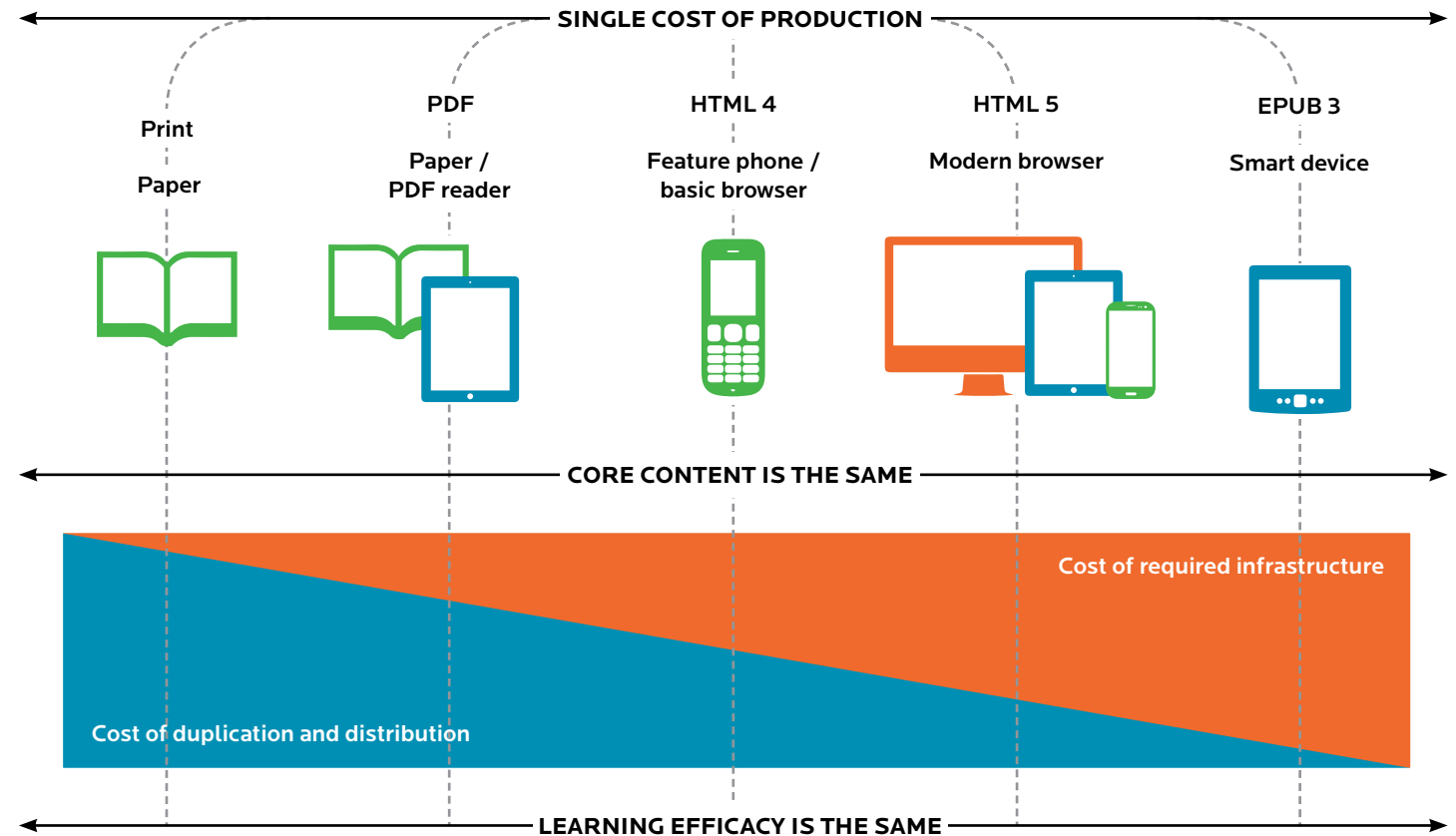
Universal Declaration of Human Rights:

"Everyone has the right to education"

Open Educational Resources

FINDING MEANINGFUL APPLICATION OF TECHNOLOGY IN EDUCATION

A school's mandate is to provide an effective learning experience. While it might be popular, it is not necessarily better to use digital content rather than paper. Effective pedagogical approaches must be developed in order to see any real beneficial use of technology in education. School budgets should focus on what enables learning experiences, not simply on books vs. devices.

SINGLE COST OF PRODUCTION

Print	PDF	HTML 4	HTML 5	EPUB 3
Paper	Paper / PDF reader	Feature phone / basic browser	Modern browser	Smart device

CORE CONTENT IS THE SAME

Cost of required infrastructure

Cost of duplication and distribution

LEARNING EFFICACY IS THE SAME

Rather than developing technology for technology's sake, Siyavula starts with the foundations of good teaching and learning and then works on developing the best supportive tools.

So, we built Siyavula Practice.

We'll unpack
- what people have to say about it;
- what it means to 'practise for mastery' and why it's a good idea;
- why Siyavula Practice is a great tool for enabling just that; and
- how it works behind the scenes, on your screen and in your classroom.

TESTIMONIALS

In the three and a half years that the company has been operational our users have completed **over five million** Mathematics and Science exercises.

"We are thankful that we came across the wonderful programme and amazing group of people that have a passion for what they do and have the teachers' and learners' best interest at heart. I am impressed with the question bank and wide variety of questions and types of questioning in the programme. The learners that used the programme on a continuous basis and worked towards a goal, did show a significant improvement in percentage from one term to another."

Rozelda Pienaar, Deputy Principal, *Prestige College*

"We find that siyavula Practice is an effective tool that not only helps the students, but supports the teacher. It helps us to differentiate between stronger and weaker students. It's a fun new way of laying strong foundations in Mathematics and Science."

Mathematics and Science Department, *Maragon Olympus*

"Maths is very important to me because it can open a lot of opportunities for me. It [Siyavula Practice] gives us a different perspective on Maths. Many people see Maths as something that is very difficult, but this system shows us that Maths is actually pretty easy. If you see it as difficult then you will struggle, but if you view it as easy then you will develop the passion for it."

Pontsho Mathuma, Learner, *Olico Youth*

"Last year, 2014, we were introduced to an online Mathematics programme called Intelligent Practice. At first I did not focus that much on my Mastery and the exercises I completed, but as time went by [...] I improved exceedingly well, not only on Siyavula Practice, but also at school. I also give myself time to practise Mathematics as I know that the more I practise the more I improve and the more opportunities I get to fulfil my dreams."

Sinenhlanhla Shezi, Learner, *Barnato Park High School and Roedean Academy*

Sineliso Sithole is a grade 10 learner from Dumabezwe Secondary, outside of Ixopo, KwaZulu-Natal. Mobile network coverage can be poor in the hilly area where he lives. To make sure his students did not run into network problems, Sineliso's teacher drove him and a few of his classmates to the top of a nearby hill so they could successfully sign up for Intelligent Practice.

In under six months, Sineliso has gone on to practise over 15 000 Mathematics and Science exercises.

He tells us he loves Siyavula Practice because his "marks have improved rapidly" and that receiving acknowledgement from Siyavula makes him feel "excited and proud of himself".

STARTING AT THE FOUNDATIONS:
What do we know about best practices for learning and developing mastery?

In addition to having access to pedagogically sound content and instruction, practice is essential to learning. This is especially true in Mathematics and the Sciences. Research, theory and experience have shown that to facilitate the most effective learning, **practising for mastery** needs to be:

1 Goal-directed, coupled with feedback

Learners need to practice "smarter, not harder". This this will depend on individual goals, strengths and weaknesses. And practice must be coupled with **targeted feedback** to promote the greatest learning gains. The sooner the feedback and the more often, the better.

2 Targeted at an appropriate level of difficulty

An appropriate level of challenge is neither too difficult nor too easy. In order for learners to progress and master the concepts they are practising, they need to remain in the **zone of optimal cognitive load**.

3 Sequenced appropriately

Not only should the sequence of exercises be specific to the level of the learner, but research has also shown that a practice session should be **interleaved** or mixed to promote long-term retention.

4 Of a sufficient quantity

Over and above targeted practice, learners need a sufficient quantity of practice for the **benefits to accumulate**. Learners underestimate the need for continued practice for mastery to develop with time.

DEVELOPING A LEARNING EXPERIENCE:
Siyavula Practice enables deeper learning through adaptive practice for mastery

We've heard it many times before: "one size does not fit all". That said, it is decidedly challenging for a teacher to manually personalise and adapt the learning experience for each child in the class according to unique needs.

Identifying relevant, regular practice that fosters the individual process of mastery development in each learner is difficult and time consuming for even the most experienced, well-resourced teacher.

This is where a sophisticated, intelligent engine can add huge value to the teaching and learning experience.

Siyavula Practice

This is technology adding real value to Mathematics and Science education to empower learners and teachers.
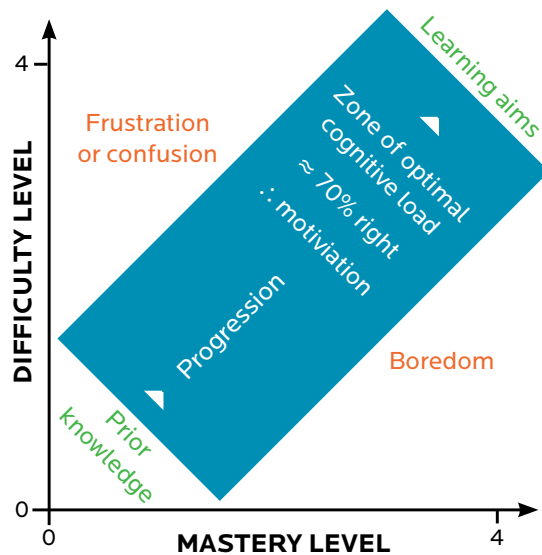
Siyavula Practice enables practice for mastery that is adapted to the **individual needs** of each learner. This **personal, unique experience** is accomplished through a machine learning algorithm underpinning the practice service.

THE INTELLIGENCE BEHIND SIYAVULA PRACTICE

Behind Siyavula Practice is a machine learning engine, adapting each practise session to the needs of an individual learner. It aims to push learners at an appropriate **level of difficulty** so that they, on average, get exercises right **70% of the time**. The more they practise, the better it is able to estimate their ability.

The algorithm makes sure their practice is neither too difficult (otherwise learners become frustrated, confused and possibly give up) nor too easy (otherwise learners become bored and are not pushed to improve).

As learners progress and master concepts, the algorithm adapts so that they move through more difficult levels. The sequencing algorithm also ensures a practice session is **interleaved** so that learners work on several skills in parallel. Both these aspects work together to ensure that learners **stay motivated** and engaged while learning.

We're also working on linking all the exercises on Siyavula Practice to *concept dependency maps* for Mathematics, Physics and Chemistry. These maps - **a hierarchy of concepts, facts, misconceptions and special cases** - plot what prior knowledge a learner would need in order to reasonably be expected to understand the concepts tested by a particular question.

Once integrated these maps will feed into the algorithm, alongside the difficulty rating of a question, to **better sequence the exercises a learner sees**.

Overlaying another map, one that dictates the order and content covered in a particular curriculum, will allow us to further tailor Siyavula Practice to suit different countries and schooling systems.
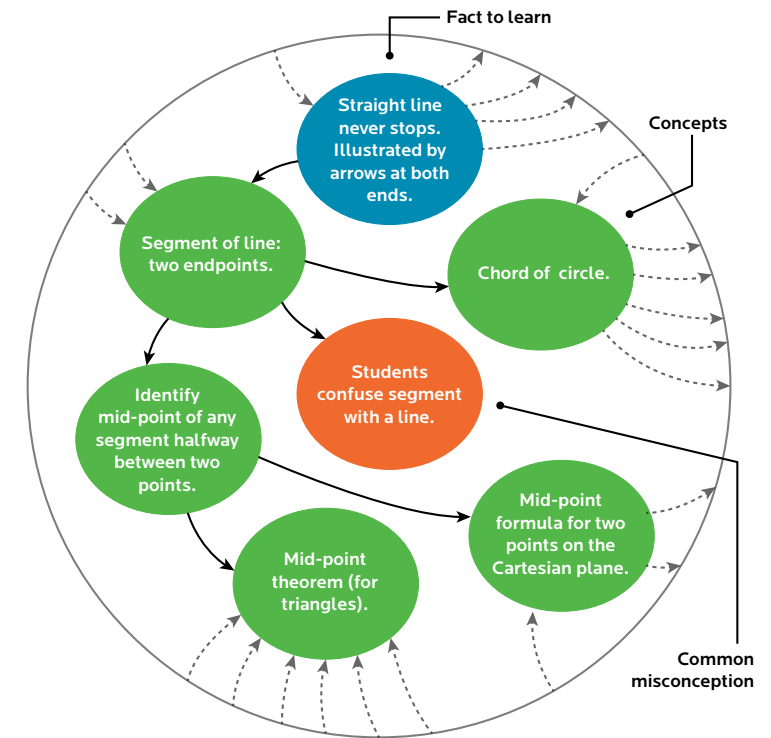
GENERATIVE ITEMS

Each exercise on the practice service is built around one or more central concepts. Its components, including images, quantities and scenarios, vary with each attempt of the question. Think of it as a computer program within a computer program, with the sole purpose of generating pedagogically sound practice items - heaps of them. Plus it'll produce a fully worked solution to match each and every question.

EXERCISE INSTANCES
Many versions of a question, generated from the same code, each with its own unique, fully worked solution.

Once set up, this code automatically generates variations on a single exercise. These often test the same concept, but each has different variables and details and requires a different answer.

XML FILE
XML is a mark-up language. It specifies how the exercise is structured.

PYTHON FILE
Python is a programming language. It controls how the exercise behaves.

THE ANATOMY OF A QUESTION

The design of questions on Siyavula Practice is rooted in sound pedagogy, expert content knowledge and skilled use of technology.

CREATED BY EXPERTS
Our in-house team of Educational Technologists includes both experienced teachers and content specialists from the fields of Physics, Chemistry and Mathematics.

We are constantly expanding our own pedagogical content knowledge to ensure we can tailor each question we create. We pay careful attention to unpacking content in a way that puts it in context and makes it meaningful and approachable, resulting in engaging exercises that promote learning.

MULTIPLE RESPONSE TYPES
The system can handle the input and marking of fractions, formulae, set notation, chemical equations, spectroscopic notation and more - all instantly. Our system's ability to accept more complex answers also means we can provide a greater range of difficulty in our questions.
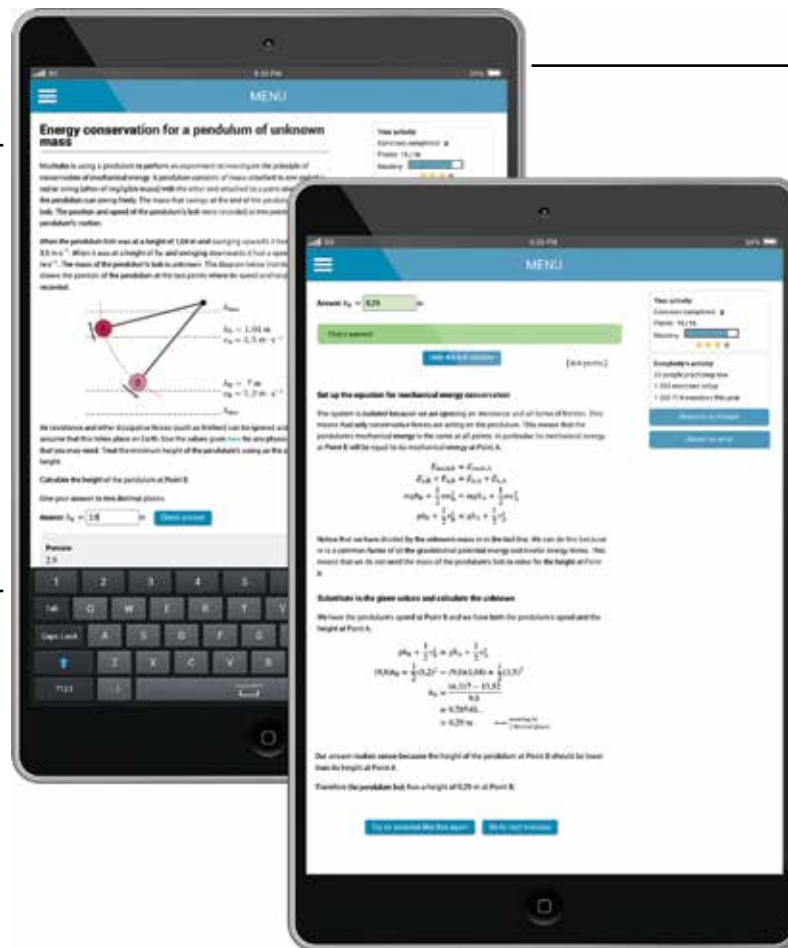
DIVERSE QUESTION APPROACHES
Rather than being limited to finite worksheets, or multiple choice questions only, we've incorporated diverse ways of approaching and asking questions, allowing us to address not only major misconceptions, but common sticking points and different reading levels too.

LIVE PERFORMANCE DATA
Feedback is crucial for reflection and learning and the sooner it's given, the better. Our exercises are automatically marked so that learners get immediate, contextual feedback. They do not have to wait until a test or exam for their marked work to be returned to learn from their mistakes.

FULLY-WORKED SOLUTIONS
The solutions contain a detailed, conceptual explanation for each step involved in solving the problem. Again we take particular care to highlight typical pitfalls.

THE LEARNER'S DASHBOARD

We all know that practising Mathematics and Science is crucial to doing well in both subjects, but it can be difficult for learners to know where to start, what to focus on or whether they're getting anywhere. In addition to getting feedback on each question they attempt, timeous **feedback on the big picture** is important too.

On Siyavula Practice a Learner's Dashboard displays **data unique to them**, giving them the overview required to answer questions like:

- What concepts have I mastered?

- What do I still need to work through?

- What are my problem areas where I should focus my revision?

- How far off am I from achieving my goals?

- What should I work on today?
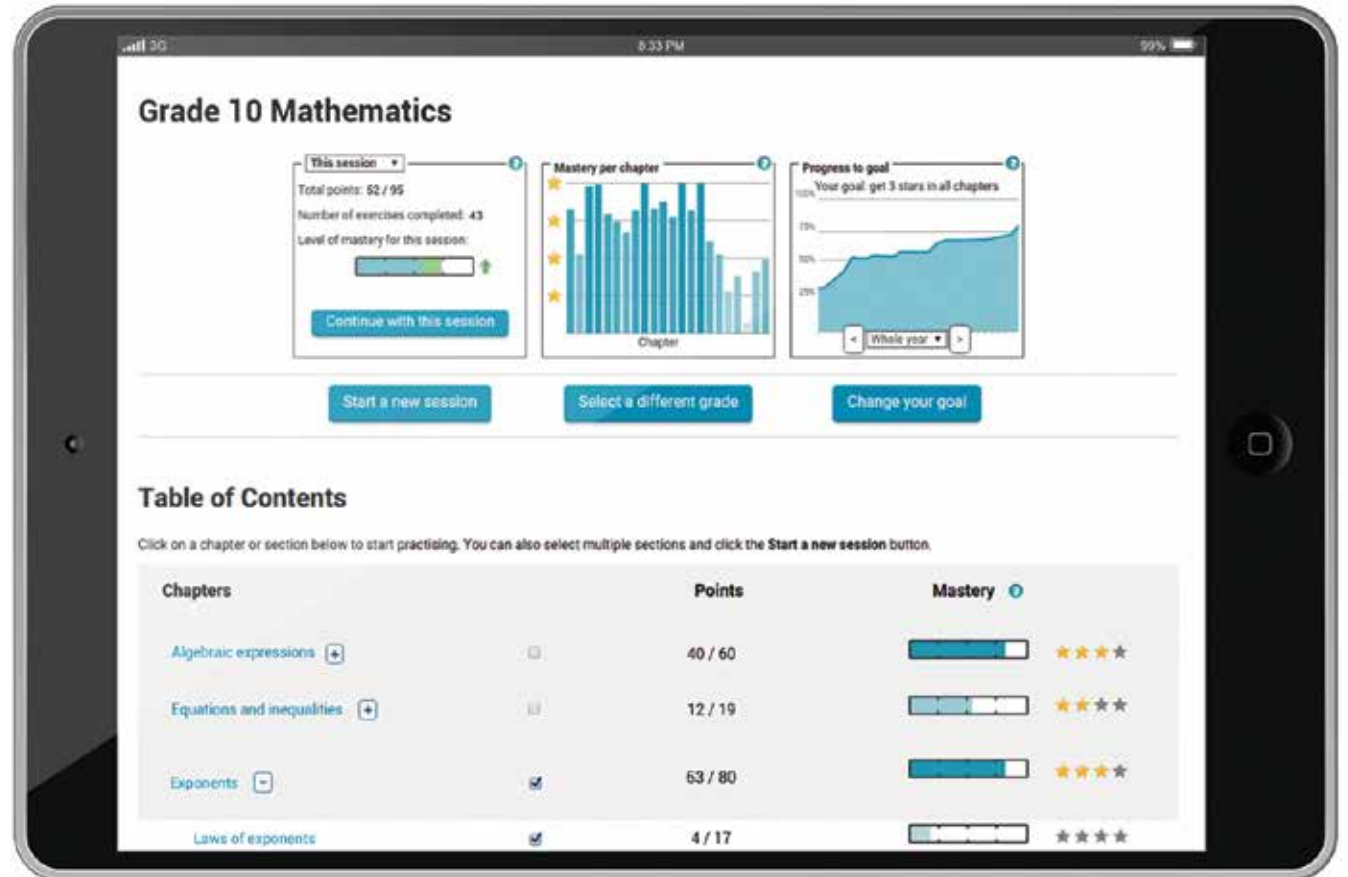
THE TEACHER'S DASHBOARD

The science and art of data analysis and making data-driven decisions is becoming prevalent in our society. Cultivating these skills as a teacher will make feedback, reporting and teaching practice even more reflective and effective.

The Teacher's Dashboard provides key insights into learner and class capabilities. Teaching is augmented by addressing important learning subtexts:

- How much effort have my learners put in?

- What concepts have they mastered?

- Are my learners working fast enough?

- Which learners are struggling?

- Which exercises and concepts are most problematic?

- What do I need to revise with my class?

- Where should I intervene?

- What can I report back to my learners and their parents?
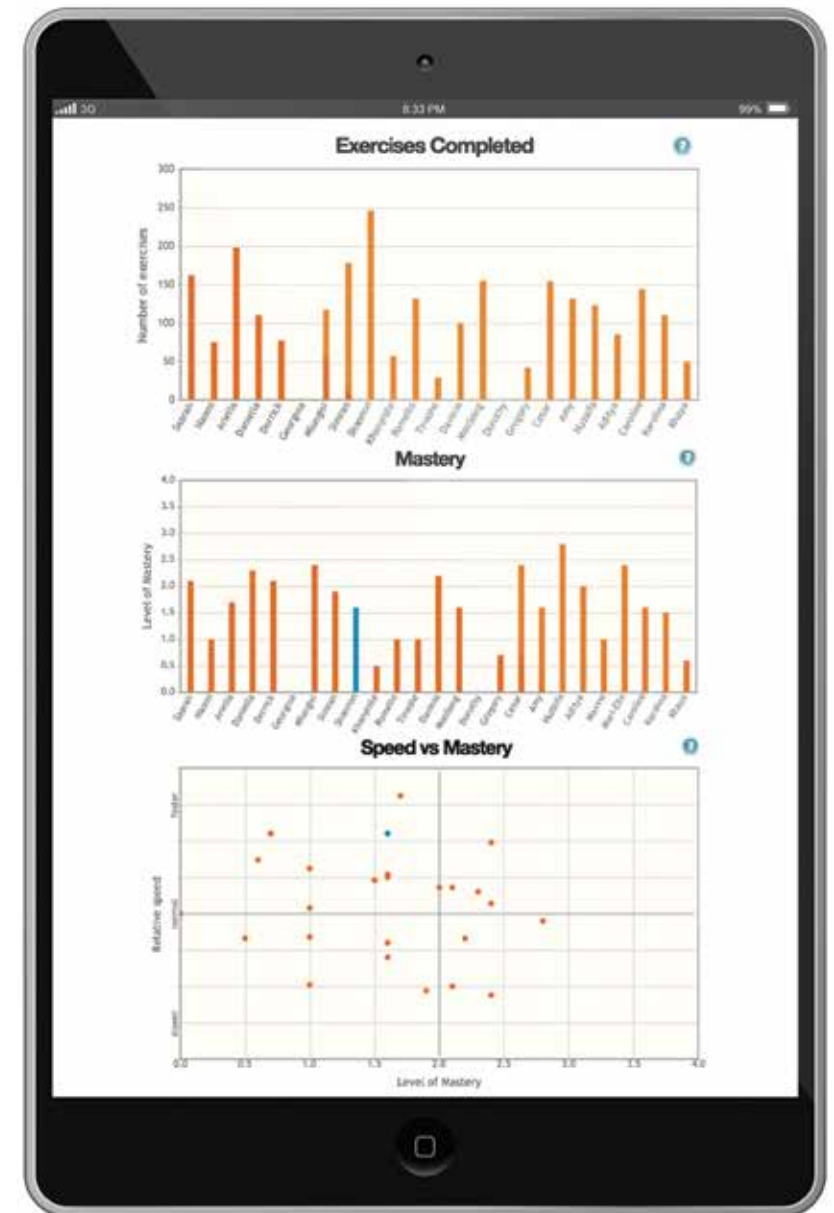
HOW CAN TEACHERS EFFECTIVELY USE SIYAVULA PRACTICE?

There are many ways in which a teacher can use Siyavula Practice to supplement, augment and improve their own teaching practice, depending on their preferences, their school and classroom context and their learners' needs and capabilities. Here are 6 ways that Siyavula has advocated for teachers to implement Siyavula Practice.

|	USE CASE	WHAT IS THE MAIN FOCUS?	WHEN AND WHERE WOULD THE SERVICE BE USED?	WHAT PART OF THE LEARNING PROCESS DOES IT FACILITATE?	EACH LEARNER NEEDS ACCESS TO A DEVICE?
1	**Regular, goal-directed practice**	*Individualised practice* to promote the greatest learning gains whilst aiming for the goal the teacher has set	Out of class or at home	Homework practice	Yes
2	**Active learning during class**	*Learning by doing* at the appropriate level of difficulty for deeper engagement during class	In class	Immediate application of skills and concepts	Yes
3	**Continued revision for accumulated benefits**	*Adaptive revision* that is of a *sufficient quantity* for the benefits of practice to accumulate with time	Out of class or at home	Appropriately spaced revision for long-term retention	Yes
4	**Revision session during class**	Effective use of valuable class time to address *common problem areas*	In class	Focused consolidation and revision	No
5	**Collaborative and peer-to-peer learning**	Implementing *social learning strategies* with the use of technology	In class and out of class	Group learning and problem solving	No
6	**Monitoring and reporting**	Using the *data analysis* to make insightful decisions and adjustments to teaching practice and adding depth to reporting	By teachers during class, in their own time and during meetings	Reflection and feedback	N/A

ANALYSIS AND DATA-DRIVEN MANAGEMENT

The Learner and Teacher dashboards on Siyavula Practice display data insights on a small scale. Zooming out a bit we can also visualise and interpret the data we collect for a whole school, province or country.

siyavula Practice acts as a large-scale monitoring system to help answer questions such as:

• How and at what rate are learners progressing through the curriculum?

• What is the aggregated level of effort for learners in a particular school/area/province?

• What is the current level of mastery of learners in a school/district/province/the country?

• When and how are learners practising throughout the day? What does this tell us about access to technology in these contexts?

• What are the most common problem areas and do these vary with different contexts?

• Can we identify classes/schools/districts where intervention is most needed based on their current performance?
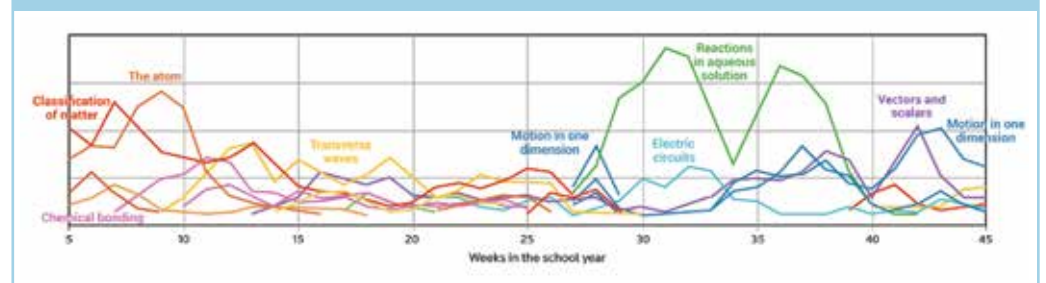
Mathematics practice activity over time
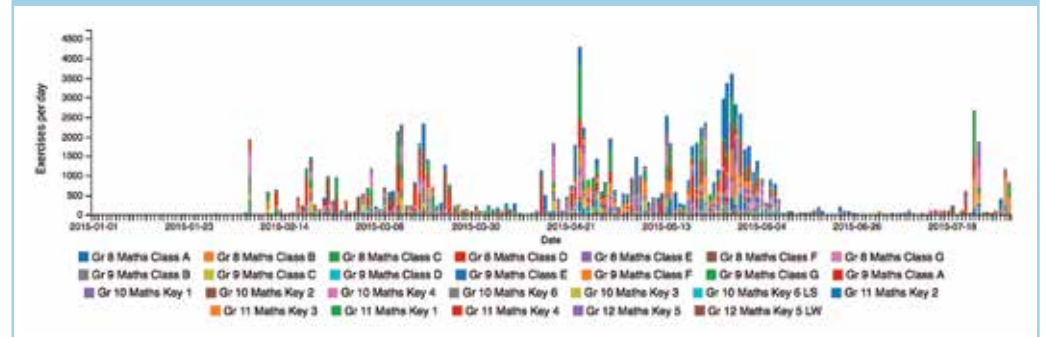
Practice activity by time of day and day of week
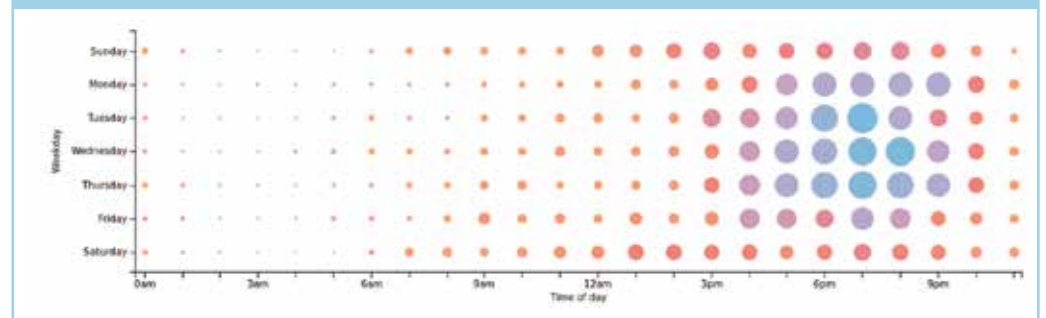
Weekly readership patterns, showing engagement with a Grade 10 Science curriculum

MAXIMISING TECHNOLOGICAL REACH

We build sophisticated tools and programs, but make sure they remain device independent and embrace open standards to maximise reach.

Software as a Service

- Access from anywhere, on any web-enabled device
- Automatic upgrades and continuous addition of new templates and features without installation headaches
- Automated backups
- Issues responded to by our team
- No servers required

Open web standards

- Maximum device support
- Future-proof solutions
- Avoid risk of platforms dying like Flash or Adobe Air
- Maximises our access to innovation
- Support everything from a feature phone, to a smart device, to a PC
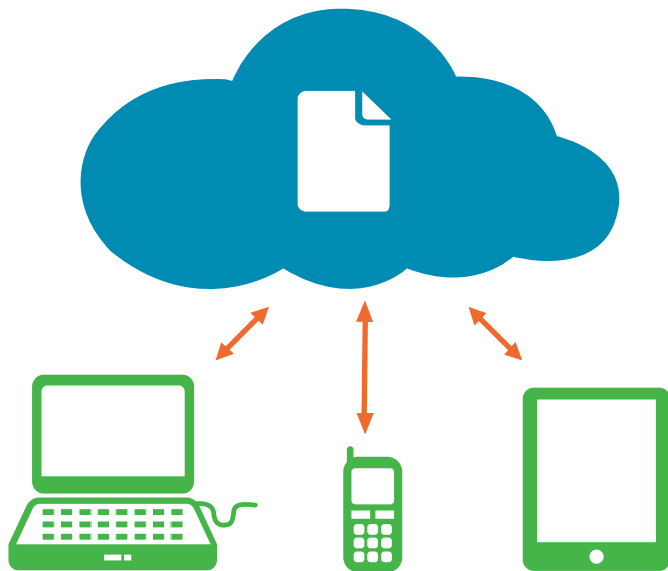
Getting around poor internet infrastructure

While access to computers may sometimes be limited, mobile phone penetration in Africa is high and provides the continent's primary access to the web. We pay careful attention to making sure our book content and Siyavula Practice can be accessed from even the most basic internet-enabled cellphone.

Some schools are able to make newer devices available to their learners, but still struggle with limited internet access. For these cases we are piloting having instances of the software running on virtual machines on school servers and syncing these periodically with our own servers - a process that requires much less data transfer than users practising on the live site. This ensures that any practice, whether done at home or at school, is still stored centrally and up to date.

SOCIAL IMPACT

The value and impact of Mathematics and Science education extends far beyond the classroom walls. Critical and analytical thinking, creativity and exploration, problem solving and collaboration - these are the skills needed to support careers from technology development to astronomy, from data science to finance, from engineering to economics. These are the skills we need for innovation, growth and change.

With this in mind, Siyavula has a social mission.

Each individual should have access to the resources and support they need to achieve the education they deserve.

Ensuring that Siyavula Practice is accessible does not only mean producing a quality learning experience at an affordable price. It also means leveraging the affordances of technology and the insights of cognitive science to reduce the inequality in our education system.

As a South African company, we find evidence of these challenges and disparities very close to home, with our country producing some of the lowest results in international educational assessments and rankings.

We are working to change this.

1. By catering for feature phones, therefore maximising device coverage, we can serve users from lower socio-economic brackets.
2. Working closely with sponsors to further our reach to low-income or marginalised communities has always been part of what we do. In fact, most of our school users are from poor, rural schools.
3. We have also set up a low-cost tutoring franchise that uses our adaptive practice service to improve the quality of tutoring available in townships. This initative also helps create job opportunities.

PARTNERS

Investors

OMIDYAR NETWORK™

PSG GROUP LIMITED

SHUTTLEWORTH FOUNDATION

Sponsorship partners

sasol inzalo foundation

sasol reaching new frontiers

MMI HOLDINGS

OLDMUTUAL

vodacom

Ventures

Brighter Futures TUITION

We're eager to grow and add to these successful partnerships and continue making a positive impact on education.

Licensing our software
Tap into what we do

We developed a number of assets that are needed to deliver adaptive practice for mastery, which includes a large set of generative and self marking question items, detailed concept-dependency maps and an adaptive sequencing algorithm.

These assets are packaged as building blocks for licensing by publishers, adaptive learning providers, adaptive platforms or academic institutions and integration into client platforms.

Standalone Question Item Service (QIS)

This service allows a client to request question items according to criteria, such as the concept being tested and desired level of difficulty. The service automatically generates the question and its full model solution, delivers it to the client platform, marks the answer and returns the result to the client platform.

This option is ideal for existing platforms or products that already handle the adaptive sequencing of questions, calculation and reporting of learner mastery, but seek access to high quality question items with sophisticated response types.

QIS + Concept-Dependency Maps (CDM)

By adding our detailed, curriculum-agnostic, concept-dependency maps to the Question Item Service, we can use the responses submitted by authenticated users to calculate and report their mastery for all concepts and topics.

This is ideal for producing mastery dashboards or adding recommendations, both remedial and advancement, to existing platforms and products.

Adaptive Sequencing Engine

This complete solution generates the question items, calculates the mastery of each user for each topic and adapts the sequence of questions presented to each user based on their practice history.

This is ideal for clients seeking to add a complete practice for mastery solution to their platform or offering.

Other services - We also work with clients to develop new or custom question items and topic maps needed for curricula or areas that are not yet covered by us.