KONICA MINOLTA

Giving Shape to Ideas

THE EDUCATORS 8 STEP GUIDE

TO IMPLEMENTING 3D PRINTING IN AUSTRALIAN CLASSROOMS

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Ahead of the class

Industries everywhere are transforming. They need educated and inspired workers with STEM skills to help them break new ground in engineering, design, healthcare and manufacturing.

PWC's modelling indicates that switching just one percent of the workforce into STEM streams would add $57 billion to the Australian economy over 20 years. Yet Australia is underachieving in STEM education.

3D printing can help. With 3D printing teachers can communicate difficult concepts, spark creativity, promote lateral thinking and deliver new experiences in STEM subjects.

But results from the introduction of 3D printing into Australian classrooms have been mixed.

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Guidance and support

Success with 3D printing requires a comprehensive 3D printing ecosystem, not just a 3D printer. It needs the right software, materials, infrastructure, service, support, knowledge and training.

To meet this need we are pleased to share this guide to implementing a comprehensive and customised 3D printing ecosystem; one that will help you nurture the next-generation of career-ready designers, innovators, and digital educators, and prepare them to take advantage of the world of tomorrow.

Resources: https://www.digitalpulse.pwc.com.au/australian-business-stem-education/

STEP 1

WHY 3D PRINTING?

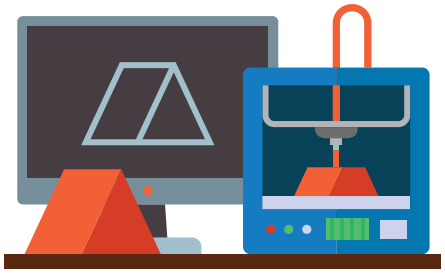
New technologies come along at a dizzying pace, and it is unrealistic to expect schools to take up every tech and incorporate it into the curriculum, but 3D printing is different.

Unleash student creativity

With 3D printing students can express their creativity in the making of real objects that have practical applications.

Prepare for the future

There's no doubt that 3D printing will play a major role in many industries in the near future: from the creation of made-to-measure surgical prosthetics to the on-demand production of replacement machine parts and much, much more. Demand for professionals with 3D printing skills will be significant.



Engage reluctant learners

3D printing is unlike anything students have seen before, and the results are tangible. Even the most unenthusiastic students are bound to be excited by its potential.

Produce practical results

School students have used 3D printing to produce objects with practical applications, solving real-world problems. For example, primary school students in South Australia created custom bag tags to avoid mix-ups. In Brisbane, students used 3D printing to incorporate design thinking into their curriculum and create a competition to design a school USB.

Bring STEM to life

Science, technology, engineering and maths subjects can often be abstract, particularly the new disciplines of information technology. 3D printing lets students realise their STEM skills through practical applications.

GROWING TRENDS

- 60% of schools already have 3D printers.
- 55% of schools are using 3D printers in STEM teaching.
- 3D printing is increasingly being used at all stages of education, from elementary onwards.

**According to a 2016 survey undertaken by YSoft*

STEP 2

3D PRINTING IN THE CLASSROOM

3D Printing can bring to life subjects across the board not just in STEM subjects. Think about how your students could benefit in a wide range of subjects. Here's just a few examples.

3D PRINTING:
INSPIRING EDUCATION

Geography

For geography, using 3D printed models of oxbow lakes and volcanoes all help students better understand the world around them.

Engineering

Engineering students can print their own designs. By interacting and testing them they can amend and optimize their designs.

Mathematics

Printing geometric patterns can help engage and hold your students' attention. This is very useful for complex subjects such as mathematics.

Historic artifacts

Students can analyze historic artects in their own hands rather than viewing them through a museum display case.

Biology

3D printed models allow students to inspect cross-sections of organs to better understand biology.

Chemistry and physics

For students studying chemistry and physics, printing and studying items such as molecules can help them grasp complex subjects.

Music

Students can print their own instruments and understand how changing the size or position of a hole can affect the sound produced.

Literature

3D printing can bring a book to life, particularly helpful for students studying classic literature. They can print a landscape from Tolkien or the vial from Romeo & Juliet.

Sports and biology

Teachers can coordinate lessons bringing together subjects such as sports and biology. This can help students better understand how our body reacts to different sports.

Art

3D printing their own, unique designs can enhance an art student's experience.

STEP 3

FIND YOUR PERFECT **3D PRINTING SOLUTION**

This is perhaps the most critical step in the whole process: the right choice will make 3D printing easy to use, safe and economical, and highly manageable. The wrong choice could lead to frustrated and disillusioned students and create a management issues.

HERE ARE THE KEY **THINGS YOU NEED TO CONSIDER** WHEN LOOKING AT 3D PRINTERS

Output

3D printers come in a range of shapes and it's essential to choose a reliable devices with high quality output for use in schools.

Depending on your requirements, we recommend three technologies:

- Material Extrusion Printing (Plastic spool based)
- ColourJet Printing (Powder based)
- MultiJet Printing (Liquid based)

Find out more

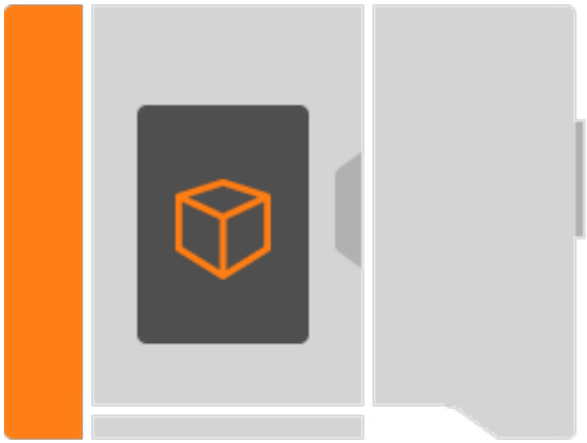
Safety

A 3D printer with an enclosed print chamber is a must in schools. It will protect students from heat and moving parts.

All our recommended 3D printers for schools use hazard-free and environmentally friendly build materials.

Security

For greatest security choose a 3D printer that is lockable and that can be accessed via password. That way students' work in progress will be secure, unauthorized use will be preventable and usage trackable.



Easy to manage Infrastructure

Make sure you choose 3D printers that support a comprehensive print management software application so you can track costs and usage.

Choosing a 3D printer that supports a pay-for-printing option will allow you to adopt a user pays policy, charging individuals or departments for usage. A centralised infrastructure that coordinates a variety of user groups through an existing network can make managing 3D printing easier.

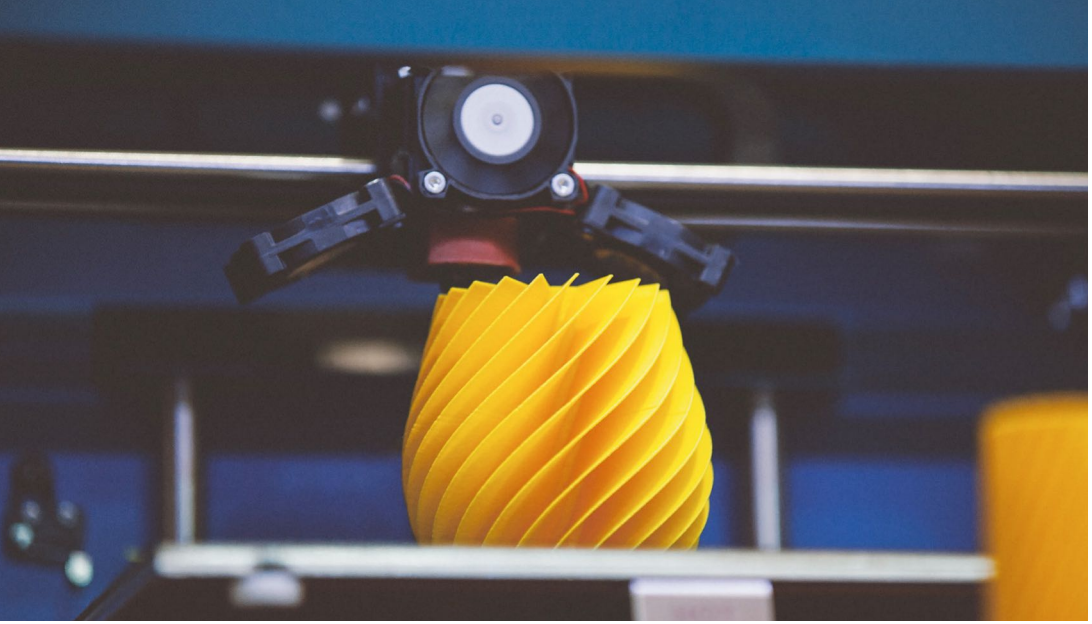
Usability

User interfaces are critical to today's complex electronic devices: your 3D printers' UI should be intuitive enabling students and staff to make the most of them, without needing extensive training or close supervision. What's more, devices can notify users of completed jobs, meaning less need to check on jobs.

STEP 4

CREATING **YOUR MAKER SPACE**

The location and design of your makerspace determines how you can effectively manage your 3D Printing infrastructure to make the most of your investment.



Make printers safe, secure and easily accessible

Location is key for the successful adoption of 3D printing. Staff and students should be able to access your 3D printers easily as part of their normal day-to-day activity.

The ideal location for your 3D printers should be an easy-to-access area where they will not disturb classes, but that is accessible to ongoing classes.

However 3D printers also need to be secure: to keep students safe from high temperatures and moving parts, and to ensure that student projects are not taken, or that printing is not stopped by other students.

Plan how you will utilise the space to train users and ensure you have the right amount for larger groups, an inspiring collaborative environment and back that up with expert advice from an established provider. You should aim to create a facility for all ages and expertise.

How many 3D Printers?

Determining how many printers you need can be difficult. The quantity of printers needed will depend on the technology you choose and how you integrate the device into your teaching.

Remember that printing an object can occupy a 3D printer for several hours. So if the 3D printers are to be used across subject, consider whether you will need to use many at the same time.

Provide good design software

CAD software is essential. Consider using online templates, guides and resources to help users develop their 3D printing skills. Also encourage students to share resources they have found useful.

You'll find some suggestions for CAD software ranging from simple, free products to those used by professionals on page 17.

Manage costs, track usage

Research shows that nearly 90 percent of schools with printers restrict student access because they have trouble managing costs. A pay-for-print feature enables you to recover costs by charging users or departments for their 3D printing. It will also make your users more cost-conscious.

Key to tracking usage and managing costs is good print management software. If material extrusion 3D printing is right for your school, the Ysoft 3D eDee provides exactly this.

If you opt for another technology, keep in mind how you will keep on top of tracking usage. Konica Minolta can help with refilling consumables and servicing your product to alleviate downtime.

STEP 5

CONSIDERING **COSTS**

There are three cost drivers of 3D printing

- Initial capital cost of the equipment
- Support and maintenance
- Consumables and spare parts

Cost Considerations

You can buy a 3D printer for only a few hundred dollars but it won't have the functions and features needed in an educational environment.

For a robust machine that will deal with the wear and tear of regular use by students and faculty and is capable of printing with better output quality that delivers greater educational outcomes, the cost can be higher.

The technology that best suits your 3D printing plans will have the biggest impact on price. When deciding this, it's best to speak to an expert in the field.

Maintenance

There's no hard and fast rules here: the more machines you have the lower the per machine cost is likely to be; the more your machines are used the more support will cost.

With Konica Minolta, you are assured of Australia's most comprehensive 3D printing support and service network, providing excellent response times in metro areas.

Consumables

In the case of 3D printing the consumable is the material used to produce the printed object. For all 3D printers likely to be used in schools it comes in the form of a spool of material a few millimetres in diameter called a filament. Costs vary greatly depending on the material type, quality weight, colour and diameter.

If consumable cost management is important to you, then make sure you choose a 3D printer that will tell you how much consumable filament is being used, so you can keep track of costs.

Managing Costs

If it's important to tightly manage and allocate costs, make sure your chosen 3D printers support print management software. This will enable you to provide secure access to students (and faculty), track and report usage and costs and offer pay-to-print services.

This will become more important as you add more and more 3D printers and at some point you might want a print management system that works across your entire fleet of printers: 3D and paper printers and photocopiers.

STEP 6

BUILDING **THE CASE** FOR 3D PRINTING

Once you have an idea of what it will cost to deploy and use 3D printing in your institution, you'll have to convince those who control the purse strings. This means building a business case: providing estimates of costs that will withstand scrutiny, and setting out the benefits to justify those costs.

Gather the supporting information

Time to do your homework! Pull together benefits to support your case. Research from those in the know and examples of similar schools that have befitted from the technology can be compelling.

In November 2016, Y Soft commissioned independent research company, Dimensional Research, to conduct a survey to better understand how 3D printers are being used by educators in the classroom. You can download the full report and use its findings in support of your business case.

You can also find plenty of information on the web to support your argument for introducing 3D printing into your curriculum.

For example, the proposed educational framework produced by the Laboratory School for Advanced Manufacturing Technologies in Virginia says allowing students to realise their ideas in a solid form provides vital motivation and simultaneously imparts skills such as "numeracy, collaboration, and problem solving."

Case studies of how other institutions have used 3D printing are a great source of material to support your business case. Technical School Prosek in the Czech Republic was a pioneer of 3D printing in education, introducing it to its senior class in 2010. A case study on its use of 3D printing will help you build your business case.

For an Australian example, you can see how Marist College Ashgrove in QLD installed a different technology to great effect

Address concerns

To get your business case up you'll also need to be prepared to address general concerns about the practicality of using 3D printing in an educational environment. These concerns are likely to include:

Security of printers: It can take quite a while to print a 3D object. You will need to be able to demonstrate that an unattended printer can be secured to prevent interruption or theft of its printed object.

Health and Safety : 3D printers have lots of moving parts and get hot; the material used to create the printed object his heated to above 200 degrees Celsius. Policies and practices to prevent injury will be essential.

How many 3D printers?

Of course your business case will have to include details of how exactly you plan to incorporate 3D printing in the curriculum, which will lead on the question of how many you need.

The quantity of printers needed to achieve your 3D printing goals varies by technology, so consulting an expert could help at this point.

The timeline

Your stakeholders will want to know when to expect a return on their investment in 3D printing.

In education this won't be in dollars unless you plan to offer a fee-based courses in 3D printing, but they will expect tangible outcomes from any funding provided.

So your business case will need to include a realistic timeframe to achieve this. Your timeline and plan should feature significant milestones along the way.

MILESTONES

- Research options and understand requirements
- Construct plan / proposal
- Prepare installation environment
- Secure / order 3D printer
- Install 3D printing solution
- Undertake training
- Integrate with Curriculum
- Share 3D printing success

STEP 7

BUILD THE **FOUNDATION SKILL SET** FOR 3D PRINTING

Technology is nothing without the creative, skilled and knowledgeable people powering it. Ensure your organisation has the right mix of tools and knowledge right from the start.

CAD software essential

A well-designed 3D printer is easy to use with minimal training. The real skills are in the use of computer aided design (CAD) software that students use to realise their creativity and from which the 3D printer prints the objects they have designed.

Schools and universities that already use CAD software require minimal additional skills and training to add 3D printing. For others, there are now several free and low cost entry-level, easy-to-use CAD software applications available.

Here's a sample of free and paid-for CAD software.

Note: Konica Minolta acknowledges these third party 3D printing related software aid the use of 3D Printing in the Education environment, and does not recommend any particular listed product. Speak with your local authorised reseller of these third party products.

Tinkercad

A free tool that is popular because it is simple to use and provides bite-sized lessons and designs from the community that you can download. It takes as little as an hour to complete a lesson and develop your 3D printing skills.

Sketchup

A paid-for tool that offers designs, tools and tutorials for beginners, intermediates and experts. Education specific resources are also available and you can also find engineering and architecture tools and designs for technical students.

AutoCAD by Autodesk

The go-to tool for schools and students. It is offered as a free trial and with special pricing offers post-trial. It has a wealth of tools and projects and is the perfect progression, once you have outgrown free tools.

Fusion360

An online tool created by Autodesk that is becoming increasingly popular with schools thanks to its simplicity and access anywhere, anytime licensing.

SolidWorks

A purchasable resource used by many technical schools. It offers a wealth of tools and resources for the experienced 3D designer, including white papers and webinars.

Vectory

A tool that allows you to customise thousands of 3D designs. It offers a free trial and is a natural progression from Tinkercad.

Find your champions

There's no need to work alone. Engage others to help you drive the project!

An often successful approach is to identify people with a passion for new technology, give them training then use them to run workshops with small groups of students to raise awareness of 3D printing across your student population.

Let peers do the training

Peer-to-peer training enables users to share their own experiences with 3D printing. This can save on the costs of external trainers enabling you to invest in advanced training for 'super users' who can boost the expertise of other staff and students.

Get expert help

Konica Minolta will happily assist in training you, your staff and even students in getting the most out of your new 3D Printers.

Training on our 3D technologies is conducted by a member of expert Solutions Training team, holding a nationally recognised qualification.

All training is done on site and can be as quick a four 1-hour sessions (metro only) or a half day workshop.

Ysoft Be3d eDEE training is offered to administrators and end users. Course content is specific to the group being trained.

To find out more, contact us via our website or call on 1800 789 389 today.

STEP 8

GET EVERYONE INVOLVED – **INCORPORATING 3D PRINTING INTO YOUR TEACHING**

Education is about the real world. The real world is full of 3D objects. Almost any 3D object can be replicated with 3D printing, so no matter what the subject, 3D printing can help bring it to life by enabling students to create objects that can enhance their learning.

Learning by doing

People learn by doing. With 3D printing students can be actively involved in the entire learning process: from the initial idea through design, to the final 3D printed object.

Deeper engagement

3D printing brings a lesson to life and helps hold students' interest. Increased engagement improves student participation and information retention. Engaged students motivate teachers and motivated teachers are better teachers.

Think beyond STEM

3D printing is becoming increasingly popular for teaching STEM subjects. However it can enhance the educational experience across the entire curriculum, bringing a diverse range of subjects to life and improving student engagement.

So don't just focus on STEM subjects, 3D printing opens new opportunities in many others. Here are just a few examples.

Engineering: 3D printing enables students to realise, test and revise designs of all kinds, something that was, in the past prohibitively expensive. They can also produce real-world solutions to real-world problems. Two US high school students 3D printed their idea for a drip-free ice cream cone, became the youngest applicants ever to pitch their idea on Shark Tank without adult accompaniment, and scored a $US50,000 investment.

History: Students can create replicas of historic artefacts they might have almost no chance of seeing in reality, let alone touching.

Music: Students can make their own simple musical instruments, investigate and understand how notes produced are determined by physical dimensions. For example, they could produce a series of simple 'tin whistles' with holes in different places that would play in different keys.

Chemistry and physics: Students can create the invisible at macro scale, making models of molecules or atoms to better understand their structure, and how different molecules combine to create new compounds.

Biology: Students can create models of organs and bones to better understand how bodies work, and giant replicas of the smallest insects, to learn how they move, feed and protect themselves.

Literature: Students can exercise their imagination and deepen their engagement with the great works of literature by translating descriptions of objects into 3D printed replicas. What might Macbeth's dagger have looked like? Or the vial of poison with which Romeo ends his life?

Mathematics: Students can realise the mathematical equations defining 2D patterns and 3D objects in solid form, deepening their understanding of the relationship between mathematics and the real world.

Broadcast your achievements

Don't let your students hide their 3D talents: showcase the best projects across disciplines and age groups to inspire others, encouraging them to develop their creativity and 3D printing skills.

3D printing has countless possibilities in many industries and areas of life. 3D-printed items will increasingly be used to make items for all purposes...Only time will tell where this technology will take us."

- Da Vinci Institute

We hope this guide has given you valuable insights into 3D printing and the incredible potential it can unlock in your classroom.

You should now feel confident to begin:

- Assessing the right 3D printer for your teaching needs
- Indentifying how and where 3D printing can enhance your current curriculum
- Begin preparing a business case for 3D printing

Konica Minolta is Australia's leading provider of 3D printing solutions, with the most comprehensive range of advanced 3DP technology, all backed by our global logistics, installation and service support infrastructure, essential for the educators of tomorrow and the builders, designers and innovators of the future.

Contact us today, and start giving shape to your students ideas.

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3D printing has moved well beyond prototyping to become prevalent within and across multiple industries. Even though there are amazing innovations nearly every day in the way 3D printers are used in key industries, including automotive, aerospace, and medical, we believe that we're still just scratching the surface of the potential for 3D printing …

- IDC (IT industry market research company)

To find out more,
contact us via our website
or call on 1800 789 389 today.

Thank you to Y Soft for supplying content used in this publication.

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