The 3D Printing Technologies
Primary School Excellence Framework

Overview

More and more schools are recognising the value of 3D printing technologies in developing students' digital skills and skills for future careers. Many schools are investing in 3D printing technology and although there are now lots of examples of good practice and anecdotal evidence of the impact the technology is having, currently there is no research data to evidence the impact of 3D printing technologies in schools.

The 3D Excellence Framework is designed as a school self-assessment tool to facilitate the successful adoption and implementation of 3D printing technologies. It supports a school in identifying where it currently sits in its 3D development journey and where it needs to go next. It is also intended to provide a research tool to gather nationwide data on the adoption and the impact of the technology in schools.

The framework consists of five development strands covering the application of 3D technologies in school and key 3D competencies.

Application of 3D Technologies

- Staff Development and Awareness
- Curriculum Application
- 3D Skills Progression

Key 3D Competencies

- Additive Manufacturing and 3D Printing Processes
- 3D Modelling (CAD) and Slicing Models

Each of these strands contain a series of scored levelled descriptors allowing individual schools to assess if they are a 3D Emerging, 3D Developing or 3D Confident School. This allows schools to comprehensively review their application of the technology through the school and the knowledge and skills of their staff. The framework will highlight areas for development and help schools to understand what they need to do to progress towards excellence in 3D printing technologies and maximise the impact of their investment in the technology.

Application of 3D Technologies

Staff Development & Awareness		
3D Emerging School	**3D Developing School**	**3D Confident School**
Lead staff member development 1 lead member of staff has been formally trained in 3D printing (CREATE Education Bronze 3D Educator Certification Level or equivalent).	1 lead member of staff has developed their practice to create, teach and evaluate a 3D printing project (CREATE Education Silver 3D Practitioner Certification Level or equivalent).	1 lead member of staff is a subject expert and mentor with succession planning evident (CREATE Education Gold 3D Master Certification Level or equivalent).
Additional staff member development 1 additional member of staff has also been formally trained in 3D printing (CREATE Education 3D Educator Certification Level or equivalent).	2 additional members of staff are confident users of the technology (equivalent to CREATE Education Bronze or Silver Certification level).	3 additional members of staff are confident users of the technology (equivalent to CREATE Education Bronze or Silver Certification level).
Whole school staff development The school has a plan in place for internally developing and training staff in at least one subject area (e.g. D&T or Computing) at KS2 in the use of 3D printing in that curriculum area.	The school internally develops and trains staff in at least one subject area (e.g. D&T or Computing) at KS1 and KS2 in the use of 3D printing in that curriculum area.	The school internally develops and trains staff across multiple subject areas in EYFS, KS1 and KS2 in the opportunities and use of 3D printing across the curriculum.
Staff technical 3D printing expertise 1 member of staff can use the 3D printer and is aware of how to access support in troubleshooting and maintenance.	2 or more members of staff can use the 3D printer and 1 member of staff is confident in basic troubleshooting and maintenance.	Multiple members of staff can confidently use the 3D printer and 1 member of staff is highly proficient in 3D printing troubleshooting and maintenance with succession planning evident.
Community engagement and awareness The school has plans in place to promote the use of 3D printing technologies in the wider community. E.g. parental engagement or staff development in other Primary schools in the cluster/network/trust.	The school has promoted the use of 3D printing technologies in the wider community on at least one occasion. E.g. parental engagement AND staff development in other Primary schools in the cluster/network/trust.	The school actively promotes the use of 3D printing technologies in the wider community on multiple occasions throughout the school year. E.g. parental engagement AND staff development in other Primary schools in the cluster/network/trust.

Curriculum Application		
3D Emerging School	**3D Developing School**	**3D Confident School**
Learner experience Learners experience at least one activity during defined curriculum time in Upper KS2 where they can develop their 3D modelling skills and see their designs 3D printed.	Learners experience at least two complete projects during defined curriculum time (Lower KS2 and Upper KS2) where they can develop their 3D modelling skills and see their designs 3D printed.	Learners experience at least three complete projects across during defined curriculum time (KS1, Lower KS2 and Upper KS2) where they can develop their 3D modelling skills and see their designs 3D printed.
Cross-curricular opportunities 3D printing is used in at least one curriculum subject area such as Design & Technology **or** Computing, and/or for cross-curricular projects.	3D printing is used in at least two curriculum subject areas such as Design & Technology **and** Computing, and/or for cross-curricular projects.	3D printing is used across the curriculum in subject areas such as Design & Technology, Computing, Science, Maths, Art, History and Geography and/or for cross-curricular projects.
STEAM and extra-curricular offer 3D printing is not part of the schools STEAM and/or extra-curricular offer.	3D printing forms part of the schools STEAM and/or extra-curricular offer.	3D printing forms an integral part of the schools STEAM and/or extra-curricular offer.
3D printing champions 3D Printing Champions are not yet established in the school.	The school has started to develop individual learners as 3D Printing Champions.	The school actively develops individual learners as 3D Printing Champions.
Careers Education Students are provided with an opportunity to learn about 3D printing applications and careers on at least one occasion during defined curriculum time in KS2.	Students are provided with two opportunities to learn about 3D printing applications and careers - on at least one occasion during defined curriculum time both KS1 and KS2.	Students are provided with multiple opportunities (across all year groups) for learning about 3D printing applications and careers both in defined curriculum time and through other means such as wall displays, careers assemblies and visiting speakers.

3D Skills Progression		
3D Emerging School	**3D Developing School**	**3D Confident School**
Curriculum planning Medium term plans and student projects incorporate at least one 3D printing activity or project at Upper KS2.	Medium term plans and student projects are starting to demonstrate progression by incorporating at least two 3D printing activities or projects (Lower KS2 and Upper KS2) where students build upon their previous knowledge and skills.	KS2 medium term plans and student projects clearly demonstrate progression by clearly incorporating at least three 3D printing activities or projects (KS1, Lower KS2 and Upper KS2) where students build upon their previous knowledge and skills.
2D to 3D Process Use of the 2D to 3D process is partially evident with EYFS and/or KS1 students able to see 3D prints being made from their hand drawn sketches.	Use of the 2D to 3D process is evident with EYFS and/or KS1 students able to see 3D prints being made from their hand drawn sketches and students in KS2 able to 3D print from a design created using 2D drawing/paint software.	Use of the 2D to 3D process is evident across EYFS, KS1 and KS2 with students able to see 3D prints being made from their hand drawn sketches and students in KS2 able to 3D print from a design created using 2D drawing/paint software and/or 3D print from a photograph.
CAD software use Use of age appropriate CAD software (e.g.Tinkercad, Solidworks Apps for Kids) is partially evident with students in upper KS2 able to create 3D models using templates or tutorials or simple models of their own design.	Use of age appropriate CAD software (e.g.Tinkercad, Solidworks Apps for Kids) is evident across KS2 with students in lower KS2 able to create 3D models using templates or tutorials and students in upper KS2 able to create models of their own designs.	Use of age appropriate CAD software (e.g.Tinkercad, Solidworks Apps for Kids) is evident across KS1 and KS2 with students in lower KS2 able to create 3D models using templates or tutorials and students in upper KS2 able to create models of their own designs. Students at KS1 also access simple CAD software (e.g. Tinkercad Scribble Tool, 3D Slash or Purple Mash 2Design&Make)
3D Printing Knowledge and Understanding Students can observe a 3D printer in action and can explain/describe in simple terms how a 3D printer operates.	Students can observe their own designs being 3D printed, upper KS2 students understand and can explain/describe in simple terms the slicing process and how a 3D printer operates.	Students can observe their own designs being 3D printed, upper KS2 students understand and can explain/describe in simple terms the slicing process and how a 3D printer operates. They also understand the concepts of infill and layer height and how these settings affect quality, strength and print time.

Key 3D Competencies

Additive Manufacturing & 3D Printing Processes		
3D Emerging School	**3D Developing School**	**3D Confident School**
3D Printing All Staff involved in teaching 3D printing projects demonstrate a limited understanding of the operation of a 3D printer and can start, pause and abort 3D prints.	All Staff involved in teaching 3D printing projects demonstrate an understanding of the operation of the 3D printer and can start, stop and abort prints, some staff can change materials between prints.	All Staff involved in teaching 3D printing projects clearly understand and can confidently operate and explain the operation of the 3D printer. They can all can start, stop and abort prints and change materials between prints and during a print.
Troubleshooting and maintenance Staff can troubleshoot and resolve a small range of issues with 3D printing (limited to the print not sticking to the build plate and blocked nozzles).	Staff can troubleshoot and resolve a wider range of issues with 3D printing (including print not sticking to the build plate, warping, shifting layers and blocked nozzles) and can perform basic preventive maintenance on their 3D printers.	Staff can confidently troubleshoot a range of issues with 3D printing and make adjustments to improve print quality. They can maintain their 3D printers.
Designing for additive manufacturing Staff demonstrate an awareness of how to design for additive manufacturing limited to understanding overhangs and bridging.	Staff understand many of the factors in designing for additive manufacturing including overhangs, bridging, shells/wall thickness, sharp and narrow points and build plate adhesion.	Staff fully understand how to design for additive manufacturing, including overhangs, bridging, shells/wall thickness, sharp and narrow points, build plate adhesion tolerances and how print orientation can affect the structural strength of a model.
3D Printing Applications& Benefits Staff have a basic understanding and can explain to students some of the applications and benefits of 3D printing technologies in industry and wider society. They can begin to inspire the engineers and product designers of the future.	Staff fully understand and can confidently and enthusiastically explain to students many of the applications and benefits of 3D printing technologies in industry and wider society. They can inspire the engineers and product designers of the future.	Staff fully understand and can confidently and enthusiastically explain to students a large range of applications and benefits of 3D printing technologies in industry and wider society. They can transform students perceptions and inspire the engineers and product designers of the future.

3D Modelling (CAM) & Slicing Models		
3D Emerging School	**3D Developing School**	**3D Confident School**
3D CAD software use All Staff involved in teaching 3D printing projects can use the basic tools and teach students in the use of an Educational 3D modelling Software Program or Application e.g. Tinkercad, Solidworks Apps for Kids, Makers Empire or Sketchup.	All staff involved in teaching 3D printing projects can use and teach students in the use of an age appropriate Educational 3D modelling Software Program/Application (e.g. Tinkercad, Solidworks Apps for Kids, 3D Slash). They can use the basic software tools and are developing their skills in using and teaching with the full range software tools.	All staff involved in teaching 3D printing projects are proficient users and can confidently teach students in the use of age appropriate Educational 3D modelling Software Program or Application e.g. Tinkercad, Solidworks Apps for Kids, 3D Slash).
3D modelling skills Staff can navigate the 3D modelling software interface and make use the basic 3D model construction tools to design and export simple 3D models.	Staff can use the majority of the 3D model construction tools and can design and export detailed 3D models.	Staff are confident and experienced in using the full range of 3D model construction tools and can design and export complex 3D models.
Limitations of 3D printing Staff demonstrate an awareness of the limitations of their 3D printing technology and a basic knowledge of how and when to use build plate adhesion and support settings when slicing 3D models.	Staff know the limitations of their 3D printing technology and understand how and when to use build plate adhesion and support settings when slicing 3D models.	Staff know the limitations of their 3D printing technology and fully understand how and when to use the different build plate adhesion and support settings where required when slicing 3D models.
Arranging and slicing 3D models All Staff involved in teaching 3D printing projects can import and slice a single model on the build plate. Some staff can import, arrange and slice multiple models on the build plate.	Most staff involved in teaching 3D printing projects can import, arrange and slice multiple models on the build plate. Some staff can move, scale, rotate and mirror 3D models prior to slicing.	All staff involved in teaching 3D printing projects can import, arrange and slice multiple models on the build plate. All staff can move, scale, rotate and mirror 3D models prior to slicing.
Understanding of slicing settings Staff understand the basic slicing settings (layer height, infill, support and build plate adhesion). They can use recommended slicing settings and/or print profiles.	Staff understand the basic slicing settings (layer height, infill, support and build plate adhesion) and know how they affect the final print including print quality, material use and print time. They can use some custom slicing settings e.g. apply different build plate adhesion options.	Staff have a clear understanding of a number of more advanced slicing settings (shell, temperature, speed, travel and cooling settings). They can use a range of custom slicing settings.

Completing the Framework

In each of the five development areas, schools should read the individual statements and select the one from each row that best describes where the school is at now. If none of the statements fit, the row should be left blank (not yet emerging).

Scoring

Each set of statements (row of the table) are scored as follows:

- 3D Confident Statement: 3 points
- 3D Developing Statement: 2 points
- 3D Emerging Statement: 1 point
- Not yet Emerging: 0 points

The impact framework should be completed using the online Primary School Review Form (www.createeducation.com/primary-impact-review-form)

This form will automatically assign and calculate your school's scores, based on your responses to each set of statements.

The scores will be averaged in each development area, this will allow schools to see at a glance which areas require the most development in order to more thoroughly embed the technology. Upon submission of the form, you will receive an email with your responses and scores. This data can be used by individual schools to inform school development planning.

An overall average school score will also be calculated.

It is recommended that the assessment framework is repeated periodically - once now, then again at the end of each academic year. Then the overall score and scores in each development area can be compared year on year to assess the school's progress in their adoption of 3D printing technologies over time.

CREATE Education will be collecting the scores (anonymised) as part of a nationwide research program we are conducting looking at the adoption and the impact of 3D printing in Primary and Secondary Schools. An annual report will be published and sent to each school who completes the online form. This will allow you to see how your school compares to others nationally.

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