The 3D Printing Technologies

Secondary 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 seven development strands covering the application of 3D technologies in school and key 3D competencies.

Application of 3D Technologies

- Staff Development and Awareness
- Application at KS3
- KS4 Pathways
- 3D Careers Education, Information, Advice and Guidance

Key 3D Competencies

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

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**
1 lead member of staff has been formally trained by CREATE Education and holds the CREATE Bronze 3D Educator Certification.	1 lead member of staff has developed their practice to create, teach and evaluate a 3D printing project and gain the CREATE Silver 3D Practitioner Certification.	1 lead member of staff is a subject expert and mentor with CREATE Gold 3D Master Certification with succession planning evident.
1 additional member of staff has also been formally trained by CREATE Education and holds the CREATE Bronze 3D Educator Certification.	2 additional members of staff are confident users of the technology with CREATE Bronze or Silver Certification.	3 members of staff are confident users of the technology with CREATE Bronze or Silver Certification.
The school has a plan in place for internally developing and training staff in one subject department in the use of 3D printing in their curriculum area.	The school internally develops and trains staff in one subject department in the use of 3D printing in their curriculum area.	The school internally develops and trains staff across multiple departments in the opportunities and use of 3D printing across the curriculum.
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.
The school has plans in place to promote the use of 3D printing technologies in the wider community. E.g. primary feeder school staff development and student projects and parental engagement.	The school has promoted the use of 3D printing technologies in the wider community on at least one occasion. E.g. primary feeder school staff development and student projects and parental engagement.	The school actively promotes the use of 3D printing technologies in the wider community on multiple occasions throughout the school year. E.g. primary feeder school staff development and student projects and parental engagement.

Application at KS3		
3D Emerging School	**3D Developing School**	**3D Confident School**
KS3 planning KS3 medium term plans and student projects incorporate few learning objectives from the CREATE Education 3D Printing knowledge and skills progression framework, foundation level but don't yet demonstrate progression.	KS3 medium term plans and student projects are starting to demonstrate progression by incorporating some learning objectives from the CREATE Education 3D Printing knowledge and skills progression framework, foundation level.	KS3 medium term plans and student projects demonstrate progression by clearly incorporating learning objectives from the CREATE Education 3D Printing knowledge and skills progression framework, foundation level.
Learner experience Learners experience at least one activity during defined curriculum time where they can develop their 3D modelling skills and see their designs 3D printed.	Learners experience at least one complete project during defined curriculum time 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 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, Computing, Science, Maths, Art, History and Geography and/or for cross-curricular projects.	3D printing is used in at least two curriculum subject areas such as Design & Technology, Computing, Science, Maths, Art, History and Geography and/or for cross-curricular projects.	3D printing is used across the curriculum in subject areas such as 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.

KS4 Pathways		
3D Emerging School	**3D Developing School**	**3D Confident School**
KS4 planning KS4 medium term plans and student projects clearly incorporate learning objectives from the CREATE Education 3D Printing knowledge and skills progression framework, foundation level but don't yet demonstrate progression..	KS4 medium term plans and student projects are starting to demonstrate progression by incorporating some learning objectives from the CREATE Education 3D Printing knowledge and skills progression framework, intermediate level.	KS4 medium term plans and student projects demonstrate progression by clearly incorporating learning objectives from the CREATE Education 3D Printing knowledge and skills progression framework, intermediate level.
CAD software use Use of CAD software is evident in KS4 Design & Technology. However this is not industry standard software E.g. Fusion360, Solidworks, Onshape.	Use of Industry standard CAD software is partially evident in KS4 Design & Technology. E.g. Fusion360, Solidworks, Onshape.	Use of Industry standard CAD software is evident in KS4 Design & Technology. E.g. Fusion360, Solidworks, Onshape.
Alternative pathways Alternative pathways supported by 3D technologies are not available to learners.	Alternative pathways supported by 3D technologies are available to some learners.	Alternative pathways supported by 3D technologies are available to all learners.
STEAM and extra-curricular offer 3D printing is not part of the schools STEAM and/or extra-curricular offer.	3D printing forms a small 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 learners as 3D Printing Champions.	The school actively develops learners as 3D Printing Champions.

3D Careers Education, Information, Advice and Guidance (CEIAG)		
3D Emerging School	**3D Developing School**	**3D Confident School**
Addditive manufacturing employment routes The CEIAG offer informs some students of the opportunities and jobs available within the additive manufacturing industries.	The CEIAG offer informs all students of the opportunities and jobs available within the additive manufacturing industries.	The CEIAG offer clearly informs all students of the opportunities and jobs available within the additive manufacturing industries providing information on local apprenticeship opportunities.
Additive manufacturing study routes The CEIAG offer informs some students of the opportunities for 3D design and additive manufacturing in further and higher education.	The CEIAG offer informs all students of the opportunities for 3D design and additive manufacturing in further and higher education.	The CEIAG offer clearly informs all students of the opportunities for 3D design and additive manufacturing in further and higher education, providing details of relevant courses at FE & HE.
Local industry links The school has identified local businesses that provide 3D design and additive manufacturing opportunities and the school.	The school is developing links with local businesses that provide 3D design and additive manufacturing opportunities and the school.	Strong and sustainable links are developed between local businesses that provide 3D design and additive manufacturing opportunities and the school.
Industry experience CEIAG includes one discrete opportunity for students to experience additive manufacturing in industry at KS4 e.g. guest speakers, industry visits and/or work placements.	CEIAG includes one discrete opportunity for students to experience additive manufacturing in industry at KS3 and at KS4 e.g. guest speakers, industry visits and/or work placements.	CEIAG includes multiple discrete opportunities for students to experience additive manufacturing in industry across KS3 and KS4 e.g. guest speakers, industry visits and/or work placements.
Local employee engagement The school has a plan in place to engage with local employers in providing specific product design briefs for "real" projects/design problems that can incorporate 3D technologies in developing a solution.	The school has started to engage with local employers in providing specific product design briefs for "real" projects/design problems that can incorporate 3D technologies in developing a solution.	Local employers are clearly engaged in providing specific product design briefs for "real" projects/design problems that can incorporate 3D technologies in developing a solution.

Key 3D Competencies

Additive Manufacturing & 3D Printing Processes		
3D Emerging School	**3D Developing School**	**3D Confident School**
Impact of additive manufacturing Staff demonstrate limited understanding of the current and future impact of additive manufacturing on industry including enterprise, sustainability, people, culture, society and the environment.	Staff demonstrate an understanding of the current and future impact of additive manufacturing on industry including enterprise, sustainability, people, culture, society and the environment.	Staff clearly understand and can provide examples to students of the current and future impact of additive manufacturing on industry including enterprise, sustainability, people, culture, society and the environment.
Appropriate use of 3D printing Staff have an awareness of when and when not to use 3D printing and when other materials and manufacturing processes are more appropriate.	Staff know when and when not to use 3D printing and when other materials and manufacturing processes are more appropriate. Staff can successfully combine 3D printing with other manufacturing techniques within student projects.	Staff know when and when not to use 3D printing and when other materials and manufacturing processes are more appropriate. Staff and KS4 students can successfully combine 3D printing with other manufacturing techniques within student projects.
Additive manufacturing applications Staff demonstrate a limited understanding of some of the applications and the use of 3D printing for one-off, batch and mass production and mass personalisation.	Staff demonstrate an understanding of some of the applications and the use of 3D printing for one-off, batch and mass production and mass personalisation.	Staff clearly understand the applications and the use of 3D printing for one-off, batch and mass production and mass personalisation and are able to provide a range of examples to students.
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 3D Printing & Slicing Models		
3D Emerging School	**3D Developing School**	**3D Confident School**
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.
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.
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 fully use custom slicing settings and can set up and manage print profiles.
Understanding of dual extrusion and IDEX technologies Staff understand the differences between common FDM 3D printers (single extrusion, dual extrusion and IDEX).	Staff have a clear understanding of the benefits of dual extrusion and IDEX 3D printers.	Staff have a clear understanding of the benefits of dual extrusion and IDEX 3D printers and know how to split, prepare and slice models for dual extrusion.

3D Modelling (CAD)		
3D Emerging School	**3D Developing School**	**3D Confident School**
3D CAD software use Staff can use and teach students in the use of an Educational/Beginners 3D modelling Software Program or Application e.g. Tinkercad, Solidworks Apps for Kids, Makers Empire or Sketchup.	Staff can use and teach students in the use of an Educational 3D modelling Software Program/Application e.g. Tinkercad, Solidworks Apps for Kids, Makers Empire or Sketchup. They can use the basics of and are developing their skills in using and teaching a Professional Industry Standard 3D Modelling Software Program (main 3D design interface and 3D modelling tools) e.g. Autodesk Fusion 360, Autodesk Inventor, Solidworks or Onshape.	Staff are proficient users and can confidently teach students in the the use of Professional Industry Standard 3D modelling Software Program (main 3D design interface and 3D modelling tools) e.g. Autodesk Fusion 360, Autodesk Inventor, Solidworks or Onshape.
3D modelling software tools Staff can use the basic 3D model construction tools.	Staff can use the majority of the construction tools and work with bodies/parts and components.	Staff are experienced in using the full range of construction tools and in working with bodies/parts, components and assemblies.
3D modelling skills Staff can design and export simple models.	Staff can design and export detailed models.	Staff are confident in designing, splitting (where required) and exporting complex models for both single and dual extrusion.
3D materials and finishes Staff are not yet using software which allows them to apply different materials and appearance finishes to their models.	Staff can apply different materials and appearance finishes to their 3D models.	Staff can confidently apply different materials and appearance finishes to their 3D models.
Presentation techniques Staff are not yet using software which allows them to use different presentation techniques for their 3D model designs.	Staff can use different presentation techniques for their 3D model designs, including rendering, producing orthographic drawings.	Staff are skilled in using different presentation techniques for their 3D model designs, including rendering, producing orthographic drawings, sectional and exploded views and producing animations from assemblies.

Completing the Framework

In each of the seven 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 Secondary School Review Form (www.createeducation.com/secondary-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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