



ShakeAM

sharing knowledge in design for AM

SHARING KNOWLEDGE IN DESIGN FOR AM

Guidelines for inclusive teaching methods



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1. Introduction

ShakeAM project aims to address inequality within education and skills by using digital technology to close these gaps, targeting Students with Special Educational Needs and Disabilities (SEND). ShakeAM project proposes an engaging and inclusive training methodology, offering a more appealing approach to disadvantaged students, using a learning ecosystem comprising different functionalities (R.3.2). The DfAM ecosystem considers the different learning options that can be used alone or combined, depending on the learner's available time, educational needs and pre knowledge. This Document intends to be a Guideline for inclusive teaching that can be applied to all the training modules/units developed in the scope of ShakeAM project. The aim of this document is to propose a set of Guidelines for inclusive teaching (teaching guidelines for inclusion) so as to achieve the general objectives of ShakeAM by making the subject of DfAM relevant and the teaching resources inclusive for SEND students. This will ensure a new approach for inclusive capacitation of personnel in DfAM in HE and VET, deployed through a Design for AM ecosystem and associated methodologies where lifelong learning is promoted by keeping professionals engaged.

ShakeAM, acronym of learning by Sharing Knowledge in design for AM, project aims to address the need for qualified personnel in Design for Additive Manufacturing (DfAM). The requirements and characteristics of DfAM are constantly changing in response to the expanded growth and broad use of Additive Manufacturing (AM) technology. Experienced designers are desperately needed because the Design for AM (DfAM) methodology is the initial step in creating practical AM products. Therefore, in order for businesses to effectively utilize additive manufacturing technology and to guarantee that engineering design solutions are produced "first time right," AM profiles with design expertise are essential. To fill the talent gap, new educational initiatives are needed. The goal of ShakeAM project is to fill this gap through a specialized DfAM Digital Ecosystem and a Design Best Practice Database. This ecosystem will have a significant and lasting effect on HE institutions' capacity and readiness to manage an effective shift towards digital technologies for a systematic approach regarding training delivery, one that will ultimately provide HE students, SEND and "non -SEND" with lifelong benefits and their active participation in the learning process.

2. An Insight into Inclusive Education

Every learner has the potential to make gains from a policy-focused approach that prioritises quality, equity, and diversity within an inclusive educational framework. Learners will advance intellectually as well as in other areas of their development, such as socio-emotional or cognitive aspects. A young learner can be protected from various risk factors through inclusive education, which helps them to develop coping skills, become accepted members of society, and deal with challenges they may face as adults (European Agency for Special Needs and Inclusive Education, 2014). There is thus both short-term and long-term advantages. The vision is that inclusive education can be beneficial to every learner, regardless of whether they have or do not have Special Educational Needs and Disabilities (SEND). Less acceptance, fewer bonds between them, and less contact with their peers who are typically developing are challenges for learners with SEND. Studies have shown dismal results, although inclusive educational policies still have a good impact. poor results can motivate educators to make advancements towards full inclusion in the classroom. While analysing the present impact of inclusive education, it is also important to consider how it will be used in a particular teaching

situation. One should also keep in mind that learners with SEND may have increased teaching needs as opposed to those who are not registered as SEND. The worldwide COVID-19 pandemic highlighted gaps and difficulties facing educational systems in terms of their capacity to offer all students opportunities for continuous learning (European Agency for Special Needs and Inclusive Education, 2022). During the pandemic, education institutions have adjusted to previously unheard-of situations. This has paved a way towards more widespread and inclusive E-Learning platforms. Inclusive digital education is a digital transformation that extends far beyond the use of properly developed digital tools in the classroom. The expectation is that all levels of the educational system will be involved in inclusive digital education, from the individual to the educational institution, and from local, regional or national levels. This is crucial if digital education is to be permanently ingrained in the educational system's architecture and build resilient educational systems that will provide equal educational opportunities for all learners, rather than merely being adopted for some.

Some standards and regulations are developed to promote Inclusion in the digital platform, including but not limited to:

- **ISO 9241-171:2008** 'Ergonomics of human-system interaction - Part 171: Guidance on software accessibility (offers specifications and guidelines for designing accessible software that can be used at work, at home, in schools, and in public areas (ISO, 2008). It addresses problems with creating software that is usable by those with the broadest range of physical, sensory, and cognitive abilities, including the elderly and those who are momentarily disabled)
- **ISO 9241-20:2021** 'Ergonomics of human-system interaction - Part 20: An ergonomic approach to accessibility within the ISO 9241 series (which outlines recommendations for enhancing the usability of ICT products and services for people with a variety of sensory, physical, and mental abilities, including the elderly and those who are momentarily disabled)
- European Standard **EN 17161:2019** 'Design for All - Accessibility following a Design for All approach in products, goods and services – Extending the range of users', that seeks to aid organizations in implementing a unified strategy for managing accessibility for people with disabilities (European Committee for Standardization, 2019).

2.1. Learners with Special Educational Needs and Disabilities (SEND)

This section discusses "SEND" which is further classified into four broad areas of Special Educational Needs - Communication and Interaction; Cognition and Learning; Social, Emotional and Mental Health Difficulties; and Physical and Sensory Needs (Plymstock School, 2017).

2.1.1. Communication and Interaction

Some of the disabilities included in this area are:

1. **Autistic Spectrum Disorder (ASD)** - ASD is a relatively new term that acknowledges the existence of several subgroups within the autism spectrum. Students with ASD have trouble understanding and utilising verbal and nonverbal communication. comprehend social behaviour, which impacts their capacity to communicate with both adults and children. Be flexible in thought and behaviour, which may be demonstrated through limited, obsessional, or repetitive activities.

2. **Speech, Language and Communication Needs (SLCN)** - A variety of speech and language issues can affect children and young people, some of which may become better as the student grows. Such issues may only affect a child's speech production in some cases. Others can struggle to find the appropriate words or put them together in a way that is expressive. They might struggle to express themselves verbally, have trouble learning a language, and have trouble speaking. In learning and using proper language for social engagement, as well as understanding and responding to verbal cues from others, they may have difficulty or delays.

2.1.2. Cognition and Learning

Some of the disabilities included in this area are:

1. **Attention Deficit Hyperactivity Disorder (ADHD)** - A complex disorder, Attention Deficit Hyperactivity Disorder (ADHD) can significantly impair a child's ability to focus, behave, and learn. A youngster with ADHD may find it difficult to sit still, easily get bored, or become distracted by meaningless sounds or images. This affects their learning because it can be very difficult for them to focus for the lengths of time required to finish assignments. As a result, their work may not always accurately reflect their genuine abilities.
2. **Moderate Learning Difficulty (MLD)** - Despite effective treatments, students with MLDs will perform well below expectations in the majority of curriculum areas. Normal differentiation and the National Curriculum's flexibility won't be able to meet their demands. Only if further educational accommodation is provided to help them access the curriculum can they be listed as MLD. Students with MLDs struggle far more than their peers to pick up fundamental literacy and numeracy skills as well as to comprehend concepts. Also, they can struggle with low self-esteem, poor concentration, underdeveloped social skills, and speech and language delays.
3. **Profound and Multiple Learning Difficulty (PMLD)** - Complex learning demands are present in students with profound and multiple learning disabilities. In addition to very serious learning challenges, students also face additional major challenges like physical limitations, sensory impairment, or serious medical conditions. Students need a high-level amount of adult assistance, both in terms of their educational demands and in terms of their personal care. Learners may require sensory stimulation as well as a curriculum with extremely tiny learning objectives. Some students use gestures, eye contact, or symbols to communicate, while others use very basic language.
4. **Severe Learning Difficulty (SLD)** - Students with severe learning disabilities (SLD) suffer from serious cognitive or intellectual deficits. Their capacity to engage in the curriculum of the school without assistance is significantly impacted by this. They may also struggle with coordination and mobility. The development of self-help abilities, perception, and communication. Those that struggle with learning will require assistance in all subject areas.
5. **Specific Learning Difficulty (SpLD)** - Children or young people with specific learning disabilities (SpLD) may struggle with one or more aspects of learning. These disabilities range from dyslexia, which causes problems in reading and spelling, to dyscalculia, which affects math, to dyspraxia, which affects coordination, and Dysgraphia which affects writing.
 - **Dyscalculia** - Dyscalculic students struggle to pick up mathematical abilities. Students may struggle to learn number facts and procedures, have trouble grasping basic numerical ideas, and lack an intuitive understanding of numbers.
 - **Dysgraphia** - The great difficulty with fine motor skills that dysgraphia patients have can make it difficult for them to arrange letters, numerals, and words on a line or page. This

may be caused in part by Linguistic processing difficulty (trouble decoding and understanding what the ear hears) and Visual-spatial difficulties in processing what the eye sees.

- **Dyslexia** - Despite improvement in other areas, dyslexic students continue to struggle with learning to read, write, and spell. Students could have poor penmanship, punctuation, and reading comprehension. Moreover, they could struggle with concentration and both in terms of organisation and word-sequence memory. They might speak well-known words incorrectly or flip the letters and sounds in words.
- **Dyspraxia** - The organisation of movement is impaired or immature in dyspraxic students, making them frequently appear clumsy. Both gross and fine motor abilities are challenging to learn, maintain, and generalise. Students may struggle with coordination and balance. be wary of taking numerous risks (running, skipping, hopping, holding a pencil, doing jigsaws, etc.). Moreover, they might have immature articulation and late-developing language. Moreover, they could lack social skills and low bodily awareness.

2.1.3. Social, Emotional and Mental Emotional Health

Children with emotional problems may exhibit various challenges resulting from other complicated demands, such as being hyperactive, unfocused, or socially immature. They may also be withdrawn or alienated. Some kids could struggle socially or with emotional issues that prevent them from learning efficiently. They may occasionally interfere with other children's or young people's learning because of the challenges they face. Some of the disabilities included in this area are:

1. **Adjustment Disorders** - A youngster who has an adjustment disorder may have experienced a traumatic incident or a significant change in their way of life. Their emotional well-being and/or behaviour may then suffer as a result.
2. **Anxiety Disorders** - A youngster with an anxiety disorder may experience panic episodes frequently. In this case, the child might express bodily complaints like headaches or stomach-aches. The youngster may also exhibit inappropriate emotional reactions, such as outbursts of laughter or sobs.
3. **Obsessive-Compulsive Disorder** - The child may exhibit recurring obsessions or compulsions in this situation. Praying, counting, silently repeating sentences, and repetitive hand washing are a few examples of behaviours.

2.1.4. Sensory and Physical Needs

Some of the disabilities included in this area are:

1. **Hearing Impairment (HI)** - Students with HIs range in hearing ability from minor hearing loss to extreme deafness. They encompass the full spectrum of abilities. Students are considered to have an HI for educational purposes if they use hearing aids, to access the concepts and language of the curriculum, students may need to adjust their environment or use specific teaching tactics. Many students who have an HI also have another handicap or learning challenge. A decibel scale can be used to quantify hearing loss, which may result from sensorineural or conductive issues. Typically, four classifications are used: mild, moderate, severe, and profound. Some students with severe hearing loss use sign language in addition to or instead of speech to communicate.
2. **Visual Impairment (VI)** - A visual impairment is commonly understood to be an eyesight condition that cannot be resolved with the use of glasses, contact lenses, or surgery. The phrases "legally blind," "completely blind," "poor vision," and "partially sighted" are all Students with visual

impairments who are described in an educational context. These are their definitions: "Partially sighted" denotes the presence of a visual disability that necessitates special schooling; "Low vision" denotes all people with sight who are unable to read the newspaper at a normal viewing distance, even with the use of eyeglasses or contact lenses; "Legally blind" refers to a person who has a vision that is less than 20/20 in the better eye or who has a very small field of vision (less than 20 degrees at its widest point); "totally blind" refers to a person who is completely blind and who learns through Braille or other non-visual means.

3. **Multi-Sensory Impairment (MSI)** - Students who have MSI struggle with both hearing and vision. Although they may still have some residual sight or hearing, they are sometimes referred to as deafblind. Many additionally have other disabilities, though it may be challenging to determine their extent due to their complex demands. Intellectual prowess. Comparatively speaking, students with MSI have significantly more trouble accessing the material and the environment. They struggle with perception, communication, and information acquisition. Learning through an accident is scarce. High levels of anxiety and sensory deprivation may occur from the interaction. Students require instructional strategies that effectively utilise their remaining hearing and vision in addition to their other senses. Other forms of communication can be required.
4. **Physical Disability (PD)** - The range of physical limitations is large, and the students' talents are diverse. Some students can successfully access the material and learn without additional educational support. Despite having a disability, they lack a SEND. Some may experience serious effects on their academic performance. In a similar vein, a medical diagnosis does not imply that a student has a SEND. It depends on how the condition affects their need for schooling. Mobility may be impacted by a number of medical problems linked to physical impairment. They include muscular dystrophy, spina bifida, hydrocephalus, heart disease, and cerebral palsy. Students with physical problems may also struggle with their senses, neurological issues or academic challenges. Even while some students can move around, they struggle with fine motor skills and need assistance. Others might require alternate or supplemental communication tools.
5. **Medical Needs** - A disability or medical diagnosis does not automatically indicate a need for special education (SEND). At any stage of development, it may not be required for a child or young person with a certain diagnosis or medical condition to receive any additional forms of care or educational provisions. The needs of the child should always be taken into consideration rather than a diagnosis. Some kids may not need SEND services provided in schools, but they may have medical issues that could make it difficult for them to attend education if they are not treated properly. Children and teenagers that have health issues include individuals who have Cystic fibrosis, Asthma, Diabetes, Arthritis, Epilepsy, severe Allergies, Incontinence, Eczema, Tracheotomy, Colostomy, and Ileostomy.

2.2. Discussion

For students to feel included, teachers must be conscious of the diversity of students in the classroom and to actively understand and recognise their perspectives and experiences. An inclusive classroom environment seeks to provide everyone with equal time and space to express themselves and their experience while recognising and valuing individual differences. There should be more emphasis on preparing teachers for inclusion than on seeing it as a specialized subject that focuses on teaching particular groups. To accommodate learners who might find it difficult to express themselves on paper due to their specific needs, inclusive educators should aim to use a variety of testing and grading procedures. When conducting assessments or grading, an additional points system or other strategies could be considered. With the wide range of students in a classroom setting, it may be unlikely that

the tutor or instructor will be able to fulfil all of their requirements. Hence, inclusion instructors may choose to work with support staff to provide learners with the best experience as possible. Such partnerships will enable the inclusive learning community to exchange concepts, deconstruct lessons, help and pool together their knowledge. When it comes to face-to-face sessions, set up the classroom in a way that will accommodate a range of students. Consider the lighting, furniture location, workspace proximity to distractions, and the availability of a wide variety of materials (eg. Braille books). Trying out a co-teaching model with a general educator and a special educator in one or more classrooms could be beneficial. Labelling classroom supplies using Braille, photos, object cues or any other symbol system will help the students.

ShakeAM provides training to the trainers to accommodate SEND students and the E-learning platform provides special attention to these students. For instance, students with hearing impairment can make use of subtitles provided in the pre-recorded video lecture and people with dyslexia can pause and play this video as many times in order to get a better understanding. ShakeAM focus to teach students with all types of disabilities under SEN except for students who are totally blind. The course modules are made considering SEND students, so it involves simple words, more pictures and videos. Special assistance can be provided to students who have a range of physical limitations when there is a face to face sessions. Flexible deadlines, different formats of assessment and proving extra time can be provided to SEND students. (European Agency for Special Needs and Inclusive Education, 2022)

3. Tools for Inclusive Digital Education

3.1. 3D Printing

The use of 3D Printers in the classroom has the potential to help facilitate collaborative learning between students with disabilities and students without disabilities, as well as student and teacher digital competency. In this ShakeAM project, we look at the integration of 3D printers into inclusive education as well as how to use them to facilitate collaborative learning between students with and without disabilities. Several assistive equipment and technology are typically needed for people with motor impairments including quadriplegia, cerebral palsy, neuropathy, or muscular atrophy to solve educational and daily routine tasks. The creation of various types of assistive equipment for students with motor impairments can be facilitated by the usage of 3D Printers. The use of 3D printers in formal and informal education can assist students with cognitive impairments to develop their computer file management, online resource searching, and other spatial reasoning skills. One disability that offers many opportunities for the use of 3D Printers and 3D models in educational settings is visual impairment. Learning models and visuals from many teaching subjects could be generated using 3D Printers. Visually impaired students' interest in learning STEM subjects in school may improve with the adoption of physical artefacts or tangible models since they will have the opportunity to experience the material on hand. The usage of 3D Printed models in education increases the confidence of students who are partially visually impaired as these artefacts can help them to visualise the content of the learning material being taught.

3.2. Virtual and Augmented Reality

Using immersive learning technologies such as Augmented, Mixed or Virtual Reality has several benefits for education. The students are able to take on an immersive experience which then sharpen students' attention and involvement. Furthermore, AR and VR engage students more actively. Also, this visual representation helps students comprehend abstract ideas and frequently helps them better

comprehend and evaluate unusual circumstances (European Agency for Special Needs and Inclusive Education, 2022). Both Augmented Reality (AR) and Virtual Reality (VR) have been demonstrated to improve short-term memory, foster engagement, boost motivation, and make lessons even more meaningful. The biggest impact is on communication skills, particularly in students with hearing issues. The use of VR can also help to make social contact easier for autistic kids. Using gamification, AR can help people with learning disabilities increase their confidence in exploring new experiences and for communicating.

3.3. Artificial Intelligence

In many industries today, the use of Artificial Intelligence is seen as a main driver of growth. AI has had a similar effect on the education sector such as the use of ChatGPT and other AI assisted tools. If implemented correctly and responsibly, AI-based Technology can be seen to provide the means to support inclusive learning whereby query-based lessons can be taught to students who have disabilities, language challenges, cultural differences, etc. in the same classroom. Between students and educators, AI can bridge the gap and make enormous strides in the education sector. AI-powered e-Learning platforms have been tailoring the course material and training pace to the needs of the learners. Students with special needs can learn at their own terms and own pace with the help of AI, and at the same time to assist instructors and teachers to suggest how to instruct pupils with unique needs. In inclusive learning, AI can help teachers choose the best teaching strategy and communication path when interacting with a student from a different background. The ALMS (Adaptive Learning Management System) is a system created to cater the resources, tasks, activities, etc. to each student's unique needs. Built using individual learner models, ALMS are also known as adaptive learning environments.

3.4. Mobile Learning

The use of mobile learning (m-learning) is gaining popularity as the majority of consumers always have their mobile devices with them, making M-learning available anywhere and at any time (European Agency for Special Needs and Inclusive Education, 2022). While it promotes social equality, learning on mobile devices can also be a crucial component of inclusive education. Particularly for poor nations or for those with low incomes, classic Assistive Technology is either prohibitively expensive or completely unavailable. M-learning can be used on tablets, laptops, smartphones and even smartwatches. These tools can be utilised to remember, remind and help keep appointments, as well as to do related activities. These tools can be directly or indirectly be controlled using mobile devices and can be seen to be much cheaper than VR or AR tools.

4. Guidelines for Inclusive Teaching and Learning

These guidelines have been referenced from various white papers from Stratasys, Create Education and Erasmus+ websites. This guideline has been prepared to teach students with all types of disabilities under SEN except for students who are totally blind. The guidelines have been written specifically for the ShakeAM project, where this can be used by both teacher-trainers and student-learners.

4.1. Overview of Guidelines for Trainers when Teaching

- Provide a demonstration on how to use the EIT Agora E-Learning platform.
- Just before the teaching starts, tutors could introduce the learning outcomes, provide learning resources, as well as introduce the teaching team.
- To improve engagement, consider adapting the materials according to the learners' background, interest and needs.
- When dealing with technical information, use pictures and videos.
- Provide pre-recorded content for essential but difficult-to-understand topics.
- When describing theories that cannot be demonstrated live, always use recorded videos.
- Add subtitles or close captions to all videos and provide adjustments to change the caption text size.
- Provide simple-to-follow instructions for learners, include numerous diagrams and photos.
- Provide 3D printed samples or photographs to discuss various processes.
- Attach digital files if they are used in the course work and encourage students to download and interpret them; as well as to provide links to free resources such as 3D CAD models.
- Provide the teaching content in the form of a word document or pdf as a handout, which are accordingly adopted for students with SEND (font, size, background, symbols etc).
- Provide recommendations for any nearby 3D printing services so that students have the opportunity to trial the use of 3D printing service bureaus.
- Provide interactive group session activities where possible to increase their engagement.
- Provide integration of real-time interactive tools such as Miro or Slido where possible.
- During the teaching, ensure that there are sufficient tutors to support the session.
- Offer a one-on-one mentoring session if the student needs more information, more support or have questions.
- Show case studies or applications to demonstrate how 3D printing is used in real-life scenarios that can be applied.
- During the print process, help students to prepare the printer and to position 3D models for printing.
- At the end of the session, obtain feedback from learners where possible.

4.2. Overview of Guidelines for Trainers when Providing Assessments

- Use formative assessments to check the students' level of understanding. Students can also learn using observations, questions, discussions, presentations, learning diaries, and peer and self-evaluations <https://www.cmu.edu/teaching/assessment/basics/formative-summative.html>
- Adjust the teaching and course content delivery strategies based on the feedback from formative assessments to meet the needs of the students in upcoming lessons.
- Ask them to make use of discussion forums to receive feedback and to ask questions.
- For a summative assessment, a test, quiz or assignment could be used to gauge students' understanding at the conclusion of the course and award a grade or to compare it with a standard.
- Provide flexible deadlines where possible.

- Ensure that there is sufficient contact time between the teacher and student before the assessment.
- Tutors may wish to provide their contact details so that learners can approach them with questions.

4.3. Overview of Guidelines for Student-Learners

- Read the handbook or handouts carefully before starting the course.
- Ensure that you have the right IT tools, browser or software to use the EIT Agora Platform.
- Watch all videos and read step-by-step guides to learn more about the topic.
- Consult with your teacher who can provide you with live demos where possible, or to direct you to recorded videos.
- To increase your understanding of the topic, read up on it and post questions in forums.
- Review what you have learned and conduct additional research to increase your understanding of the topic.
- Conduct a self-evaluation to keep track of your development.
- To become familiar with the CAD software's interface and tools, you are encouraged to explore and practice.
- Interact with other students to share your knowledge and clarify any doubts that you may have.
- Contact the trainer in advance, if you are joining the course in person and you have additional mobility requirements or where assistance is needed.
- Notify the trainer if there is a person accompanying you for the course so that additional facilities can be set up.
- Wear safety gear when operating a 3D printer, and to consult the instructors for help.

5. Conclusion

This report has provided the context for the ShakeAM project where Inclusive Teaching can be effectively applied. Some of the significant highlights include providing learning through the use of case studies, and examples of applications where students will often find 3D printing to be useful. Next, the use of rich visual content should be used to explain the various components of 3D Printing. Where required, provide learners with pictures and videos, and walk through trainers and learners through each step when dealing with technical parts of the material. Lastly, continually assess the training programme, the way it was delivered, and the knowledge of each individual, and evaluate what has been learnt. After the project's deliverables are finished, it is anticipated that the students in Higher Education or tertiary education, including those from disadvantaged backgrounds, learners with Special Educational Needs and Disabilities (SEND) will have access to tools that will help them develop their 3D printing skills and benefit from the ShakeAM project.

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