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Teachers' and Educator's Perceptions and Experiences of Maker education: Readiness, Attitudes, and Challenges

Masters Thesis

Faculty of Education

Master's Degree Program in Learning, Education, and Technology

2021

University of Oulu

Faculty of Education

Teacher's and Educator's Perceptions and Experiences of Maker Education: Readiness, Attitudes, and Challenges (Jawad Ahmed Malik)

Master Thesis, 68 Pages, 3 Appendices

May 2021

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Maker education can be recognized as one of the most recent and autonomous learning strategy which helps the students to explore themselves in different ways while polishing a particular skill in their way. This study aims to identify the perceptions and experiences of teachers and educators towards the use of maker education while evaluating their technical readiness towards the use of resources, their attitude towards maker education, and lastly, explaining the challenges which teachers are facing in the current scenario regarding the maker education activities. This research study is based on Qualitative analysis, as it is going to investigate the quality of certain perspectives and particular situations while aiming for an in-depth analysis of the situation regarding maker education. The data collection tool being selected was the survey Questionnaire, which was distributed to 14 university teachers and educators while focusing on various international educational setups. The targeted audience for this research belongs to Finland, the University of Oulu, and the University of Helsinki. But the most distinguished and amazing aspect of this research was to get involved with two professors from the University of Copenhagen (Denmark), the University of Malmo (Sweden), and Omnia (Estonia).

The research finding shows that time management during activities were found to be a challenge for the educators, as teachers were mostly new to digital fabrication and they needed time to incorporate maker education activities in the educational curriculum. As far as the teacher's interest towards the integration of maker education into pedagogical education is concerned, most of them were found in favor of aligning the maker spaces with the professional standards for teachers. Computational and digital learning is found to be an area, where some of the teachers need to learn these skills to implement digital fabrication in maker spaces. As far as the pedagogical integration of curriculum and maker activities is concerned, all the respondents were found to be very optimistic and agreed towards the successful integration, as many of them were already using this technique in their particular subject method. A positive attitude can be seen from teachers and the challenges can be resolved with a little effort from both sides either it is the management or the educators.

**Keywords:** Maker Education, Makerspace, Attitudes, Educators, Perceptions, Challenges, and Technical Readiness.

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## 1. Introduction

Rapid developments in the technological fields reveal that mankind is moving towards improved ways of getting an education or even teaching while having a more life-centered and technology-integrated approach. This indicates a continuous need for skilled professionals who must be able to handle not only the technical tools but also the skillset to develop and produce on their own. These developments had been found inefficient use of the human brain such as learning a skill while experiencing something similar or even staying in a similar environment equipped with skill development tools (Lindfors, 2019). Maker education provides the opportunity to learn the inbuilt skills in the learners while allowing them to explore themselves in their desired fields. The maker spaces provide the opportunity and equipped place, where they can find various tools and equipment to analyze their development opportunities. Multiple skills can be developed using maker education such as critical analysis of the current situations, problem-solving skills, evaluation of the issues, and use of available resources efficiently (Ayu Istiana Sari, 2017). Through all of the current and previous educational movements, the maker movement is the most acknowledged especially when it comes to the Finish educational environment. Various self-learning skills such as painting, 3D designing, and modeling at various levels, use of Analytical tools to manage forecasts and outputs, code generation, etc. are the most concerned domains. There are three basic desired outcomes while following the do it yourself strategy, which makers educational spirit involves which are:

- Students must be capable of sharing their outcomes with others in a competitive environment.
- Skills must be preferred over money.
- Experience must be preferred rather than extensive memory (Education, 2017).

It has been found that during the last decade, the students and youngsters have applied their online learned skills in various ways to experience and explore new ways of earning either it comes to freelancing leading towards entrepreneurship. The young students have approached the information handling and sharing in a newer spectrum while learning on their own, which can be seen attached to the maker movement. The use of modernized tools and ways of education enabled them to find more effective ways towards a solution, rather than going for the contemporary procedures. It was found that their inner capabilities have been polished over the period using maker spaces at school and college levels and enabled them to pursue their desired



fields (Cohen, 2017). STEM education i.e. education focused on Science, Technology, Engineering, and Mathematics being the traditional one, can be equipped with an 'A' representing an Artistic state of mind, changing STEM into STEAM can help students to perform the same tasks, but with complete ownership and using some artistic illusions (Blueprint, 2017). Having the complete authority to change and develop can help the nations to develop better educators, developers, artists, computer scientists, entrepreneurs, and content producers.

Another most important and nationwide vital aspect is related to the economic spectrum, where these skilled students can play a significant role in the desired fields, as discussed above. Thus, the teacher needs to be well-equipped, educated, and skilled enough to initiate the makerspaces, on their own in their premises, to ensure effective learning and student interest as the priority (Pao-Nan, 2018). There are some important aspects of a maker space that needs to be reflected from the teacher's point of view as they are responsible for this whole project such as effective collaboration, encouragement of ideas, availability of required tools, rules and regulations of the institutions being followed and lastly, the basic aim must never be sabotaged i.e. giving equal opportunity to all (ICHEI, 2020).

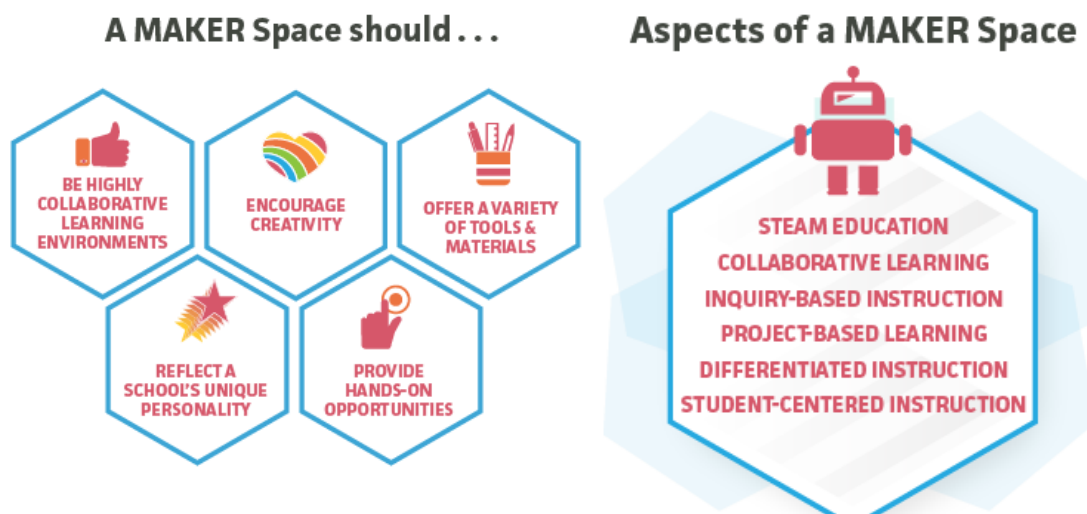
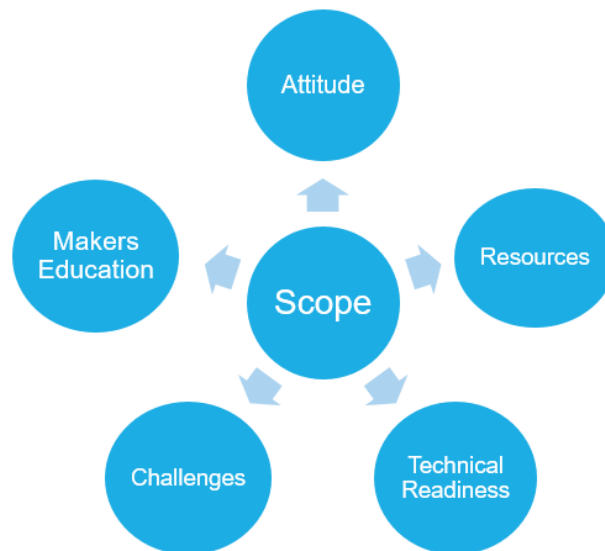


Figure 1: Specification of Maker Space (Blueprint, 2017)

Teachers and educators at various sectors have played a significant role in this overall maker movement, as a better learning environment provides better opportunities to explore the domains and choices, to find the most interesting by the students while giving them the equipment and technology to build and produce. This research study is going to focus on the five basic components of maker education and its impacts on teachers and educators while focusing on the below-illustrated domains:



*Figure 2: Research Scope*

## 1.1 Research Background

Finland had its perspective as long as the maker education is concerned, maker space has been named as the "Craft class" where the pupils must be able to develop themselves socially, logically, mentally, and physically (Juha Jaatinen, 2020). The teachers are responsible for implementing such places. During the start-ups, there was one craft class for boys and one for girls. Later on, these classes were turned more intrinsic and equipped with more materials like wood and textile while focusing on the rooted finish mindset. Papert was the person behind the emergence of the Maker Movement, a theory launched from the theory of constructionism, being focused on student learning. This hands-on learning experience was the objective of the maker movement, where the students can build their artifacts in the desired environment (Education, 2017). Papert believed that the learning process is most inductive, collaborative, and student-centered, aiming at the student's willingness (ICHEI, 2020). Student-driven approaches are focused rather than the teaching material. This research is going to have a close eye over the teacher's attitude, and behavior towards the use of the latest tools, the status of availability of resources in order to analyze the challenges being faced by the teachers. Makerspaces can be disruptive due to the attitude of teachers, as they need to understand the necessities of maker education, while primarily focusing on the collaborations among students (Piia Naykki, 2019).

## **2. Literature Review**

Since 2005, maker education had got a clear recognition as an approach towards educating the children while looking over the problems coming through and giving project-based learning to have hands-on experience as a problem solver. This technique is closely relative to the Stem learning technique (Juha Jaatinen, 2020). This method provides the opportunity for collaboration and had been recognized as a learning principle towards problem-solving techniques. This education started because of the known maker movement, where people started making smaller projects named "maker spaces" while calling themselves "Makers". All this started as by-products of the famous maker movement. This movement was started by the junk of independent designers and innovative tinkerers. All the traditional artists along with the computer hackers established this niche to have their recognition across the globe almost two decades ago. The most important part of this movement was the inclusion of the latest technology in art designing while recognizing various technological and contemporary designing technologies such as 3-D printing and the use of 3-D printers in this regard (Lewis, 2017).

When it comes to the history of maker education in the perspective of Finland, the country got its version of makerspace, while being incorporated in the education system to help sustain the STEM architecture. The maker space is called a "craft class", for boys and girls separately initially. The reason behind the initiation of these individually crafted classes was to let children learn and practice craftsmanship as per their will while being provided with project-wise materials whether it comes to wood. Colors or textiles. It had been made compulsory from grade one to seven to learn crafts as a separate subject, having various equipped exercises aiming towards craft expressions, design, and technology (Juha Jaatinen, 2020). This chapter will be going to analyze all the important aspects relative to maker learning while looking forward to the opportunities and challenges coming for the teachers in maker education.

### **2.1 History Elements and Evolution of Makerspaces**

Back in 2005, Dale Dougherty was the person who had invented this mode of education while founding the "Make Magazine", whose basic idea was to help those who wanted to learn skills. This embarked upon new hobbies, learning new skills, and bringing innovation in the societies as per their interests. In 2006, the first Maker Fair was held in California's state named San Mateo, to introduce this idea officially, where people were brought together to explore and

collaborate about making ideas. Various workshops after the first faire were expanded throughout the globe while initiating various, sessions including competitive advantages for the winners, and other advantageous workshops were originated to ensure public interest (Avneet Hira, 2014).

Two people named Dennis Krannich and Paulo Bilkstein initiated the FabLab project, to pay focus towards skill building while focusing on the fluency-based approach to ensure students can design and engineer their thoughts. The basic aim of this digital laboratory was to enable students to think outside the box and design their solutions for the already defined problems. Fablabs was the initiative being prompted by the Makers Movement, which was created to meet the challenges of learning coming shortly (Avneet Hira, 2014).

There has been a slight shift in the idea of maker spaces in the upcoming years, as now the maker spaces are working inside and outside of schools at individual and collaborated levels where the ideas flow freely among instructors and students while fulfilling the gap. Various goals had been focused on during these sessions such as peer-to-peer learning and teaching, iterative sessions being infused, learning driving exercises, and lastly, interdisciplinary learning programs (Pao-Nan, 2018). The mistakes are discussed completely while leading towards eventual success toward learning. The maker movement played a significant role in the overall passion, human capability to understand their skills, and development of problem-solving techniques (Education, 2017).

### 2.1.1 Role of Maker Movement

The maker movement played a significant role in bringing a revolution in the educational system especially in the USA region and various European countries. There is no doubt that the enhancements in the maker movement come in with conceptual and technological advancements, which were never observed before. Attributes like self-learning, technology learning such as computing, programming languages, sketching, video making, and 3D designing have been the most significant learning outcomes of this movement (Janneke van der Poel, 2016). Some of the most significant societal trends that helped the maker movement alive throughout the previous historical era in the education sector are:

- i. Progressive education was accepted on a bigger spectrum due to its innovative ideas and tenets coming with it.

- ii. The economy of nations still needs innovative ideas to be accomplished to buy in more constructive ideas (Education, 2017).
- iii. Making Education brings in more popularity for the code lovers as they will be able to play with the code during making (Ayu Istiana Sari, 2017).
- iv. The reduction had been observed in the physical computing choices while aiming to reduce costs for digital fabrication.
- v. The invention of more powerful, innovative, easy, and rigorous tools for learners, to examine their making skills while performing tasks and achieving project goals within the maker spaces (Janneke van der Poel, 2016).

## **2.2 Introduction to Maker Education**

Start thinking of solving a simple math question being a child, one can do mistakes, then learn again and try until you get the right summed or subtracted answer. This trial method is believed to be the basis of the maker education concept. Maker education can be defined as the most advanced and transformational approach towards educating the child while trying to use the real and most relative requirements of learners. It provides an opportunity for the learners, where they can explore themselves as learners while giving new ideas to improve the existing systems (Schad, 2019). It's not particularly about the stuff being used, rather it focuses on the native approaches being adopted while using various mindsets, especially when it comes to teachers. Teachers do belong to different communities and this type of education facility does provide the to think outside the box, to make their students explore themselves while doing some sound learning and education.

### **2.2.1 Theoretical Foundations of Maker Education**

Being a relatively new concept regarding the structuralism of the educational ways, thus, only three theories are being attached with the maker education and maker space. The strongly correlated theories are:

- **Constructionism Theory by Papert:** This theory as the name indicates emphasizes the learning strategies using making (Kurti, 2014), as in 1993 Papert proposed that all the learners can give a personalized learned artifact while exploring the knowledge bases towards building and coming up with some unique solutions. The participants targeted in this theory use

to explore the ideas while generating some products, using their knowledge, and actively engaging in these activities also give them a physically sound life (Chou, 2018).

- Dewey's theory for Experiential Learning Approach: This approach got its roots in the year 1997, where Dewey focused on learning and how it happens and disclosed learning is possible only by doing that particular act (Dougherty, 2012). Dewey focused on how the students can learn while performing activities themselves. Thus, it can be said that in order to discover the problem solution and to resolve the problems, one needs to develop the learning approach, while teachers can develop various learning activities on their behalf, to help students learn using their knowledge (Piia Naykki, 2019).
- Educational Methods for Montessori level is the last one, which can be approached through playing activities. The materials or educational sets being prepared to be used by Montessori students are specially designed while thinking about the playing activities to be included in either way to indulge student's interest (Lee, 2015). The basic concept building is the result that can be attained implying the active discovery manipulations for children while aiming towards new learning.

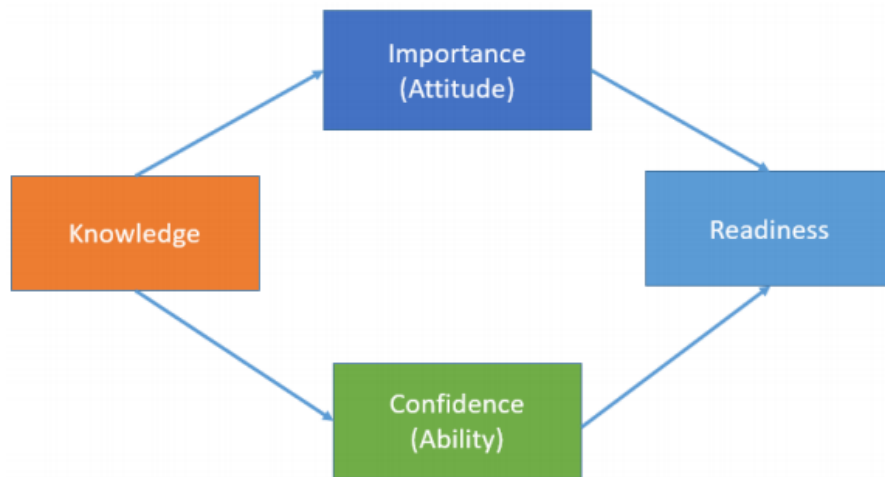
While analyzing all the above-mentioned theories it can be rightly said that maker education was no doubt built on these theories while realizing the importance of learning at each level of education and the learning activities can be designed a per the expected level of learning, while challenging the young minds to discover learning methods and exploring new ways to solve a problem (Chang, 2019).

### **2.3 Teacher's Perception & Attitude towards Technical Readiness towards Maker Education**

Technical readiness can be explained as a term, where the teaching faculty needs to get ready themselves to ensure that they are capable enough to carry out the making process while utilizing some technical skills. With the passage of time and advancements in technologies, every teacher now wants to learn and seek some technical aspect in their teaching habits, while varying in the extent towards the use of technologies (Masood A Badri, 2013). Various researches have been performed to understand the relationship of educator's capability, attitude, and readiness toward maker education. However, there is still a gap present toward finding the relationship among these attributes toward online learning and teaching, as there was not that much need of educating online earlier before the pandemic (Florence Martin, 2019).

To deliver the best learning results and capabilities, the best way is to explore the newer ways to analyze, understand, prepare, organization of teaching material, and delivery it in the best possible manner. Researchers have argued that teaching using the maker process is not very difficult and different from the usual way of teaching but yes it requires a little more effort from the teacher's perspective, as they need to prepare the material to continue the learning process (Masood A Badri, 2013). Teachers need to assure themselves about their competency being a part of maker education to support this strategy. Educators need to be well aware of the fact that these activities must relate to the goals of the content and curriculum being required to learn and resources must be manageable. To join the makerspace, one needs to align all the professional standards with the strategies which can be useful in attaining Information and Communication Technology, while establishing the most challenging learning goals. The teachers must be able to select and use maker education resources while maintaining student safety responsibly and ethically, Readiness towards Use of Online Teaching during Maker Education (Chou, 2018)

Institutions can play a significant role in understanding and finalizing the value of maker education while utilizing the strategical frameworks to access their teacher's capability in this era of modern educational strategies. While the world is fighting through pandemic conditions, it had been observed that various schools and colleges had been moved towards online teaching modules, to students, while putting instructors under tremendous pressure. Making education is the best approach during such times that could help an instructor to explore the ways to teach and let the students learn and skill themselves in the best possible manner (Piia Naykki, 2019). To find the technical readiness of various institutions towards their teaching faculty, various frameworks or strategies can be used based on several attributes either it comes to professional treatment or the value a teacher gives to maker education. But many of them were never tested systematically to be tested and verified when it comes to online makers education. The framework being utilized by various organizations to ensure either their faculty members are technically ready to do maker education online or not is based on the following four attributes:



*Figure 3: Elements of Readiness Measurement Instrument (S. Rollnick, 2010).*

A research study performed by Gay showed the empirical importance of an online service/help desk for the students was the most urgent help needed by the students before, during, and especially after the course had been completed, to seek whatever they want before exams (Gay, 2016). It has been observed that the teachers were not ready to accept this help desk while not being ready towards accepting the latest mode of communications regarding educational queries. Maker education being the latest mean of education first need the educators to be well aware and well equipped before starting the makerspace, to ensure students can completely explore them throughout the sessions especially when it comes to online teaching where the students are sitting on the other side of the screen. There was a conflict being found as the old age educators were not ready to accept the new normals while sticking towards the old ways of teaching, believing that traditional methods are more basic and solid towards learning while the new teachers showed a relative readiness towards the acceptance through various research studies (Ayu Istiana Sari, 2017). Those teachers who were new to online teaching were reluctant as compared to those who were already doing this, as they were more use to technologies as compared to the non-technical makers.

To seek the readiness towards maker education, we need to understand the term "attitude" first, as it can vary as per different aspects, but in the education sector, when teacher's or educator's got their point of view about their teaching style, or the way they use in relevance with their thinking, can be called as an attitude towards learning (Florence Martin, 2019). Various research studies had declared that measuring the directed ability of an educator is not quite possible so we look over the perception and attitudes of educators towards the adoption of newer technologies, rather not challenging them directly (Chang, 2019). The attitude cannot be



concentrated towards one way of learning i.e. what students are learning, rather it is directly related to teachers in maker education, as they need to positively accept this technique while showing their readiness towards maker education. While looking forward to the current pandemic conditions, it can be seen that the teachers and educators around the globe are showing more willingness towards the acceptance of these technological ideas to teach and develop skill development.

### 2.3.1 Competencies towards Online Teaching

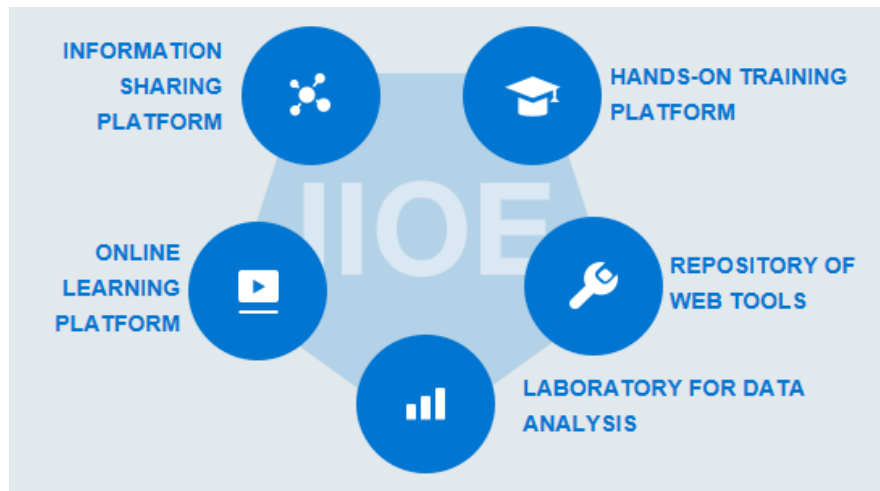
It had been long argued in various recent researches that teaching online is much different as compared to the classroom but when it comes to online maker education, the whole spectrum changes, either it comes to the communication, level of understanding the whole phenomenon or preparation for the study material, where students must be able to explore the new ideas and generate distinctive ways to perform a specific task. Competencies can be explained as a particular skill of a person that makes him effective for that particular task relative to the occupation such as teaching capabilities of teachers can be competency (S. Rollnick, 2010). When it comes to online tutoring, the teachers involved in maker education must be capable enough to handle the online classes (as per the pandemic conditions) while allowing the students to perform the activity and explore the ways to do it themselves and not letting them indulge in something which doesn't allow idea generation (Avneet Hira, 2014). Various researchers had put efforts into understanding the competencies and how these can be measured while looking over the initial theoretical framework being provided (Chang, 2019). In order to test the competencies of the faculty members that either they can execute maker education or not the following four attributes can be checked:

- i. Ways of learning and instructional methods (Ayu Sari, 2017).
- ii. Collaboration skills throughout the maker education process.
- iii. Technology knowledge (Schad, 2019).
- iv. Lastly, management and administration of the overall process.

Another most important factor which can make online teaching a disaster is the design of the course material which can be reflective towards the teacher's ability to perform the maker education. The teachers need to design the course while looking forward to the course outcomes and making sure that the particular activities being enrolled in maker education must be capable

of dealing with the student's workload (Florence Martin, 2019). The assessments can be designed in such a way that they can involve maximum learning while aiming towards the goals of education in that particular area. Course guidelines must be checked before starting the maker education to ensure that the syllabus is not overloaded or dull enough to not let the student explore new ways of doing a task. Course modules can be a helpful way to design the activities of maker education, where the students will be working on idea generation while learning and enhancing the overall learning experience. The most significant role in such a case is assumed to be performed by the school/ college administration, where they need to analyze critically the competencies of the faculty members while looking forward towards the above mentioned four attributes in order to ensure the institutional effectiveness during the pandemic or even normal days where the courses are taught online (Juha Jaatinen, 2020). Lastly, the materials being utilized for the maker education sessions must be credible enough to be examined, verified, and used at various educational levels and the teachers should be more focused on the quality as that cannot be compromised at any chance. The materials included may vary such as the inclusion of play cards, videos, audio aid, simulations, and any other kind of printed media which can help learn and interpret the basics of the module.

Recently, while looking over the pandemic conditions, the International Institute of Online Education (IIOE) working under UNESCO had developed a competency plan for the educators in the developing countries to ensure that the teacher's competencies will not let the making process slow down, especially when it comes to online teaching working under the Higher Education Institutions (HEI) and regarding the learning and making better the competency individually, a teacher/educator needs to develop the below-illustrated skills to manage the online teaching classes.



*Figure 4: Commitments towards Maker Education (ICHEI, 2020).*

These skills will be going to help not only the teachers in learning perspectives but also will allow them to learn the latest techniques and fields such as Artificial Intelligence, Data Sciences, Big Data Analytics, E-commerce, and last but not the least Internet of Things (IoT), etc. Learning these skills will help them to design creative activities for the maker spaces where they can teach in distinctive ways (ICHEI, 2020).

#### **2.4 Teacher’s Perception & Attitude on Utilization of Maker’s Educational Resources**

Maker educational resources can be defined as those technical tools, designs, software, hardware devices, or even the experimental instruments and material being used during the maker education. Various researches had shown that teachers were not ready for the use of resources as they need to design them from the scratch, and these efforts take time, cost, and expected quality, although in some cases, schools and colleges do provide the resources (Cobo, 2021). As maker education is believed to be human-centered strategies, thus, it can be related to the sustainability, availability, and quality of the resources used.



*Figure 5: Makerspace Resources (Austin, 2021)*

In order to ensure that the resources were as per the quality, the institutions were found using effective change management strategies in the most effective way to manage the changed methodology of teaching. Leadership can play a significant role in the utilization of the maker education resources (Ayu Sari, 2017). As the overall perception of teachers towards the use of learning material resources depends upon the professional and technical caliber of the instructor, which can be improved with learning and experience. The instructor's experience can be helpful and challenging especially when it comes to online teaching (being a newer strategy) in building better resources for the students, to be used during the maker education process.

## **2.5 Challenges Faced by the Teachers/Educators during Maker Education**

While looking ahead towards the challenges being faced by the instructors and educators in their classrooms, this section will be going to present some of the basic challenges during classroom sections. These challenges have been collected by various researchers who got the experience of teaching from the third standard to the 12<sup>th</sup> grade. Mathematics, Engineering, and Science classes had been focused on the selection of challenges (Duhaney, 2019). The challenges being identified are:

- Student's Unwilling Behavior towards Working Together:

It has been found that the students exposed to these projects are sometimes reluctant to work as a team, which an essential component of this is kind of learning is sabotaged. As reported by a fifth-grade instructor, children don't want to expose their skills in front of others, while being dependent on others. Thus, they try to avoid working together, which makes the learning process slow (Avneet Hira, 2014). To overcome such situations, the teachers try to make such

programs, where one step is dependent on the previous ones and thus, the students have to work together to get the overall results and this also makes them dependent on each other's help.

- Irresistible Approach towards Program Scope and Scaling:

It has been found through various researches and experiences of teachers, that as every school comes with limited resources, this sometimes makes resilience towards the use of tools for projects, as some student can use them at once during the maker class time, and some remain in the waiting while looking towards their uncompleted projects (Inna Chervinska, 2021). This limits their creative thinking process. The constraint of time and technology can be a hurdle in achieving the real goals behind these classes and can lead to a lag (i.e. behind the schedule).

- Wrong Assessment of Maker Projects:

Maker projects are mostly graded based on the bench-marking process, as perfection is not possible, but putting a grading system for such projects can be a hurdle towards the thinking process. As benchmarking can be a reason behind the loss of student confidence that could lead to failures (Avneet Hira, 2014). Teachers must try to focus on giving comprehensive feedbacks to encourage students, rather than telling them that they failed to meet the criteria. They must be enabled to look and review peer work while leading towards self and peer assessment. Another important aspect being narrated by various maker education experts is that to grade the student's work, rather than having a benchmark, the teacher could go for any presentation element, that could be easier to achieve, to carry on the self-learning process (Cohen, 2017).

- The setting of the Project Boundaries:

The project boundaries if settled while trying to achieve a masterpiece creation are a difficult choice, thus, the maker spaces need to assure that the maker classes are only held by those who got proper education in this field. As rather than settling a masterpiece to achieve, if the dedicated teachers will be settling the goal to make whatever the learner wants, it will be easier and only a well-versed teacher can do it (Janneke van der Poel, 2016). The maker education is slightly different from the norms of education, and this must be understood by the maker educators, otherwise, these boundaries can become unachievable, and the students can lose their interest in the learning process.

- Tools & Equipment Tracking:

Schools always come with limited tools for such kinds of projects, either it comes to the time of these classes or the equipment. In such scenarios, most of the students try to escape with tools to apply and complete their projects at home. This makes the overall tracking process more difficult for the assessor. In short lack of technical infrastructure in institutions is another challenge for the educators which can be related to fewer finances or less education regarding the benefits of using maker education (Avneet Hira, 2014).

- Accessible for Lower-Middle Class Societal Schools:

These programs are quite expensive as compared to the other school-based programs, as the upper-middle-class schools can buy extra equipment and tools required for the project's making, thus, another challenge for these programs is to make them available for all those who cannot afford it either it comes to administration or the students. The equipment such as 3-D printers, scissors, sketching boards, cutters, and many other tools are expensive to buy from the school expenses (Education, 2017).

- Limited Knowledge and Understanding

Maker education being the latest learning and educating technique, first needs the educators to understand their core responsibility whole utilizing the benefits coming in with this technique. Contrary to this, the teachers are not well aware of the process which can help them integrate maker education resources in maker activities while leading this gap in understanding and appliance (Pao-Nan, 2018). As it had been observed through various research studies that it was difficult to integrate and design a maker's lesson for a mixed class of students with technological and non-technological backgrounds, which can lead to disorientation at both ends (Duhaney, 2019).

- Lack of Training in Software and Websites:

As maker's education is a newer technology, most of the faculty being dependent on the old school techniques for children are unable to adopt the latest technologies, leading to least use of software technology (Cohen, 2017). Another biggest opportunity of learning is the internet, which the school teachers seem to be a failure to use effectively while posing that these cannot affect student's learning process (Duhaney, 2019).

- Lack of Time in Institutions:

As every institution is already following a curriculum throughout their educational years, thus, to find some extra time out of the daily timetable is another conspiracy, which various principals and management had been found saying as an excuse (Education, 2017). Time management seems to be a hurdle, but still, it can be recovered, using rigorous scheduling, while putting an extra-curricular activity on weekly basis for every subject.

- Student Safety:

It had been observed that as a maker's education allows the student to explore various ways to achieve the end-product or the skill, thus, for some projects relative to science it could be unsafe. And thus, it had become the biggest concern in Maker Education (Ayu Istiana Sari, 2017).

- Lack of Maintenance of Makerspace Equipment:

Due to negligence had been received from teachers in utilizing the maker's education strategy, as they were unable to utilize the equipment in the right way (Schad, 2019). Thus, it had been another challenge for them to maintain this learning strategy while securing the equipment either it comes to the computing devices or the tools being equipped for students to learn further.

## **2.6 Opportunities for Maker's Education**

The opportunities coming along the maker education can vary from the teacher's perspective towards the student's perspectives. Makerspace came with a lot of opportunities not only for the educators and learners but also for the organizations initiating it. Such as having maker education at the schools and colleges can bring in more entrepreneur and business opportunities for the suppliers bringing in the supplies needed for the activities to be included either it comes to tools or the equipment. This step can help increase the economic uplift of the society as well (S. Rollnick, 2010). Maker education help to promote contextual education, while increasing the basis of contextual concepts, which doesn't even help the child to learn basics but also helps to invent their ideas while bringing in different solutions towards scientific principles. Makerspace helps in building basics for problem-solving which can help the child to explore and learn various ways to solve the same problem (Chang, 2019). This strategy helps the students to integrate sustainable STEM education i.e. Science, Technology, Engineering, and Mathematics to meet the standards set by the educational boards and committees.

Another most significant opportunity which maker education brings is the appreciation of social media, which helps to generate public awareness to let the parents and educators understand the significance of maker education and helps to promote maker space enhancement in educational institutions (Lee, 2015). Maker education brings in learning the latest technology opportunities for the instructors also, where they can learn the latest tools and software to make themselves equipped to carry on the maker education. This will help to increase the workflow, as new hiring for most advanced people will be done to ensure they will carry out the online and physical maker education most effectively. The biggest prospect which can be witnessed along with the enrollment of maker space is the society build-up towards the latest learning tools either it comes towards the technological tools or the use of learning using various online resources for the benefit (Dougherty, 2012).

## **2.7 Chapter Summary**

This chapter included all the existing literature regarding the use of maker space and how maker education can help build a better future in regards to the attitude and perspectives of teachers. A complete overview of maker education had been performed while looking over the attitude of teachers towards the utilization of resources in giving education and finding out the technical readiness of teachers for using the technical tools to provide education and training. This chapter also included various challenges and opportunities in using maker education either it comes to collaboration during the pandemic or the idea generation from the student's perspective (Chang, 2019).



### **3. Research Aims & Objectives**

This research study aims to provide the basic understanding of maker education while looking forward towards various perspectives such as technical readiness, attitude during maker education attached with the teacher's or educators' point of view. In addition to these, this study aims to identify the challenges faced during the process. Following the key objectives of this study:

- To describe the Maker's teachers' technical readiness towards maker education resources.
- To describe the Makers teacher's attitude towards maker education activities during the maker education while using resources.
- To identify the challenges faced by the Makers teachers during the maker education activities.

#### **3.1 Research Questions**

Following are the research questions, which this research study is going to answer while exploring the results:

RQ1: What is the level of technical readiness of teachers/educators on utilization of maker resources in maker classes in universities?

RQ2: What is the Maker Teacher's/educator's attitude towards maker-based teaching activities during maker classes in universities?

RQ 3: What are the challenges faced by Makers Teachers/educators during the maker education activities?

## 4. Research Methodology

Finding the role of teachers towards the maker education was the goal of this research while looking forward towards certain factors such as teacher's readiness towards the use of technical equipment for maker education, attitude towards the maker activities, and lastly, the challenges teachers and educators faced during the maker activities at the university level. Thus, this research study is based on Qualitative Research Analysis, as it is going to investigate the quality of certain relationships and particular situations while aiming for an in-depth analysis of the situation regarding maker education (Chang, 2019). A detailed and descriptive analysis will be performed to analyze the use of maker education while looking forward towards the opportunities provided by the universities of Finland to the educators.

As there was not enough and qualified research was performed regarding the teacher's perceptions and experiences during the use of maker education, thus, a qualitative exploratory research design is optioned out to explore the answer to the research questions. The qualitative research analysis will be going to benefit in identifying the behavior of teachers towards the technological equipment while representing the issues they faced and the level of knowledge towards using the latest tools and equipment etc. This exploratory research design is going to focus on three basic attributes coming from the instructors and students which are readiness, attitude, and challenges, as they are believed to help decide the research results in an effective way (Pao-Nan, 2018).

### 4.1 Population Sampling

A total of 20 university professors were asked to fill the questionnaire while describing the real purpose behind this survey-based research. Among them, 14 agreed to fill the questionnaire and among those 14, three wanted to be anonymous, although they mentioned their job role. The table below represents the overall demographics of the instructors:

Attribute	Count	Percentage
GENDER:		
Male	9	61.5 %
Female	5	38.5%
AGE:		
30-40	8	57.1%

41-50	4	28.57%
51-60	1	7.14%
60 above	1	7.14%
INSTITUTE NAME:		
University of Oulu	9	64.28%
University of Helsinki	2	14.28%
University of Copenhagen	1	7.14%
Anonymous	2	14.28%
OCCUPATIONAL ROLE:		
ICT-Development teacher	1	7.14%
Professor	1	7.14%
Ph.D. Student	2	14.28%
Ph.D. Candidate	2	14.28%
Associate Professor	1	7.14%
Researcher/Instructor	2	14.28%
Education Coordinator	1	7.14%
International Educational event organizer	1	7.14%
Host	1	7.14%
Craft Designer	1	7.14%
University lecturer	1	7.14%

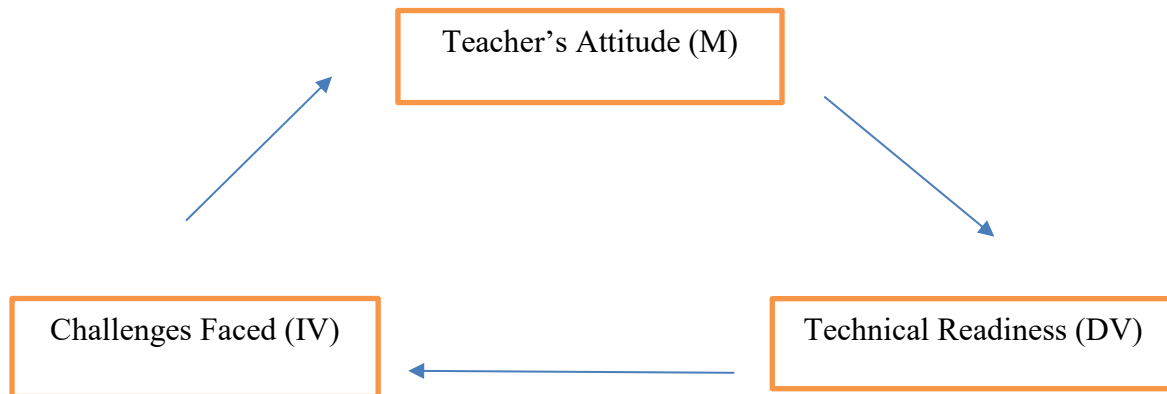
*Table 1: Demographics*

## 4.2 Research Framework

After doing a complete systematic review of literature, it has been confirmed that there is a significant role of teacher's readiness towards pursuing the teacher's attitude for the maker education and thus, a framework shown in Figure below is designed to explore the perceptions and experiences of teachers and educators towards maker education (Lindfors, 2019). This research aimed to explore the see teacher's readiness, the attitude towards activities being performed, and lastly, to recognize the challenges being faced during the maker activities, thus, a comprehensive research methodology was optioned out to analyze the critical aspects of maker

education. The overall research framework was built on three basic attributes regarding the teacher's perspective over the use of maker education in their respective institutions (Inna Chervinska, 2021) which are:

- Teacher's Readiness towards Resources (Dependent Variable)
- Challenges Faced by Teachers during maker education (Independent Variable)
- The attitude of teachers towards maker activities (Mediator).



The designed framework doesn't only illustrate the direct relationship among the selected variables but also describes the mediating role of teacher's attitudes while demonstrating the use of maker education in Finnish Universities.

### 4.3 Data Collection

Questionnaire Survey was distributed under complete supervision, in order to collect the data from the respective instructors. The questionnaire was designed over the software tool named "Google Sheets", which later on was shared with the agreed professors, as before distributing the questionnaires, they were asked either they want to participate in this informative research or not.

#### 4.3.1 Data Collection Tool

To collect the data from the diverse group of respondents, the Questionnaire-based survey strategy was selected based on three basic categories, while dividing each category into further 10 questions each, to understand the individual stance on each factor. One open-ended question was asked at the end of each part, to give the opportunity to the respondents to explore their relative perceptions and experiences regarding the technical readiness, their attitude towards

the use of resources in maker activities and lastly, challenges coming through the maker activities.

#### 4.3.2 Scales Used for Questionnaire

The scale being used in the questionnaire, in order to get the absolute results regarding the teacher's and student's behavior towards the use of maker education, the following three scales were used based on the three categories being diagnosed already:

- **The Scale used to Evaluate Teachers Technical Readiness:**

To evaluate the readiness in accordance with the statements regarding the teacher's readiness towards resources used during maker education while using the following scale in order to justify and explain the results.

1= No compatibility, 2= Average, 3= Fair, 4=Good and 5= Excellent

- **The Scale used to Evaluate Teachers attitude towards Maker Activities:**

To evaluate the attitude of teachers towards the maker activities during teaching, the following 5-Likert scale was used:

1= Strongly Disagree, 2= Disagree, 3= Undecided, 4= Agree and lastly, 5= Strongly Agree

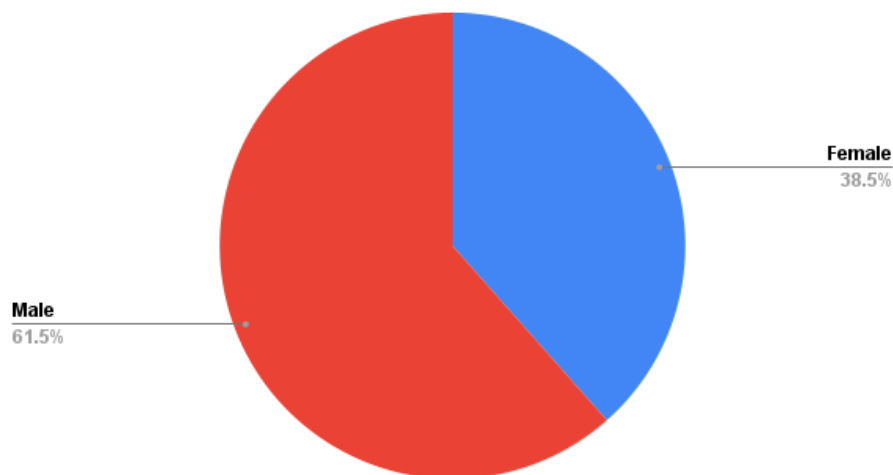
- **The Scale used to Evaluate Challenges faced by the Educators in Maker Activities:**

In order to evaluate the challenges faced in the maker teaching process during maker education activities while using the following scale to justify and explain the results: (Ayu Istiana Sari, 2017).

1=Never, 2= Seldom, 3=Sometimes 4= Often, and 5= Always

## 5. Results

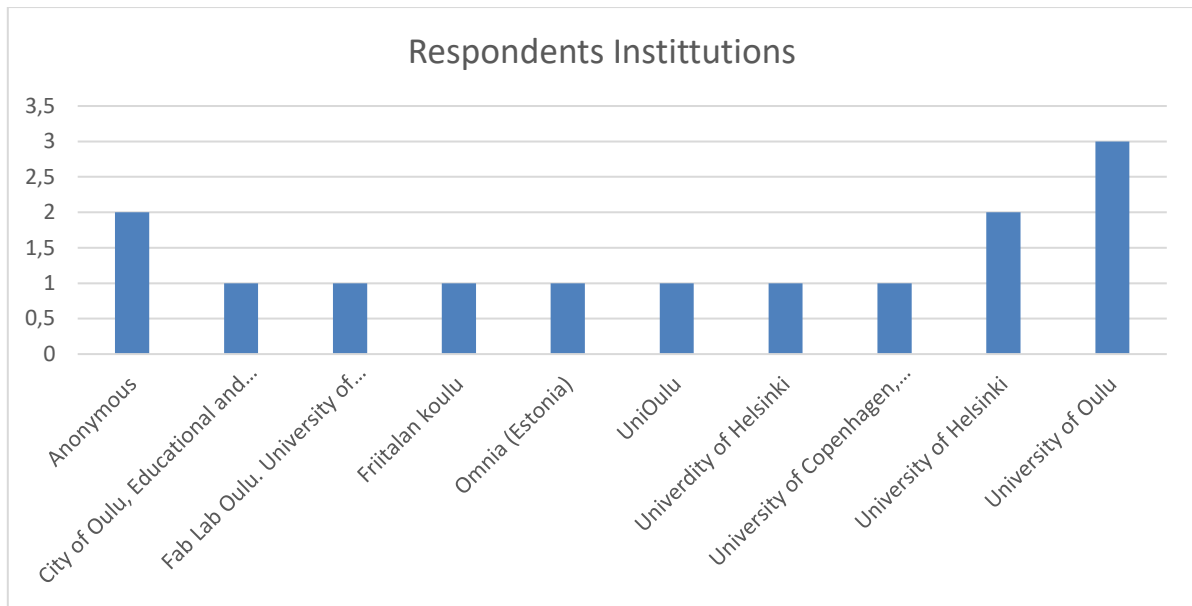
This chapter is going to explain all the answers to the survey questionnaire while illustrating the results in graphical format. To make the results of this research more effective and collaborative, the respondent's comments have been incorporated while ensuring that the research ethics are not demolished. Out of the total expected sample size of 20 (as assumed), only 61.5% of representing 8 men out of 14 agreed to complete the survey, on the contrary out of 20, only 6 women responded with complete responses representing 38.5% of the total making a total of 14 respondents for this research study.



*Figure 6: Total Number of Respondents*

The most experienced and qualified professionals from the education field were requested to fill the questionnaire while looking forward to their experience in maker education. As far as the institutions are concerned, from where the educators belong who had answered, as the graph below illustrates, most of the respondents belong to Finland, the University of Oulu, and the University of Helsinki. But the most distinguished and amazing aspect of this research was to get involved with two professors from the University of Copenhagen (Denmark), the University of Malmo Sweden, and Omnia (Estonia).

So it can be said that collectively we got a response from Sweden, Denmark, Estonia, and Finland, which allowed exploring the ways how maker education is used at the international and Scandinavian level. Out of the 14, two of the respondents didn't want to share their institution name, so it was accepted while following the ethics of research.



*Figure 7: Institutes of Respondents*

To move towards conclusive results, the results section is divided into basic three portions, while aiming towards each goal as described earlier.

- i. Technical Readiness towards Maker Resources.
- ii. Attitude towards Maker Activities.
- iii. Challenges coming in Maker Activities

### **5.1 Level of Technical Readiness of Teachers towards Maker Educational Resources**

Technical Readiness was the core component of the first part of the questionnaire, where three basic skills were examined using 10 questions inside the survey. The skills selected and incorporated in the questionnaire are:

- Computational Thinking Skills
- Creative Technological Skills
- Problem-Solving Skills.

This part of the questionnaire focused on the teacher's and educator's awareness regarding the integration and alignment of maker education and the relative integration of maker education and the individual Competencies either it comes towards the organization of the curriculum planning while targeting time and maker education learning goals. To answer the very first research question, the questionnaire responses for the first part including the 10 questions had been evaluated to reach authentic and valuable results.

### 5.1.1 Educator's Competency

Mixed responses were found regarding the readiness towards the use of maker resources while supporting the educational methods, such as 50% of the respondents considered them confident enough to share the maker resources while teaching and they showed positivity towards the use of technology equipment.

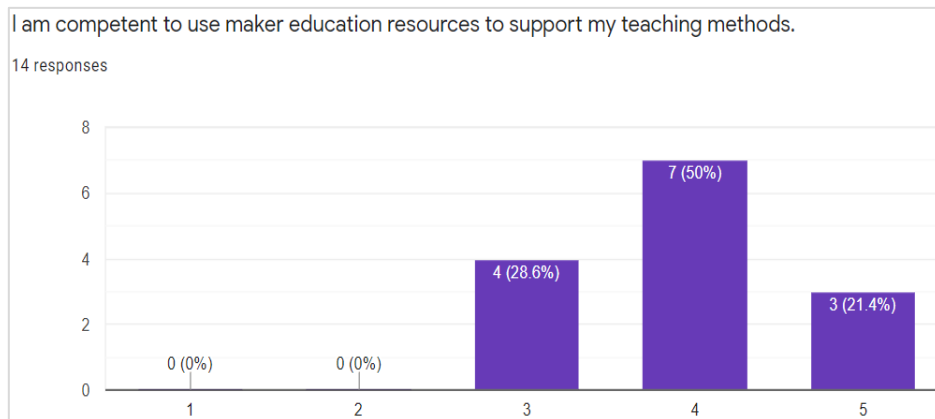


Figure 8: Overall Competency Percentage

There are multiple reasons behind that as some (31.3%) of them knew the maker education already prior to their teaching and learning experience, so they were already clear enough to use the resources, while some wanted to learn it more clearly, so after complete understanding, they can apply the resources in a better way.

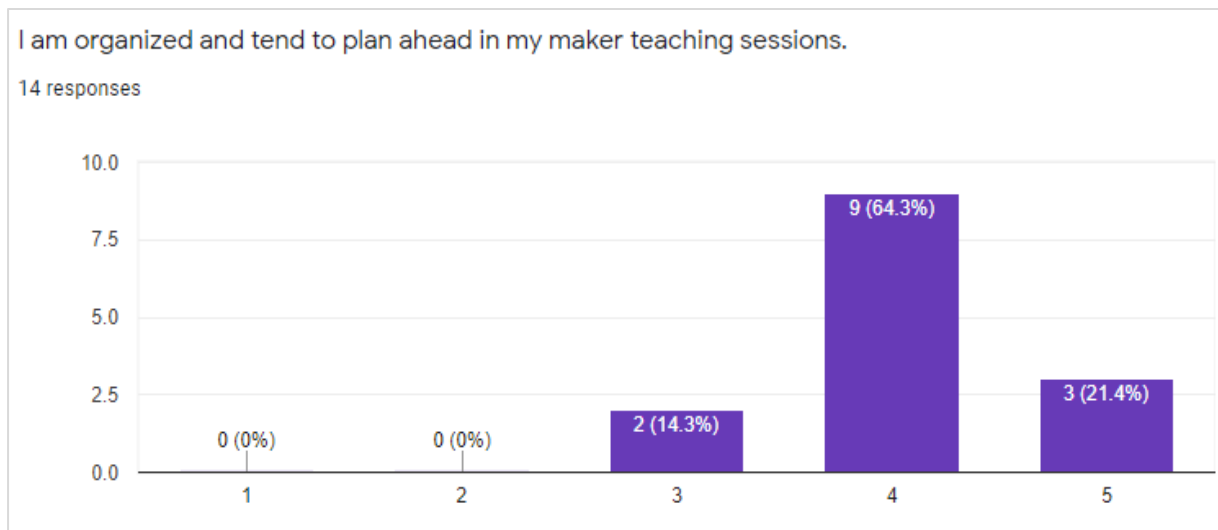


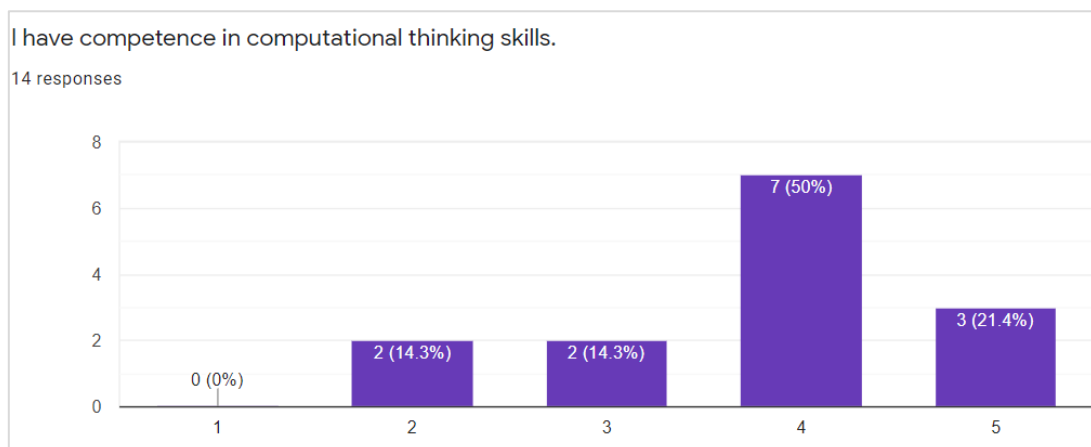
Figure 9: Technical Organization



As far as the question related to organization and planning of the content is concerned, 64.3% of the respondents were found to be ready and showed acceptance towards planning and organizing the maker education resources into their curriculum while 21.4% of educators found to be already using the maker education in their curriculum activities. These results indicate that still teachers are aware of the advantages of using maker education but they are facing challenges regarding time management in order to create a new activity that will suit their curriculum goals and align perfectly in between.

### 5.1.2 Technical Awareness

Technical awareness can be explained as a term relative to the readiness of teachers towards the use of technology while incorporating maker education. To measure the technical awareness in teachers, questions relative to the computational, problem-solving, and creativeness towards technology use have been asked. As it can be seen in the graph below, 50% of the respondents were found to have computational thinking skills and the reason behind this was because of internet resources and prior knowledge in their specific domains. 3 (21.4%) of the respondents found completely able to incorporate computational skills in the thinking process while utilizing the maker education resources.



*Figure 10: Competence towards Computational Thinking Skills*

The graph below illustrates the problem-solving skills of the teachers, as it can be seen that there is a strong coherence being found towards readiness from teachers while indicating that almost 43% of teachers are already resolving issues related to makers education using these skills and 57% teachers showed good competency towards technical awareness.

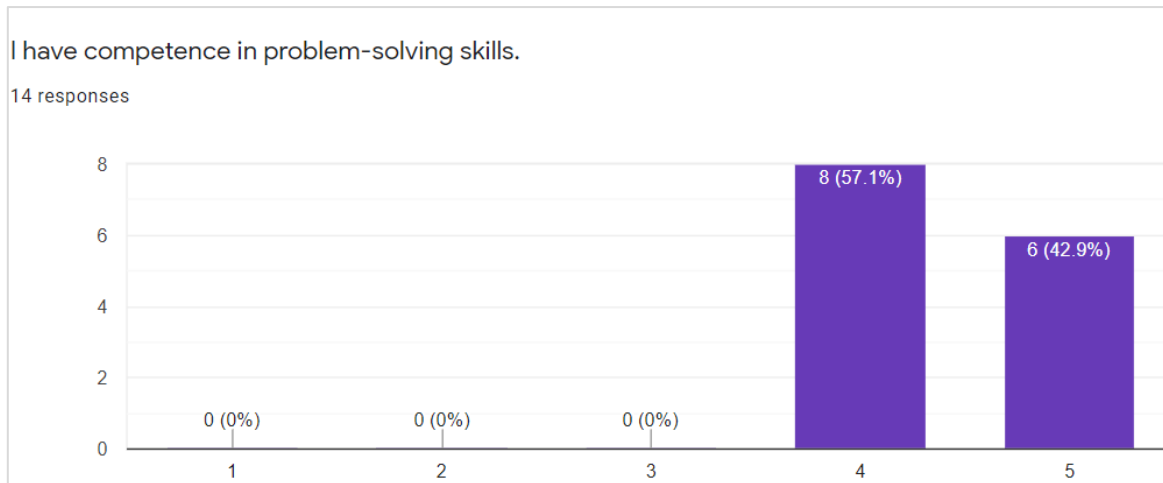
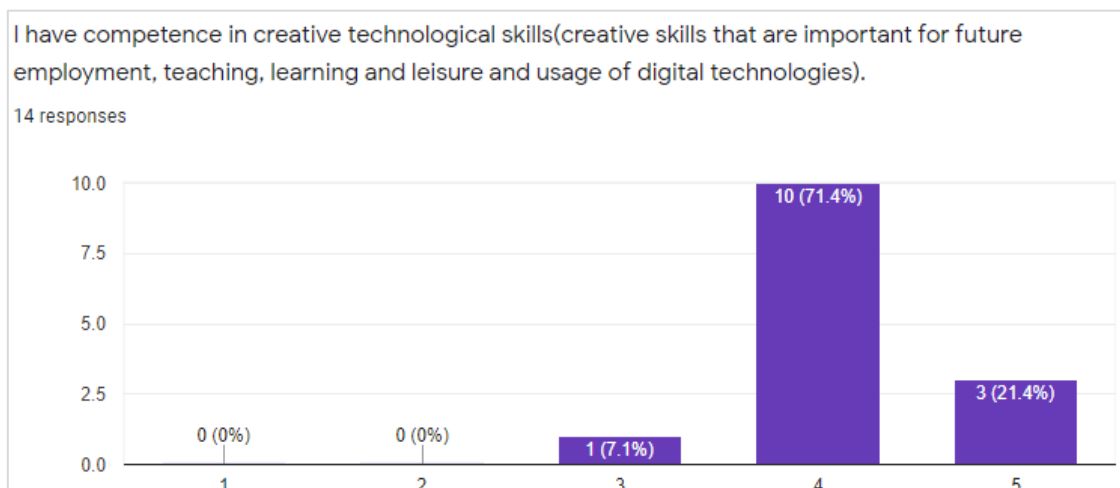


Figure 11: Competence in Problem-Solving Skills

Competence in creative Technological Skills can be defined as a personal attribute for teachers, where they can be able to induce technology-based creative solutions towards problems, as being a teacher they must be ready to induce such solutions or give ideas to students to incorporate them as 71% of the teachers were using this competency in their daily work. 21.4% of the teachers were found using these skills perfectly as one of the respondents was found to be an award winner in using the creative skills.



### 5.1.3 Alignment of Makerspaces

On the contrary, there were slightly different results when it comes to the integration of maker education into the curriculum contents, while trying to achieve the same goals. Only 25.7% of respondents agreed with the statement while considering themselves able to integrate, on the other hand, 14.3 % of respondents were found on average level and lastly, 1 of the respondent found difficulty in understanding some of the features in maker education. The table below

clearly indicates that there is a strong need to re-defining maker education and its tools for teachers so that they can become able to use them on their best while incorporating curriculum goals into the resources.28.6% of teachers were already using the completely aligned technical resources.

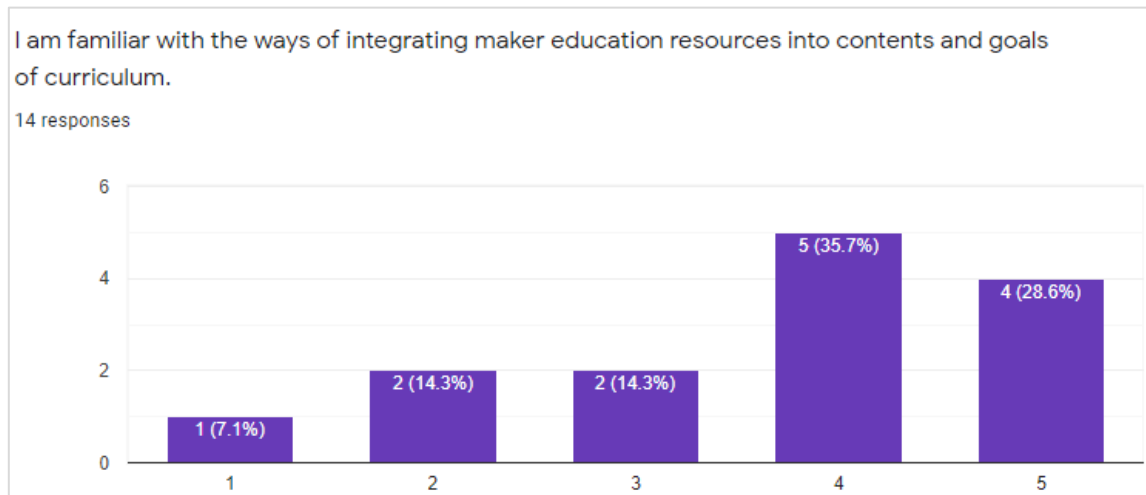


Figure 12: Familiarity with Integration of Resources into Educational Content

14.3% of the respondents were found managing their time for the maker education activities, these activities need separate time to utilize the best creative skills for making and organizing these activities within the curriculum as illustrated below. Usually, the digital fabrication of the activities has to be planned carefully, because they usually take more time than additional activities and that's why 3 respondents only managing a fair amount of time from their busy schedules to make such activities. You always need to book time for unexpected events.

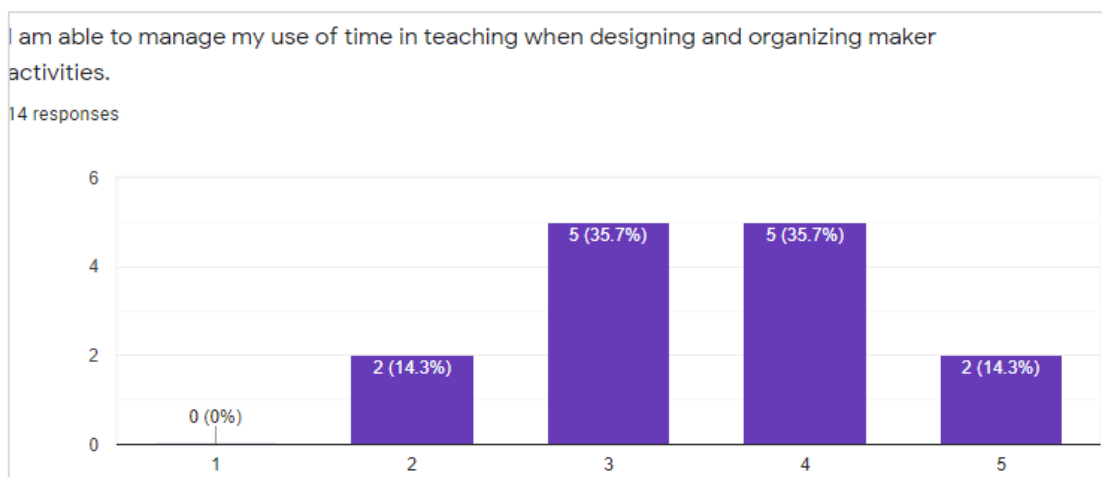


Figure 13: Time Management

The alignment of maker education as per the standards is not an easy task, as many of the time the real essence of maker education can vanish when it comes towards making the curriculum and educational resources. The answer to this question was interesting as only 1 (7.1%) respondent was found to be not in favor of following the standards. 28.6% of the respondents were found using the standards completely and 50% of the respondents were found using some of the standards but not all the provided.

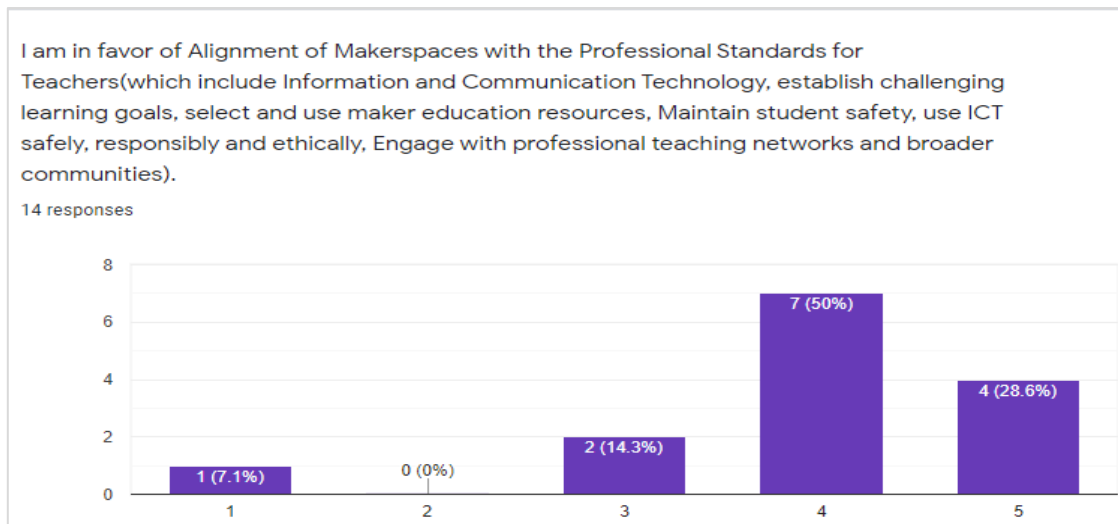


Figure 14: Alignment with Professional Standards

The overall competency at the individual level has been evaluated while understanding the individual readiness towards the user of maker education and utilizing the responses from each question in this part has been illustrated below. Most of the respondents were positive either it comes towards the use of maker education or the knowledge of the technology needed to ensure effective maker education utilization during the curriculum management.

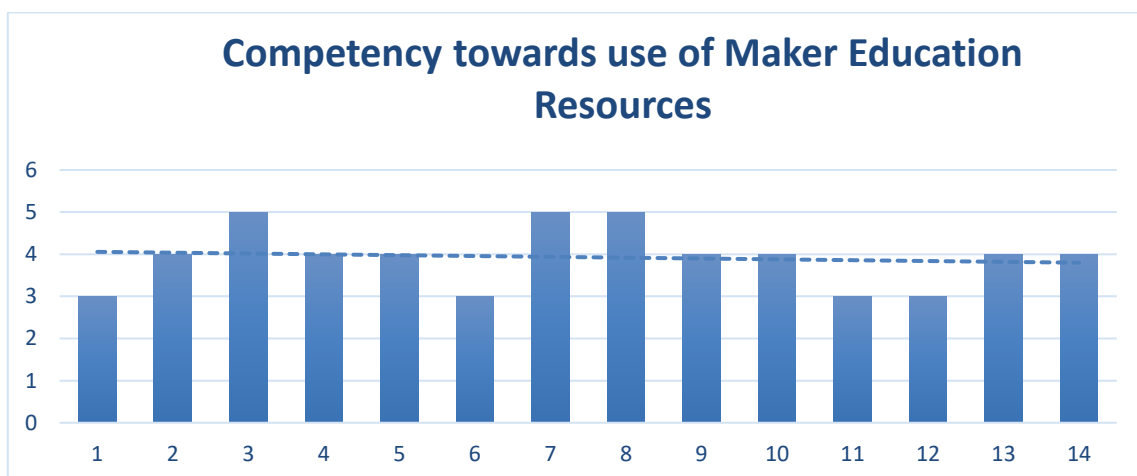


Figure 15: Overall Competency towards Use of Maker Resources

The use of resources for the maker education and learning process showed a relatively positive behavior from the teacher’s perspective, as it can be said they are ready to integrate the maker education into the curriculum and some of them are already using the maker education successfully while managing the time and resources. As far as technological readiness is concerned, many of the teachers are confident in saying that the digital fabrication of activities needs to be planned carefully, as this process usually takes more time than adding the other curriculum-based activities.

## 5.2 The Attitude of Teachers towards Maker-Based Teaching Activities

### 5.2.1 Interest towards Maker Activities

As far as the interest of teachers is concerned towards learning and experiencing the maker education resources. As it can be seen 28.6% of educators completely agreed with this learning experience, as they believed that this strategy can enhance the overall teaching experience. As Maker education activities come with an interesting toolbox towards enhancing teaching while making it more attractive. As it provides teachers with additional skills apart from technical ones. However, the below graph illustrates the results well while depicting 50% of the audience agreed while showing interest in maker educational activities as a source of self-learning:

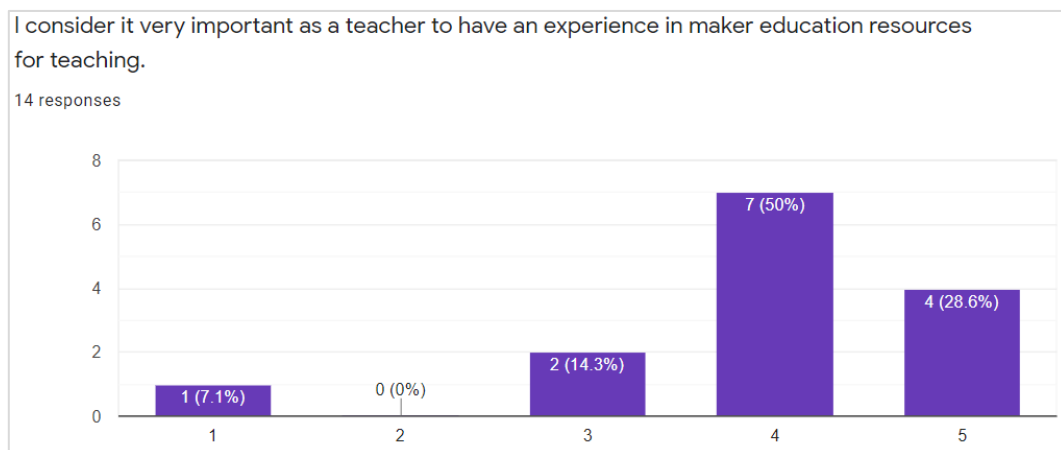
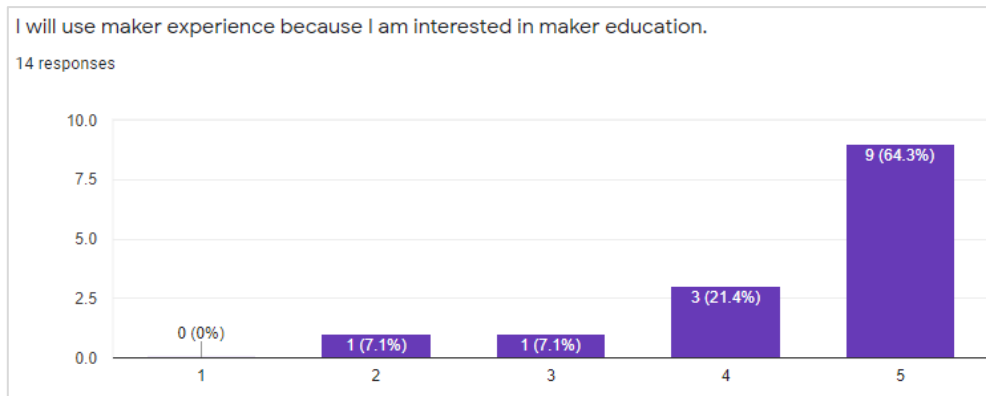


Figure 16: Level of Interest in Maker Activities

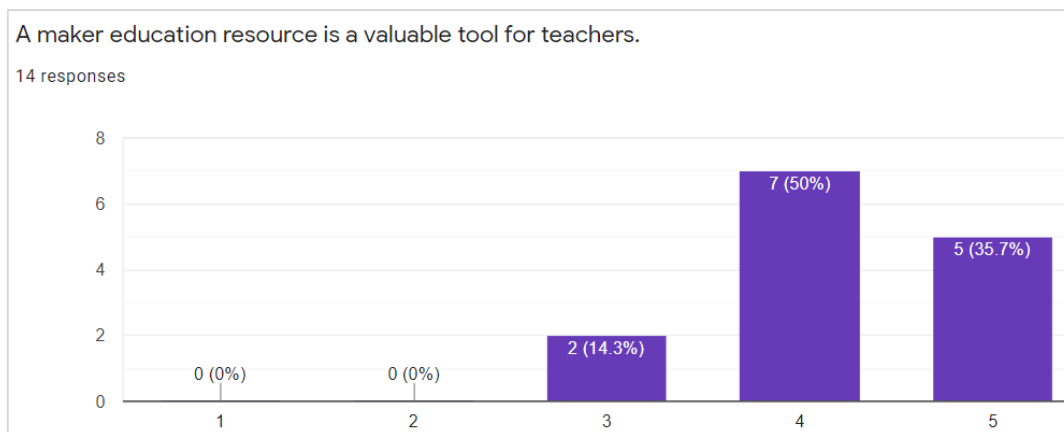
### 5.2.2 Maker Experience

A higher percentage i.e. 64.3% teachers agreed to utilize the maker education experience as many of them are already interested in maker education.



*Figure 17: Maker Experience*

While the teacher's interest in maker education, it has been found that almost 50% of the teachers felt comfortable using the maker education resources as tools and equipment while teaching and learning. On the contrary, 21.4% of respondents were undecided either they wanted to use maker education resources as equipment for learning and teaching. The graph illustrated below indicates that 50% of the respondents agreed that maker education is a valuable tool when it comes to as an additional helping skill for the teachers. 35.7% consider that maker activities can engage students while bringing in expertise for various problem-solving skills. 14.3% of the teachers found undecided towards considering maker education as a valuable tool.



*Figure 18: Value of Using Maker Tools*

There is no doubt that the maker educational tools have been considered to be the best learning equipment either it comes towards the teacher's perspectives or the student's. Teachers do agree with the statement shown below, as almost 85% of the teachers completely agreed that maker education brings new learning opportunities for teachers while focusing on individual

experiences which make them excited. Another reason found were the rewards and recognitions from the management as students indulged in maker activities are another opportunity for the organizations.

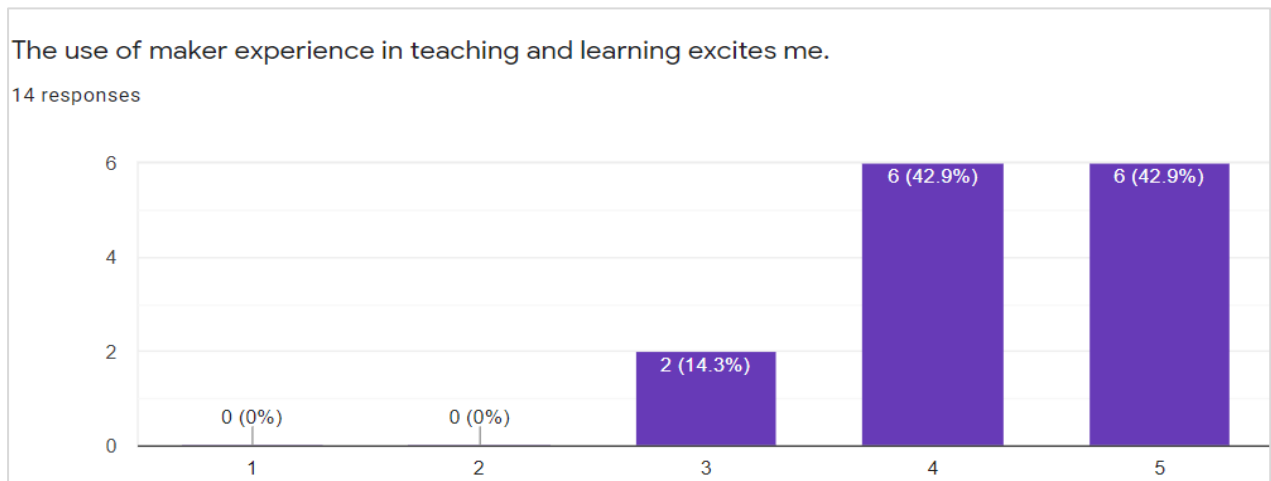


Figure 19: Excitement towards Maker Experience

As far as the value of maker activities is concerned, 42.9% of the teachers found maker education as the best learning resource, as it brings in various positive effects for students while processing the way of thinking and working. While repeatedly using making exercises, 28.6% of the teachers believed that goal-oriented sessions bring the opportunity of exploring and learning with a more practical approach and tangible resources can be an effective way of bringing in better opportunities.

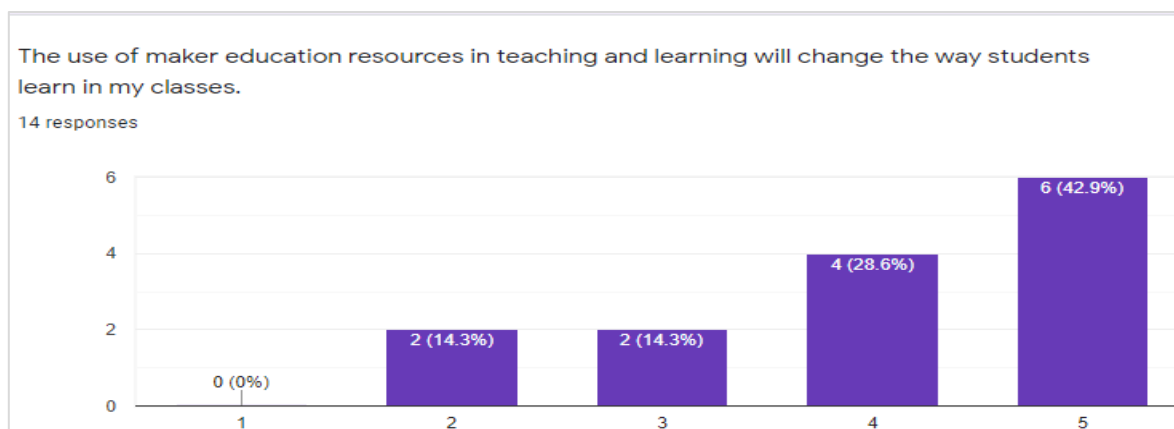


Figure 20: Student Learning

### 5.2.3 Maker Activities

As we know the basic purpose behind the initiation of maker education was the opportunity towards exploring personalized ideas while seeking a specific skill or even a technological tool. Maker education allowed exploring in one's way while incorporating the curriculum along with the activities. Most of the time it has been seen that the teachers forget the basic aim of maker education and focused more on the tools and gadgets while not giving enough space to students to learn the tool themselves. As 14.3% of teachers completely disagreed with the statement shown below. While 64.3% of educators were not focused enough to determine either they ever lost the basic aim of maker education during maker activities or not.

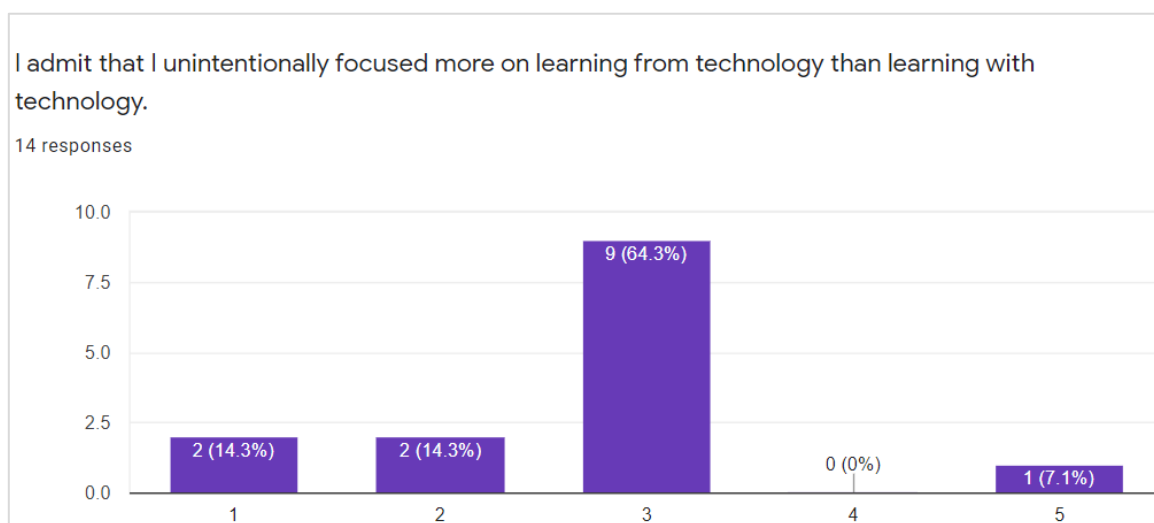


Figure 21: Focus on Learning Maker Education Activities

Looking forward towards the current pandemic conditions, the teachers must be ready to accept the maker education as the new normal, and the question asked in this regarding while looking towards the knowledge of using advanced technologies, 64.3% teachers were found aware towards understanding the necessity of maker education. Although more discussion on the ethical and environmental issues with digital fabrication and technology use is required, 50% of the teachers agreed that they clearly understand the role of maker education towards meeting the sustainable developmental goals, especially when it comes to activities used in the business management subjects. As generating ideas while learning the latest technologies allows students to generate better business ideas on their own, but for that teachers must be aware of the SDGs, so they can teach.

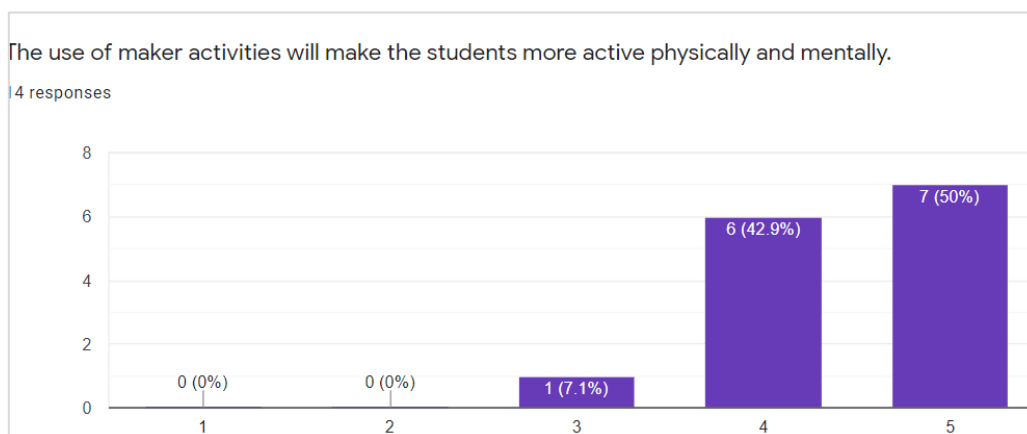




*Figure 22: Awareness about Importance of SDG's*

#### 5.2.4 Response of Maker Activities towards Students

Maker education is believed to be the most interactive tool either it comes to mental health or physical. As 50% of the respondents completely agreed to this point, that it helps the students to get better growth mentally and physically. Almost 43% of the respondents also responded positively to this question as shown below in figure 24. Maker education can affect different children, as said by 7.1% of the educators. It cannot behave in the same manner for every child, as the perceived level of every child is different and can portray a different kind of results to each of the students.



*Figure 23: Student Attitude towards Maker Education*

On the contrary, 35.7% of the teachers were not assured that maker education is not an efficient and effective way of learning for students, while on the same time, 35.7% of the respondents agreed while considering this strategy as an effective technique towards building student's mental and physical health. While 4 (28.6%) of the teachers were found completely in favor to

consider this learning opportunity as one of the most effective ways. As illustrated in the figure below:

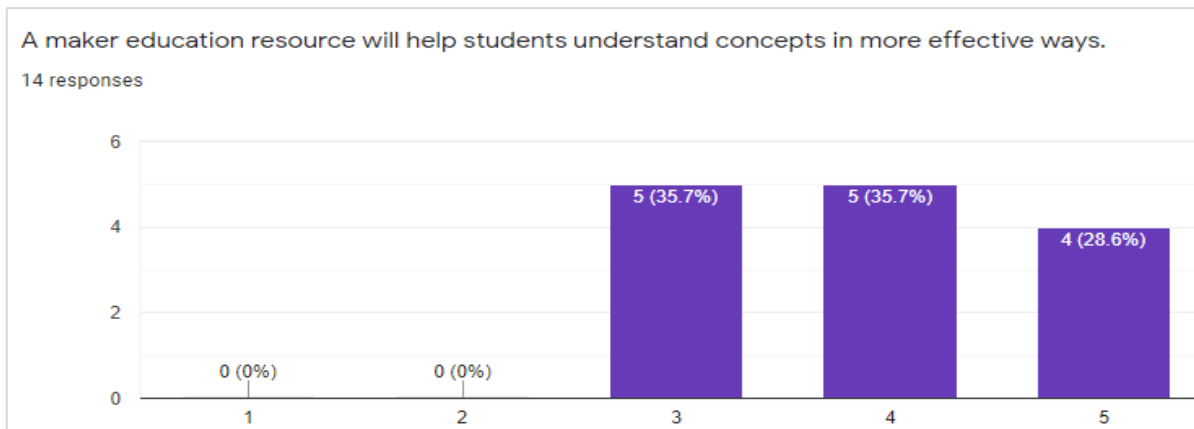


Figure 24: Use of Maker Activities

As far as the individual learning is concerned, when it comes to the issues which the teachers are facing, it has been found that 14.3% of the teachers agreed that using maker education does cause stress to them either because of maintenance of the equipment, learning new technologies, learning the skills to develop various crafts and lastly, developing the skills after learning them. On the other hand, 50% of the respondents disagreed with the statement, as many of them already had the experience of maker education. But still, maker education is believed to be a challenge for teachers at some point in learning.

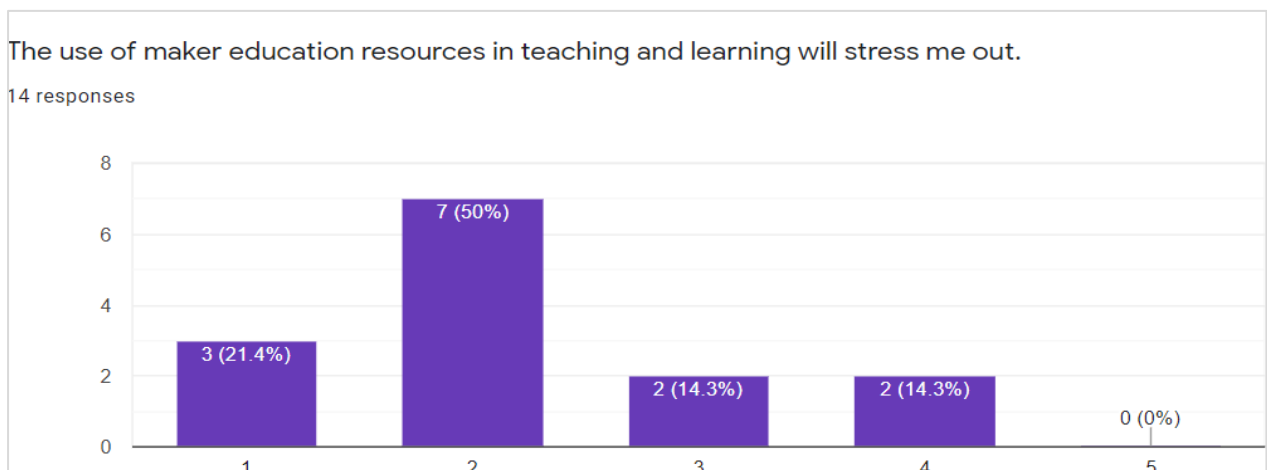


Figure 25: Stress Attached with use of Maker Resources

### 5.3 Challenges faced by Makers Educators during Maker Education Activities

#### 5.3.1 Challenges faced by Teachers

Various significant challenges are being looked forward to when it comes to maker education not only from the teacher's learning perspectives. Various challenges such as alignment of activities with curriculum, technological incapability, resource management, and lack of time management strategies by teachers lead to challenges in this situation. As 42.9% of the teachers agreed that there is a lack of technical infrastructure in their institutions, which lead to various hurdles, while on the other hand, 14.3% of the teachers disagreed with this statement while saying that teachers are facing various other issues such as unavailability of various software tools.

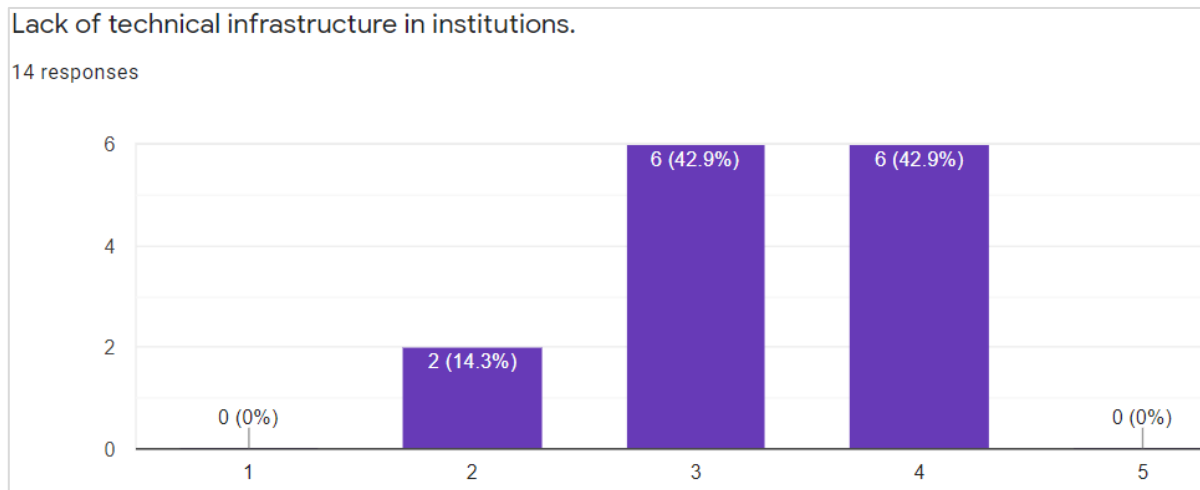


Figure 26: Lack of Technical Architecture in Universities

As far as time management is concerned, 35.7% of the educators were not able to decide either time management is an issue or not, as they faced various other hurdles towards incorporating maker education into the curriculum. The digital fabrication and induction of maker spaces require more time than all the other activities involved. While 43.9% of the respondents agreed that time management is an issue no doubt as planning requires time and thus, it takes time to run maker activities and the time needed is often difficult to assume.

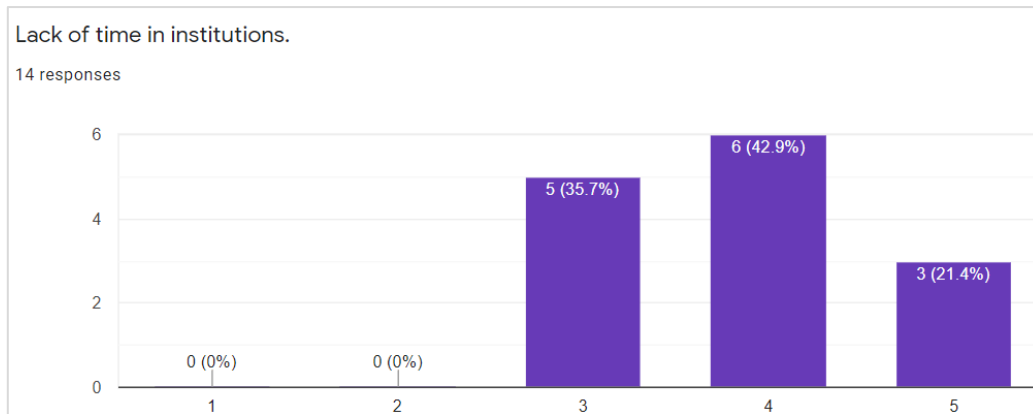


Figure 27: Lack of Time

As far as the conduction of maker activities is concerned, almost 50% of the teachers agreed that there is a lack of knowledge and basic understanding towards integration of various resources in maker activities, while 28.6% of the respondents disagreed, as they said that there are other factors also such as lack of infrastructure in the institutions which lead towards failure in the integration of maker resources.

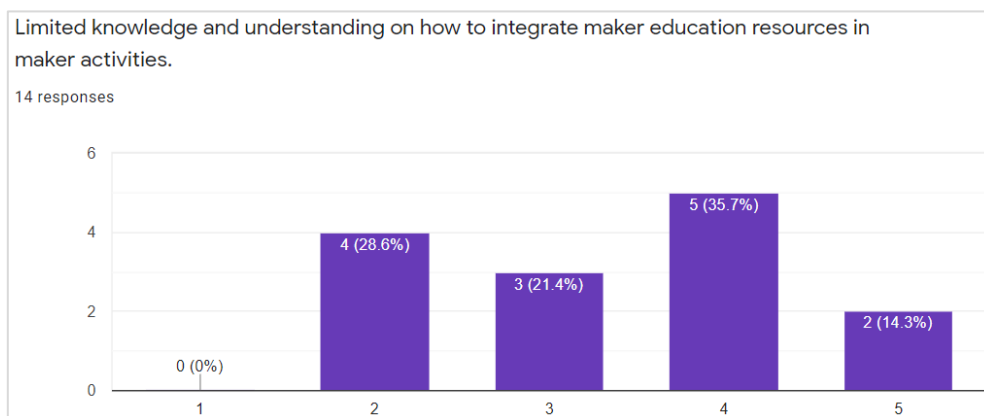


Figure 28: Lack of Knowledge

Maker education does require technological information to handle the latest software tools, either it comes to the field of ICT or any other. The integration of modern technologies requires training for both the teacher and students, as agreed by 21.4% of the teachers. On the contrary, 14.3% of the teachers disagreed while constituting the aspect that in today's era, as the internet is available with all the teaching resources, thus, teachers can learn the tools if they need it.

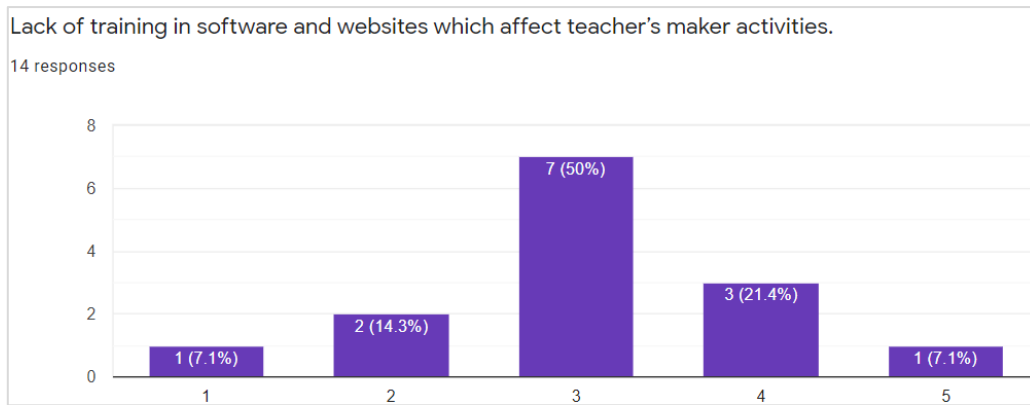


Figure 29: Lack of Technical Training

### 5.3.2 Institutional Challenges

A major part of the implementation of maker education depends upon the institutions, as the management support is necessary to integrate the maker education into the curriculum while managing all the plans accordingly. Thus, it has been found by 35.7% of the respondents that various challenges have been faced due to the lack of maintenance in maker equipment and tools. 42.9% of the audience neither agreed nor disagreed that this issue causes a challenge or not.

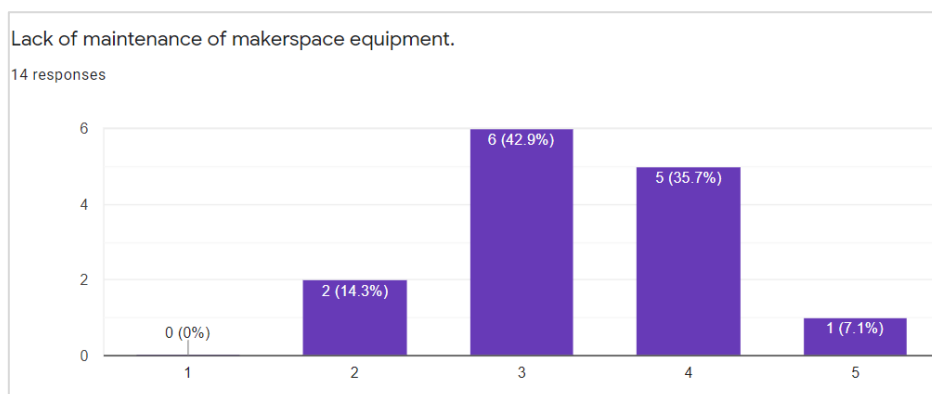


Figure 30: Maintenance Issues

The graph below illustrates another challenge being faced by various educators during maker activities i.e. lack of finances to ensure that the required tools and resources are provided by the management to carry on the maker education. 21.4% of the respondents agreed to this statement while 50% of the teachers were unable to decide, as it can be said that funding majorly depends on the institutional culture, and if the maker culture is not induced already, then funding cannot be an issue.

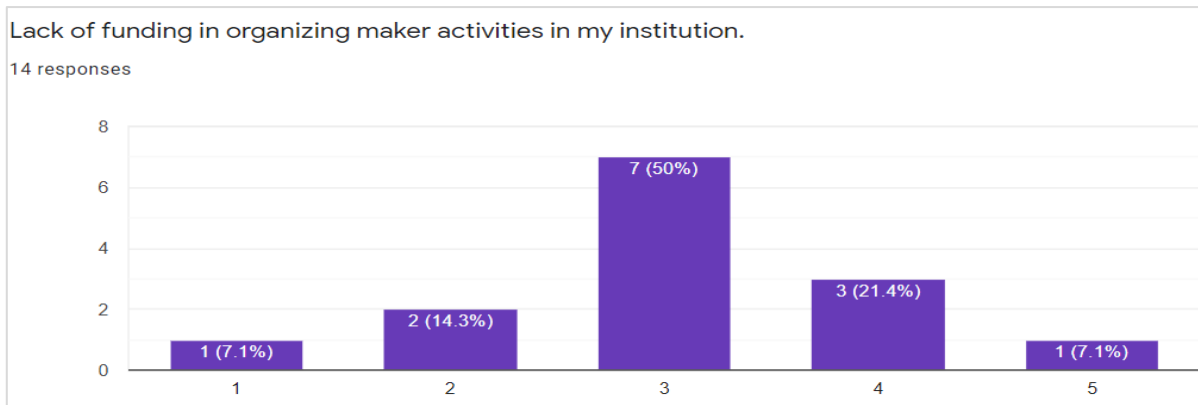


Figure 31: Financial Lack in Maker's Activities

50% of the teachers partially agreed when it comes to the integration of maker education activities inside the curriculum, as it's been said that every lesson can be turned into a maker education activity but only if the teacher wants to. On the contrary, 21.4% of the teachers agreed while saying that making a special place for maker activities is a challenge, as curriculums are already filled with specified activities either it comes to the weekly assignments or the final projects.

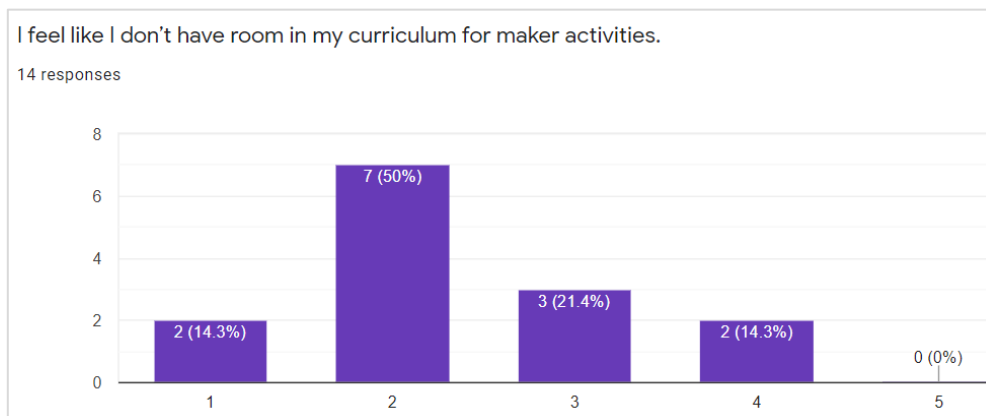


Figure 32: Curriculum Challenges

### 5.3.3 Challenges faced Regarding Students

When maker education includes process and experiments aiming student learning also includes student safety to be focused while inducing the maker activities. The selection of resources needs to be assured that teachers only use safety equipment for all the maker activities. A mixture of reactions came out as far as safety is concerned. Contrary to this, 28.6% of the teachers disagreed with this fact, as one of the teachers said that whenever, students enter a makerspace they should be aware of the due risks and rules for space, while almost 22% of the teachers

said that student safety is necessary, as they should be following these activities in the same way when they enter a chemistry lab or handicraft workshop.

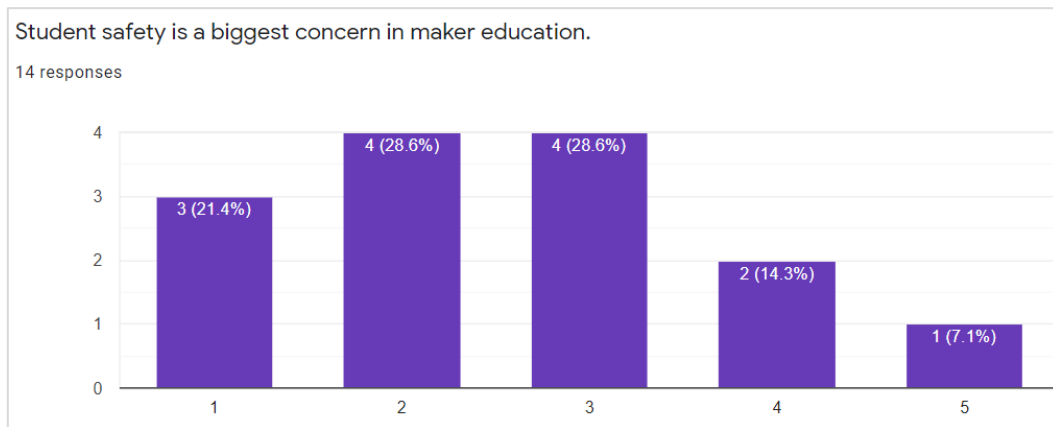


Figure 33: Student Safety during Maker Activities

Maker education doesn't only include technological activities, rather craftsmanship is another aim towards maker spaces. Teachers find it difficult for designing and integrating the activity lessons. As the statement illustrated below, showed that only 28.6% of the teachers agreed towards finding this difficulty, as well as 35.7%, gave undefined answers while assuring their uncertainty towards designing the maker activities. 14.2% of educators completely disagreed while ensuring that there are several other challenges than the educational background of the students.

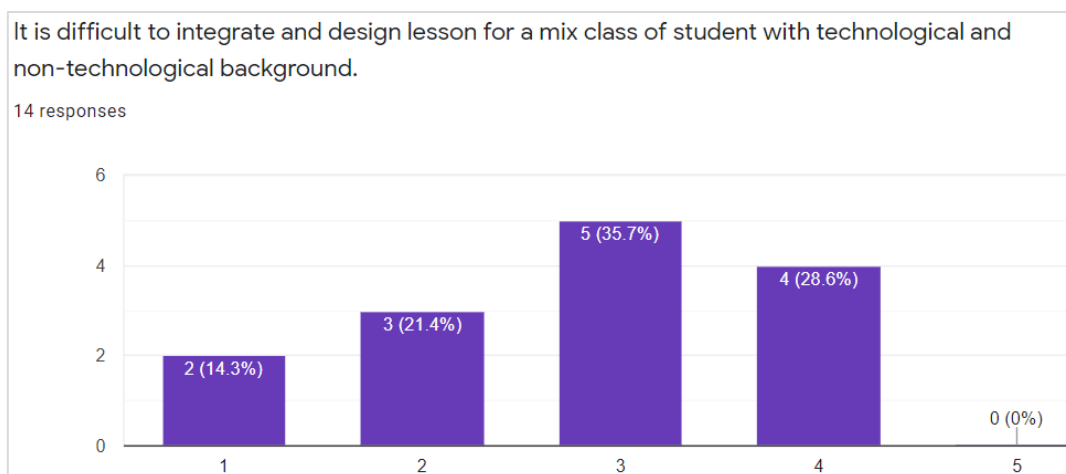


Figure 34: Difficulties in Integration of Maker Activities

## 6. Discussions

Using the literature review and the result is obtained from the research questionnaire, this chapter is going to perform a deep and explanatory discussion over the results while focusing on the three aims relative to the perspectives of educators relative to the technical readiness, attitude towards maker activities and challenges teachers are facing to utilize maker education.

### **6.1 RQ1: What is the level of technical readiness of teachers/educators on utilization of maker resources in maker classes in universities?**

Maker education being the latest and improvised self-learning-driven education needs to be implemented in the Finnish schools and colleges while making sure that the teachers and educators are capable enough to deal under such circumstances. While looking towards the research output, there is no doubt that the teachers are ready to accept the technical challenges coming forth along with the maker education as most of the educators agreed for planning the maker education, as they need to plan the lessons and play them individually before going to students but for that, they need prior training or some educational material to help them understand the maker education completely. Teachers seem to agree to align the maker spaces with the professional standards such as ICT, goal-oriented challenges, select and use maker education resources, maintain student safety, protective and secured architecture of computing, responsible and ethical decision-making towards activities, engage with professional teaching networks and broader communities. Teachers were found applying the maker education and wanted to integrate them with curriculum activities using the latest tools and techniques, but they need time for designing such activities and aligning the maker education activities with curriculum assignments. However, some teachers are already successfully integrating the technical resources because of various reasons, either it comes to personalized education, training, previous experiences on technical tools or equipment, or the knowledge gained from online resources.

#### 6.1.1 Open-Ended Question

To check the technical readiness, along with the close-ended questions, one open-ended question was also used in the data collection process, to focus on individual needs and individual-level perspectives. As the question states:



### **“How Teachers’ technical readiness can be built regarding maker activities?”**

Various interesting thoughts and collaborating suggestions were received from instructors while building their settlement for maker education. Teachers should design lessons to integrate maker activities into the curriculum. As maker education is a context to learn some subject matters in the curriculum. The teachers can utilize a pedagogical approach, such as inquiry-based learning or design process, using scenarios to integrate maker activities can be optioned out according to the subject matters and the educators must be able to consider the ways which they should use to scaffold students learning. Proper training for the teachers must be inducted while ensuring that this kind of practical-based application of resources must be used having a hands-on personal experience. As most of the respondents were working for more than a decade in the educational field using the traditional ways of teaching, they need to be encouraged towards learning the latest technology. The school management can play a significant role in promoting the maker mindset i.e. the willingness to explore and find out about technologies. The school management can use some experienced teachers or trainers in maker education, as collaborations among various institutions can bring in an overall positive change towards increasing the readiness.

### **6.2 RQ2: What is the Maker Teacher’s/educator’s attitude towards maker-based teaching activities during maker classes in universities?**

While looking forward to the answers and comments being provided in the survey questionnaire for this variable ( teacher’s attitude), there remains no doubt that the teachers and educators are very much positive towards using, accepting, and applying maker activities while aligning them with the curriculum. There may be various issues coming along the way, but teachers are quite hopeful while looking towards the learning opportunities present over the internet. Maker resources have been believed to be the most valuable tools as agreed by more than 50% of the respondents while seeking various aims such as growth towards latest tools, student effectiveness towards problem-solving, initiates self-learning in students and lastly, maker activities do provide the room to accumulate the curriculum lessons to generate better ideas, craftsmanship and designing capabilities at both ends either it comes to students or the teachers. Teachers have found it interesting to engage students mentally and physically at the same time, although designing the maker activities does require extra time but still, the positive attitude leads the conversation.

### 6.2.1 Open-Ended Question 2

Teacher's attitudes towards maker education play a significant role in the overall upbringing of the maker educational activities and to focus on those activities, the below-mentioned open-ended question was asked to ensure that they can share the real perspective while using their own experience.

**“What is your perception and thoughts about the teachers without a technology background being hesitant to participate in makerspace activities?”**

It has been found that the educators/teachers having experience in maker space creation and its activities can actively use the technological tools contrary to those who don't have a background in maker space activities. There can be multiple reasons behind this behavior either it is the inability towards using the makerspace as an effective way to learn or the hindrance towards accepting the latest technology and tools. It has been found that the teachers also feel hesitant because of the crafts being used and the biggest role is played by the organizational culture. (Inna Chervinska, 2021) Thus, it can be generalized that if a teacher gets himself familiar with the maker activities while learning basic tools and methods to accomplish goals, then he/she won't be tentative to participate in maker space. It has been found that the teacher's reluctance towards the maker activities is due to various reasons such as not having enough time to learn new skills along with the integration process into the classrooms. Moreover, technology-related topics change rapidly and teachers might not be able to catch up with them because of their busy schedules, personal commitments, and many other responsibilities (Juha Jaatinen, 2020). Thus, it can be said that the overall attitude of teachers is quite positive towards implementing maker education as having a technology background doesn't matter that much unless the teachers have interests and motivation to develop teaching methods using maker education.

### **6.3 RQ 3: What are the challenges faced by Makers Teachers/educators during the maker education activities?**

Various issues have been identified while looking forward to the challenge which the teachers are facing while incorporating the maker activities into the curriculum and class lessons. Teachers have been profoundly attracted toward the integration of maker education but few issues

are becoming hurdles in the way. Such as lack of technical infrastructure inside various institutions, leading to the increase in the limited knowledge and understanding on how to integrate maker education resources in maker activities (Ayu Sari, 2017). It has been found that the incapability of teachers and educators concerning effective time management leads to a lack of interest and motivation. Various educators lack training in some latest software tools and are incapable to look forward to online resources which affect maker activities consequently (Sini Maarit, 2020).

Another implication towards maker challenges is the lack of maker material needed for maker activities such as the unavailability of 3D printers, laser cutter, internet resources, and lastly software tools, etc. This leads to the lack of financial resources, which are directly hitting the use of maker education for various institutions. As many teachers are new to maker education and pedagogical approach, they are incapable of maintaining the makerspace equipment either because of less experience, interest, or less time (Inna Chervinska, 2021).

### 6.3.1 Open-Ended Question 3

In order to relate directly with the perspective of teachers over the pedagogical integration of maker education and class curriculum, an open-ended question has been asked as described below:

**“What are your views on the pedagogical integration of curriculum and maker activities?”**

As far as the teacher’s interest towards the integration of maker education into pedagogical education is concerned, it is believed to be the perfect combination, I believe curriculums generally lacks a lot the making culture and it would be so beneficial and joyful to include that as children are less excited when learning is passive and they watch they aren't doing something. It will also help the teachers to grow multiple skills such as crafting details, technical skills while using various tools, arranging goal-oriented but informational and learning activities, and lastly, the collaboration skills on the professional aspects. As it is believed that this process will be going to benefit the students while engaging them in deep learning using problem-solving skills, trial, and error processes, and lastly, learning by doing in an independent, collaborative and interactive manner. It is one of the most challenging aspects in Finish educational culture no doubt but teachers must be able to design lessons to integrate maker activities

into the curriculum. As maker education is a context to learn subject matters while enhancing the curriculum, the teachers can utilize pedagogical approaches in this way (Jacobsen, 2020). They could consider using scenarios to integrate maker activities and subject matters and they should consider in what ways they should scaffold students learning. One last opinion which came from teachers is that this integration must be expanded as it can help both the sides either it is research in quality or effectiveness. This will help ultimately to develop and focus on meaningful teacher resources for teacher's practice, as it's the need of the hour rather than just focusing on already developed tools.

## **7. Conclusions**

Maker education is the new normal is found to be an interesting way to bring in digital fabrication, while being posed as a challenge for instructors, as aligning the curriculum activities with maker activities is not an easy and one-day task. Various challenges had been discussed in detail, regarding the attitude of teachers towards using the resources to ensure a maker activity is productive enough for the child to explore the ideas in their ways while learning a specific set of skills. This research study examined the perspectives and experiences of 14 instructors of different ages and different teaching styles while looking forward to the challenges they are currently facing during maker education activities.

This research study no doubt filled a large literature gap regarding the maker spaces and maker education in the Finnish educational background while exploring the perceptions of teachers, working in various areas of education and especially, as the two respondents were international instructors, so this study also aid towards understanding the experiences of teachers working outside Finland. While implementing the qualitative exploratory research design, various problems were found which the teachers were facing, as the open-ended questions in the survey questionnaire helped to have an in-depth understanding of the perceptions of various educators regarding the challenges faced and the techniques they are using to align the curriculum with maker activities. The attitude of teachers being individual learners was quite optimistic as they wanted to learn the digital fabrication of data into the curriculum but because of various challenges, they need more time and resources along with some training to continue the latest and modernized educational ways.

### **7.1 Main Findings**

Maker education and maker spaces is a comparatively new term when it comes to the use of technology and learning through idea generation and attempting the particular task. Teacher's readiness towards the use of technical resources to conduct maker activities is found to be positive as teachers found maker education as the need of today. The competency level of teachers towards various technical skills such as computational thinking skills, creative technological skills, and lastly, the problem-solving skills was quite elaborative (Lindfors, 2019). The awareness about the integration of maker education & competencies needs to be polished especially when it comes towards the teachers who didn't have much information about the use of technological tools, especially when it comes to aligning the curriculum activities with the

maker activities to save time and ensure the basic goals of maker education. The biggest challenge being discussed by various respondents is the management of time, as maker education activity designing and aligning needs time while making sure that all the standards have been met. Training is needed for the technology-based resources (Schad, 2019). The digital fabrication activities have to be planned carefully because educators usually take more time than additional activities while preparing themselves for unexpected events. The educators have seemed to agree to align the maker spaces with the professional standards for teachers such as establishing the challenging learning goals, selection, and usage of maker education resources, maintaining the student safety during maker activities, using the ICT safely, responsibly, and ethically, and lastly, the engagement with professional teaching networks and broader communities (Cobo, 2021).

As far as the attitude of teachers is concerned towards the use of maker activities during the educational process, overall teachers are very hopeful and enthusiastic towards the use of maker education, while integrating the process of learning latest tools and technologies, to get the maximum benefit. Although teachers do feel that there is some reluctance towards accepting the activities as part of their curriculum, mainly because of lack of training in a particular field. For example, the engineering focus of maker spaces doesn't allow for an inclusive experience for non-technical teachers and students. Also, there are a lot of maker activities that are more focused on STEM education, while requiring technology-based solutions, and innovative strategies that can be hard to apply to creative and more social-based topics (Chang, 2019).

Lastly, various challenges have been identified at various levels of teaching while anticipating maker educational activities to ensure the learning and idea generation process is not sabotaged. Teachers do find difficulty in integrating the maker activities into the curriculum because of various issues such as the inefficient resources provided by the management, lack of resources for some activities, lack of confidence from the educator's side while insuring their capability either it comes to student safety or the maintenance of equipment is provided. It can be said that having a strong and relative technological background can be useful in inducing the maker's educational activities (Piia Naykki, 2019). As most of the successful teachers are successfully handling these activities or sessions either because of prior experience, technical background, or due to their learning while using the online resources, which help them to be updated in their curriculum designing.

Most of the teachers agreed to add the maker activities should be one of the major parts of pedagogical integration. Teachers must be able to design lessons in such a way that they can integrate maker activities into the curriculum. The teachers can utilize pedagogical approaches, like inquiry-based learning or designing any process.

## **7.2 Practical Implications**

The results being assumed from this research study can be used for various purposes while looking forward towards the current pandemic conditions. The nature of maker education has been discussed thoroughly while looking over the skillset checked deeply. Teachers were contacted -based on their prior teaching skills, their ways of incorporating maker education at some point of educating the children, and lastly, their education background, as a teacher can be the only person, (Ayu Sari, 2017) who can give the definite and experience-based opinion of maker spaces and maker education in the perspective of using these strategies. As the questionnaire also included the comments section, to ensure the complete perspective of teachers from different backgrounds, this strategy allowed looking forward to the suggestions coming to recommend future researchers and teachers reading this research (Chang, 2019).

As far as the attitude of teachers is concerned towards the maker activities, the teacher found quite optimistic towards the use of activities while aiming towards the project-oriented activities having a more practical approach while using the tangible resources. Teachers need to encourage others who are enthusiastic about learning the technological tools while being provided with the right tools including retraining and support (Austin, 2021) Teacher having a background in maker space can actively use technology and make the most out of it as compared to those teachers who do not have a background in maker space activities. Lastly, this research study discussed various challenges faced at the end of teacher, while using the maker education either they belong to the management side or towards the individual hindrance towards learning latest tools and technologies (Inna Chervinska, 2021). Various reasons were found such as the lack of technical training from the school management. Instructors were found quite interested and optimistic towards the pedagogical incorporation of curriculum and maker activities while aiming towards the management of personal learning makerspaces for each student. As the curriculums generally lack a lot the making culture and it would be incredible to induce that as children will be least excited when learning is passive. Thus, maker education will also help the students to grow multiple skills that they need in their daily life.

## **8. Evaluations**

To test and review the credibility of this dissertation, a complete and precise evaluation strategy was used while focusing on the results being gathered. The data being collected is based collected based on the profession of attendants and their educational background. As the sole purpose of this research was to ensure that the results had been demonstrated using complete trustworthy and reliable conditions. To move forward, the ethical issues which were focused on during the research have been discussed, along with the discussion regarding data validation and reliability (Moore, 2016). In order to perform ethical research, the guidelines from the Finnish Responsible Conduct of Research (RCR) were taken as guidelines.

### **8.1 Concerned Ethical Issues**

As far as data collection and personal privacy are concerned, I followed all the data integrity ethics. As three of the respondents were reluctant to share their identity so, I preferred sharing their answers rather than sharing personal information. All the guidelines being provided by the Ministry of Education in Finland, while following the instructions provided by the Ethical Evaluation of National Board on Research Integrity TENK (TENK, 2021). It was clarified to the participants of the research that they can leave the questions unfilled or can leave the questionnaire anytime they want. The purpose of the research was completely explained to the participants before the data collection process. No harm was given to any kind of stakeholder in this research project either it comes towards society, university fellows, or the participants. Data privacy was another concern that was protected, using secured Google Sheets and restricted access to the users (Rautiainen, 2021). Lastly, no plagiarised content was added in this research study to ensure the university ethics and guidelines being followed completely.

### **8.2 Validity and Reliability**

In order to validate the research quality, the questionnaire of this research study was validated and approved by the professor considered to be an expert in the education field. The Finnish Advisory Board on Research Integrity was properly and thoroughly followed while ensuring that data can be validated to reach a solution regarding the current research problem



(Rautiainen, 2021). Google Forms is found to be a reliable tool for data collection and questionnaire sharing and it had been secured with multiple permissions to ensure that no doubt remains in data validity (Helsinki, 2019).

### **8.3 Research Limitations**

Like every other research study, this study also came with some major limitations which restricted the results and discussions section. The major limitation was the restriction from the data collection side, as many people even working under the maker education system were reluctant to fill the questionnaire which resulted in non-generalized findings as the sample size was too small to generalize the results (Cobo, 2021). Because of this, the changing role and perceptions of teachers and educators towards maker spaces and maker technologies were found limited and prohibited.

Following the previous research studies, this research study came with various limitations either it comes to the time frame or the reluctance towards becoming a respondent towards research. The biggest limitation was the reluctance of the teachers and educators to participate in data collection due to various personal and professional issues, as the bigger, the sample size (N) better the results. Many people were reluctant to share their experience regarding maker education either due to less knowledge or restrictive university culture, which never allowed them to learn and experience maker education. Thus, a smaller population size, allowed restricted research results, while not encompassing various groups and cultures. Lastly, another limitation was the time slot, which became the reason for the limited approach towards instructors and educators, as definitely there will be more than 14 people around the country teaching using maker education but due to the limited period, it was impossible to let other teachers agree to participate in research.

### **8.4 Future Recommendations**

While looking forward towards the limitations as described above, there can be various opportunities for future researchers, while looking towards the perceptions, attitudes, and challenges faced by the educators and teachers across the country. As far as the current pandemic conditions are revealing the most interesting future research the researcher can do is to analyze the activities teachers are using for the students for online teaching. The ways they are going to use to implement maker education using online sessions can be the next research target. The

strategies teachers are using while ensuring student's interest in maker activities, as online maker education is not an easy target to be achieved while not losing the real essence of maker education. The ways to create maker spaces can be further explored using the literature being reviewed in this research (Cobo, 2021). Another opportunity which the future researcher can explore is with some newly employed educators, as the most who participated in this research were working in this field for a long time.

Another expected implementation could be the specialized study over the ways STEM education can be related to make education while using online opportunities. The Craft Culture of Finnish schools can be another research opportunity for future researchers, as it provides good opportunities for the development of maker culture which can be used as an inspiration towards the technical readiness of teachers. In order to compete with the challenges. Lastly, the future researchers can change the method of data collection while increasing the sample size, such as interactive and collaborative sessions with school and university teachers can be used to understand the change in their perspectives, their attitude, and the challenges they are facing during the process of maker education.

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# Appendix 1

## Research Questionnaire-Part 1

The questionnaire is divided into 3 sections:

### 1. Teachers' / Educators' Technical Readiness on the Utilization of Maker Education Resources in Makers Activities

Evaluate your readiness in accordance with the following statement by using the following scale. You are free to add your comments for each statement in order to justify or explain your evaluation.

1 = No Compatibility; 2 = Average; 3 = Fair; 4 = Good; 5 = Excellent

Teachers'/Educators' technical readiness towards Maker education resources	No compatibility	Average	Fair	Good	Excellent	Comments
I am competent to use maker education resources to support my teaching methods.						
I am familiar with the ways of integrating maker education resources into the contents and goals of the curriculum.						
I can manage my use of time in teaching when designing and organizing maker activities.						
I am organized and tend to plan ahead in my maker teaching sessions.						
I have competence in computational thinking skills.						

I am in favor of Alignment of Makerspaces with the Professional Standards for Teachers (which include Information and Communication Technology, establish challenging learning goals, select and use maker education resources, maintain student safety, use ICT safely, responsibly, and ethically, Engage with professional teaching networks and broader communities).						
I have competence in creative technological skills (creative skills that are important for future employment, teaching, learning and leisure, and usage of digital technologies).						
I have competence in problem-solving skills.						

**Open Question 1:**

- How Teachers' technical readiness can be built regarding maker activities?



## Appendix 2

### Research Questionnaire-Part 2

#### Teachers' / Educators' Attitudes about the Utilization of Maker Education Resources in Maker Education

Express your views about the attitude towards the maker teaching experience. The following scale is to be considered in responses. You are free to add your comments for each statement in order to justify or explain your evaluation.

1 = Strongly Disagree; 2 = Disagree; 3 = Undecided; 4 = Agree; 5 = Strongly Agree

Teachers'/Educators attitudes towards Maker activities	Strongly disagree	Disagree	Undecided	Agree	Strongly Agree	Comments
I consider it very important as a teacher to have experience in maker education resources for teaching.						
I will use maker experience because I am interested in maker education.						
I will feel comfortable using maker education resources as tools in teaching and learning.						
A maker education resource is a valuable tool for teachers.						
The use of maker experience in teaching and learning excites me.						
The use of maker education resources in teaching and learning will change the way students learn in my classes.						
A maker education resource is not conducive for learning because it is not easy to use.						

Maker education resources will help students understand concepts in more effective ways.						
The use of maker activities will make the students more active physically and mentally.						
The use of maker education resources in teaching and learning will stress me out.						
I guide students in ways that put them in charge of showing their understanding and knowledge through activities that provide the context for authentic learning, using maker education resources.						
I admit that I unintentionally focused more on learning from technology than learning with technology.						
I am aware of understanding 21 <sup>st</sup> -century skills in terms of maker activities.						
I am aware of sustainable development goals (SDGs) in relation to maker activities.						

**Open Question 2:**

- What is your perception and thoughts about the teachers without a technology background being hesitant to participate towards makerspace activities?

## Appendix 3

### Research Questionnaire-Part 3

#### Challenges Faced by the Teachers / Educators towards Maker Activities

Record your response by sharing your experience on challenges faced in the maker teaching process. Consider the following scale while answering. You are free to add your comments for each statement in order to justify or explain your evaluation.

1 = Never; 2 = Seldom; 3 = Sometimes; 4 = Often; 5 = Always

Challenges faced by the teachers/educators in maker activities	Never	Seldom	Sometimes	Often	Always	Comments
Lack of technical infrastructure in the institution						
Lack of time in institutions						
Limited knowledge and understanding on how to integrate maker education resources in maker activities						
Lack of training in software and websites which affect teacher's maker activities						
Lack of maker physical materials in maker activities i.e.,3D printers, laser cutter, etc.						
I feel like I don't have room in my curriculum for maker activities.						
Lack of funding in organizing maker activities in my institution.						
Lack of maintenance of makerspace equipment.						

Student safety is the biggest concern in maker education.						
It is difficult to integrate and design lessons for a mixed class of students with technological and non-technological backgrounds.						

**Open Question 3:**

- What are your views on the pedagogical integration of curriculum and maker activities?

**Thank you very much for your participation!**