Making STEAM Accessible for Inclusive Classroom

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ABSTRACT

Purpose: As the education world explores strategies to equip students with 21st-century skills so that they could evolve as innovators and creators, there has been a growing emphasis on STEAM — the educational discipline that focuses on the application of science, technology, engineering, and mathematics through art and design. It is imperative for all to adapt to and embrace technology and scientific way of thinking, and the STEAM model is an interdisciplinary learning model to address this and make learning accessible and comprehensible for all.

However, the inclusion of children with special needs, children from marginalized sections, and girls in STEAM still seem to be a distant dream. A considerable amount of work has been initiated in the field of curriculum framework of STEAM to reach learners from marginalized sections, girls, and special education needs students to implement an inclusive STEAM model where every student gets a chance to thrive. The purpose of writing this paper is to explore the possibilities of Inclusive Education in STEAM by creating a STEAM model integrated with tested methodologies to address the learning needs of the students.

Design/ Methodology/ Approach: Based on the studies and available methodologies, the approach used to address STEAM education to make classrooms inclusive is STEAM curriculum infused with Universal Design for Learning, which addresses diverse learning needs of classrooms and enhances student engagement in STEAM learning. As this model is quite new in Indian scenario, a survey was done to understand how effectively it can be used in Indian classroom scenarios. The students surveyed were the students in the Inclusive Education setup, which included students with special needs, marginalized sections, and girls.

Findings: This paper discusses how STEAM infused into Universal Design for Learning (UDL) helps give all students an equal opportunity to succeed, which transforms the concept of equal education into an equitable education.

Originality/ Value: The STEAM approach with Universal Design for Learning and imparting education using tech tools have been quite new but have also been proven as effective and inclusive tools to address STEAM learning. The above-mentioned methodologies have been in use in western countries, but this concept is quite new in India. With the COVID pandemic, there has been an exponential advancement in the field of virtual learning and educational technology in India too. The STEAM education integrated with Universal Design for learning and education technology can be a turning point in the Indian Education System.

Paper Type: View Point

Introduction

While generally, individuals try to slot people's talents into science or the arts, Leonardo da Vinci believed that the two genuinely influenced each other. His scientific studies and knowledge allowed him to depict the world in deeply naturalistic ways, while his artist's eye, which was an eye for understanding the details, intricately opened up new ways of looking and thinking about that world. For Da Vinci, the inner working of a machine was just as pivotal as Mona Lisa's smile.

It is evident from the historical pieces of evidence that how the holistic approach towards learning has been proved to create a work of excellence then and continues to do so now. This is the reason the STEAM approach has been brought into the curriculum from the perspective of enhancing students' learning by equipping them to understand the interconnectedness of the world we live in.

STEAM is an inquiry-based learning approach that integrates Science, Technology, Engineering, Arts, and Mathematics in a way that resembles real life. This approach not only helps children to learn how different subjects work together but also develops a skill set that is essential for future jobs. On the one hand, it is being seen as interconnected learning by the students; on the other hand, it brings teachers of Sciences and Arts disciplines together to understand the connection in their disciplines by blurring their disciplinary boundaries. This helps teachers to employ a project-based inclusive learning culture where every student gets an opportunity to thrive by creating adaptable and accessible STEAM learning environments.

Literature Review

Setting up STEAM in the classroom is about preparing students to express innovative and creative ideas and taking ownership of their learning. It's about becoming increasingly curious about the world around them and be empowered to change it for the better.

But not all students can recognize the opportunity and possibility of success in the STEM field. Often learners from marginalized sections, especially girls and learners with special needs, are underrepresented and do not get a chance to voice their thoughts and ideas in the classroom.

Despite India making great strides in girls' education, participation and performance of women in STEM are still a challenge. According to the All India Survey on Higher Education (AISHE) 2018-19 by the Ministry of Education, women constitute nearly 43 percent of the total STEM enrollments in the country. Only 3 % of women enroll in Ph.D. in science, and 6 % opt for a Ph.D. in Engineering and Technology. Further, they constitute only 14 % of the total scientists, engineers, technologists in research development institutions.

Similar is the case with children from marginalized sections. A recent survey by feminisminindia.com states that "As per Census 2011, the total child population in India in the age group (5-14) years is 259.6 million. Of these, 10.1 million (3.9% of the total child population) are victims of child labor. Also, more than 42.7 million children in India are out of school. Language barriers, gender roles, and reliance on child labor stall progress to provide quality education to students hailing from most unprivileged backgrounds [14]. They usually fall behind an average privileged student in terms of academic performance. Instead of helping them to overcome these adversities, academia in general and STEM in particular plays to their disadvantages".

According to a recent survey report from UNESCO, three-fourths of children with disabilities at the age of five years and one-fourth between 5-19 years do not go to any educational institution. Also, the number of girls with disabilities in schools is "fewer" than boys[16]. This underrepresentation often makes people believe that students with disabilities are less capable, particularly in STEM-related fields. Lack of guidance and support affects the ability of the students and the chance to fulfill their true potential.

There is an urgent need to address these issues and take action to dismantle the systemic barriers to educational opportunity for all students. By restructuring and transforming STEM to STEAM education to engage students with technologies through open-ended, arts-based assignments that address relevant real-life engineering problems, the learners – especially women, minorities, and underserved populations - will acquire a sense of agency and empowerment, creativity and confidence, and other dispositions to address the needs of their future.

Methodology

STEAM infused with Universal Design for Learning aided with educational technology can be a one-stop solution for effective implementation of STEAM for diverse learners in classrooms. It is a process focused learning which can be addressed as following interconnected phases-

1. Planning

2. Implementing

3. Accommodations & Provisions

Planning-

The 'A' of arts in STEM subjects, to make it STEAM is also a progressive step by CBSE to initiate STEAM learning in schools. An article on kqued.org explains how the integration of Arts in other subjects makes learning come alive by considering Art as integral, not extra. (*How Integrating Arts Into Other Subjects Makes Learning Come Alive | KQED*, n.d.)

To implement and practice STEAM effectively, there is a need for understanding STEAM aligned with curricular concepts integrated with SDGs (Sustainable Development Goals) [21] in the right spirit. SDG (Sustainable Development Goals) integration in learning aids application-based / real-world learning.

To begin the process of STEAM education in classrooms, the first and foremost need is to train the educators for STEAM practices and principles. Other aspects include collaborative planning for curriculum mapping, integrated lesson processes, and strategies through team teaching and alignment and unpacking of standards and assessments. Facilitators are required to collaborate and develop an inquiry-based STEAM learning platform, which required an intentional or natural connection between lesson planning, assessment designs, and standards. (What is STEAM Education? The Definitive Guide for K-12 Schools, 2021)

Brainstorming and logical alignment of the STEAM unit will aid the facilitators to think about the concepts beyond the disciplinary boundaries and view the same more broadly by understanding each one's disciplinary and personal perspective.

To aid the familiarization of STEAM education in the Indian education scenario, small meaningful steps towards STEAM education can help in developing educators' understanding of the same. The learning unit can be brainstormed from conceptualization of the STEAM project to process, assessment, and outcome using **backward by design approach** (Wiggins & Mctighe, n.d.). This is an effective way of providing guidance for instruction and designing units. When the learning goals, or desired results, have been identified, it becomes easy for facilitators to develop assessments and instruction around laid learning outcomes. The experience of interdisciplinary unit planning for integrated projects will aid facilitators to think through STEAM project-based learning by incorporating the element 'R' of reading to make STEAM a STREAM approach [22].
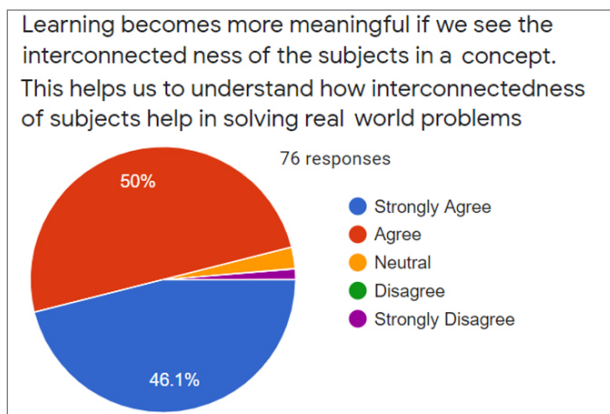
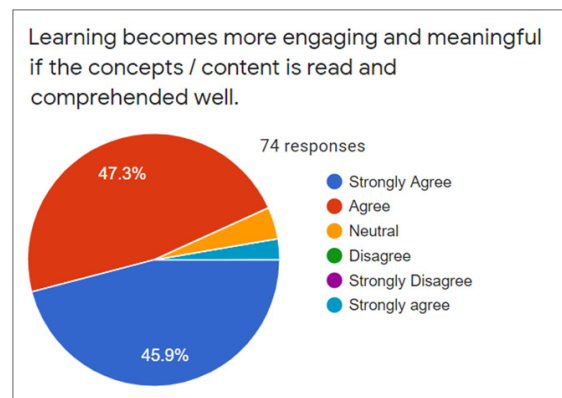Based on the responses shared by students in the survey question related to interdisciplinary learning, 46.1% of students strongly agreed, 50 % agreed, 2.6 % students were neutral, and 1.3 % strongly disagreed. The result analysis clearly indicated how an interdisciplinary approach towards learning enhances students' understanding.

This will help the facilitators to understand what they are looking at collectively as a learning outcome of the unit for the students and will create opportunities for differentiation. Designing Lessons by incorporating the Core competencies of Social-Emotional Learning (*SEL: What Are the Core Competence Areas and Where Are They Promoted?*, n.d.) (Self Awareness, Self-Management, Social Awareness, Relationship Skills and Responsible decision making) can aid to an engaging STEAM unit plan or learning engagements by addressing the first aspect of Multiple means of Engagements for UDL (Universal Design for Learning).e

Implementation with Accommodations

Successful inclusive education happens when students' differences and diversity are appropriately challenged, accommodated, and welcomed, which can include physical, cognitive, academic, social, and emotional limitations or challenges.

Universal Design for Learning can be adopted as a one-stop place to make classrooms inclusive along with the STEAM approach. Language Arts (ARTS component of STEAM) works on the fundamentals of enhancing the reading, writing, listening, and speaking skills along with its use to express what students have learned effectively.

Students with special needs face difficulty according to the limitations they have, which primarily include reading, writing, listening, and speaking skills. If these skills are addressed appropriately, then it is easy for students to engage with the concept well.

According to the responses shared by students in the survey question related to reading and comprehension, 45.9% of students strongly agreed, 47 % agreed to the statement of learning becoming more engaging and meaningful if it is read and comprehended well. 4.1 % of students were

neutral. The result analysis clearly indicated how reading and comprehension of information lays the foundation of any kind of learning in classrooms.

Universal Design for Learning (UDL) is a way of thinking about teaching and learning that helps give all students an equal opportunity to succeed and transforms equal education into equitable education. This approach offers flexible ways of accessingcontent and engaging with it.(Schreffler et al., n.d.)

- **Providing Multiple Means of Engagement for students- the WHY of learning**

This includes designing the extrinsic environment so that it can support motivation and engagement by recruiting interest and sustaining efforts and persistence by personalizing learning, keeping in mind their interests, and giving them autonomy to steer the STEAM unit by incorporating real-life application elements and guiding them appropriately to arrive at them. (Refer Fig 1) (Schreffler et al., n.d.)4_01-01-2020.pdf (isres.org)
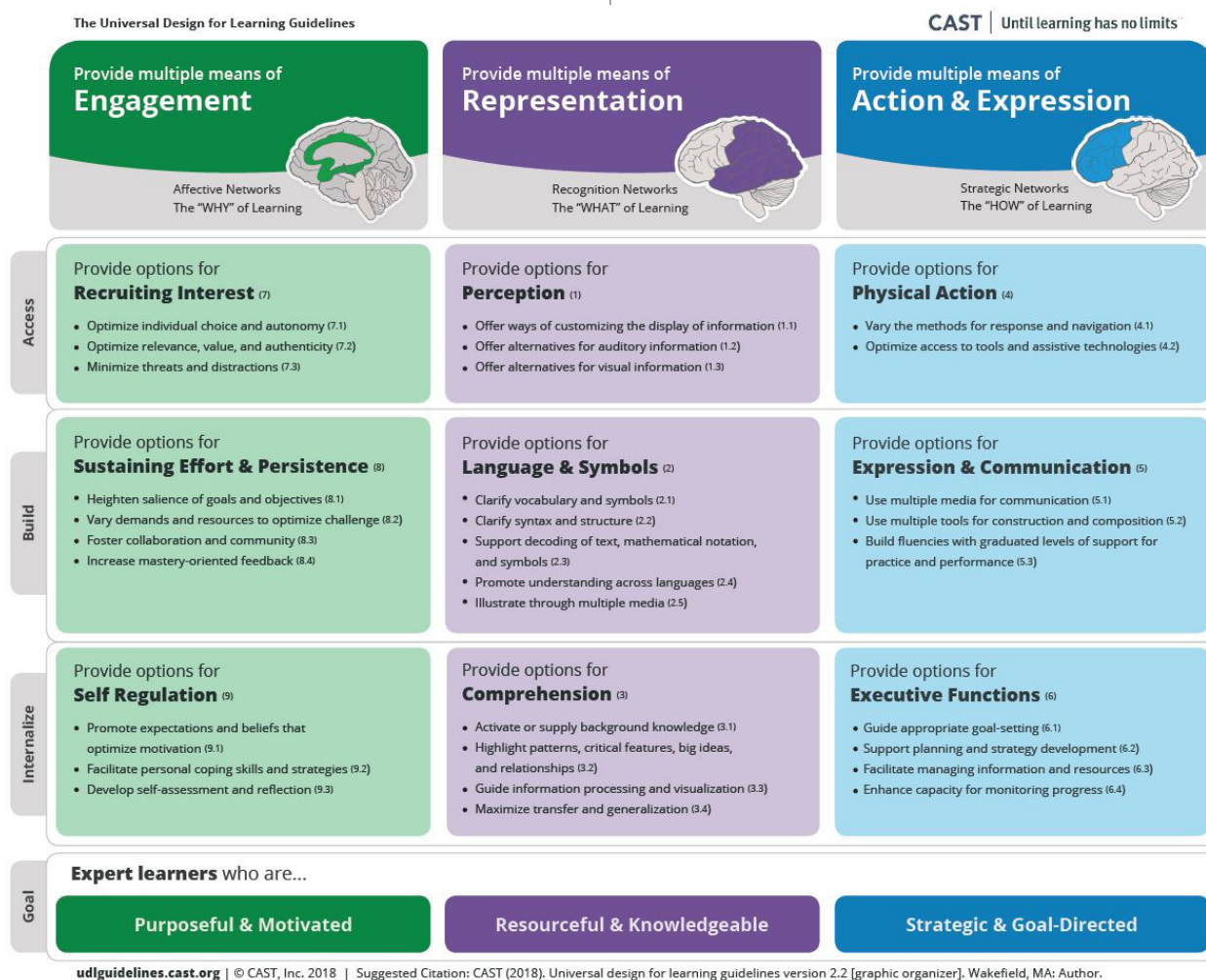

Fig 1. Universal Design For Learning

Developing lesson plans this way helps all children, but it may be particularly helpful for children with learning and thinking differences. (Schreffler et al., n.d.)

The three components of UDL can be considered while lessons are planned for STEAM Project-based learning.

Responses shared by students in the survey question related to the component of multiple means of engagement, 52% of students strongly agreed, 44 % agreed to the statement – Learning becomes more meaningful and engaging if we understand why we are learning what we are learning. 4 % students were neutral. The result analysis clearly indicated
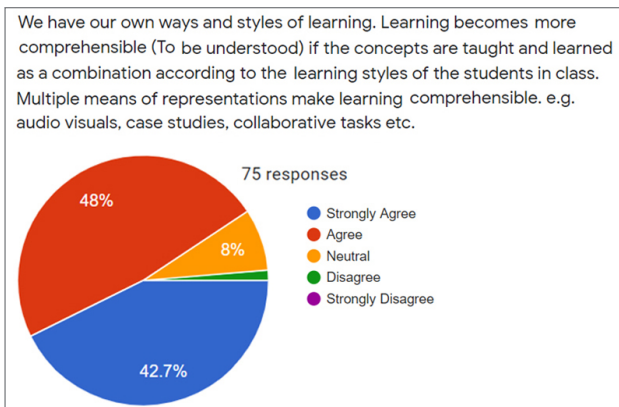
how the component of multiple means of engagement sets the stage for any kind of learning to happen.
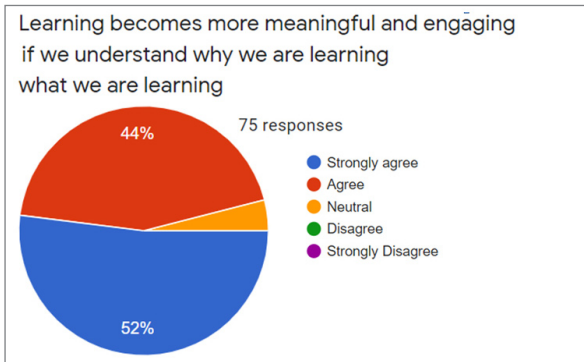
*   **Providing Multiple Means of Representing the information and the curriculum to help students understand the way that best suits them- The What of Learning**

This can aid in addressing diverse learning styles to the students, thus optimizing learning by addressing all the students' way of learning. To reduce barriers to learning, it is essential to ensure that key information is equally accessible to all learners by:

1. providing the same information through different modalities to accommodate the needs of all learners. (e.g., through vision, hearing, or touch)

2. providing information in a format that allows adjustability by the user (e.g., text that can be enlarged/ magnified, sounds that can be amplified/ reduced). Such multiple representations not only ensure that information is accessible to learners with particular sensory and perceptual disabilities but also easier to access and comprehend for many other learners who face similar challenges at varying degrees.

The result of responses shared by students in the survey question related to the component of multiple means of representations indicates, 42.7% of students strongly agreed, 48 % agreed to the statement, and 8 % of students were neutral, and 1.3 % disagreed. The result analysis

clearly indicated how the component of multiple means of representation addresses the diverse learning needs of the students in the classrooms.

*   **Providing the flexibility to the students to present their learning by way of Multiple Means of Expressions – the How of learning**
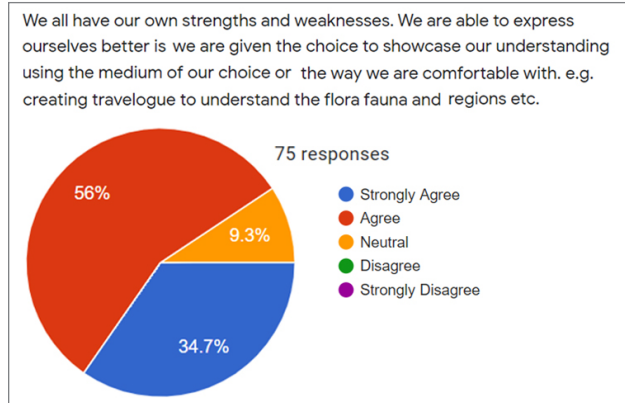

It implies providing multiple alternatives to students to demonstrate their learning. This can be achieved by incorporating a variety of assessment formats, providing options for student response, encouraging the use of technologies to ensure students accurately express their understanding.

The result of responses shared by students in the survey question related to the component of multiple means of expressions indicates, 34.7% of students strongly agreed, 56 % agreed to the statement, and 9.3 % of students were neutral. The result analysis clearly indicates how the component of multiple means of expressions provides opportunities for students' voice in the classrooms, which may be interpreted as taking charge of their learning to become lifelong learners

Accommodations and Provisions

The following intervention provisions and accommodations can help to engage and sustain the admissions of more special education students, girls, and children from marginalized sections into school education:

*   .The addition of components of ARTs (Language Arts, Performing Arts, and visual arts) can help in attracting and engaging girls, marginalized section, special education students, and other learners who find STEM subjects daunting in this field and to break the stereotypes of having male domination in the occupations concerning STEM. It will also aid in enhancing the understanding of students through an interdisciplinary approach. This can also be an effective strategy to make STEM students understand the interconnectedness of concepts from the lens of Arts too to identify the same in the world they live in.
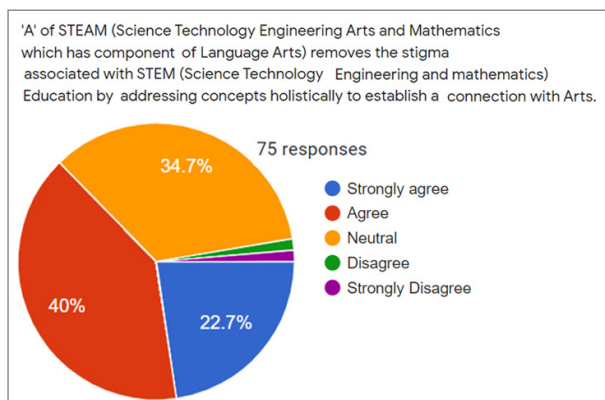
The result of responses shared by students in the survey question related to the addition of arts component of STEAM education removes the general stigma associated with STEM education, 22.7% of students strongly agreed, 40 % agreed to the statement, 34.7% of students chose to go for neutral choice, and 1.3% students disagreed and strongly disagreed. In the above result analysis, the sector % of neutral responses is comparatively more than other responses although it is not more than the percentage of the students who agreed and strongly agreed, the reason may be interpreted as the STEAM education concept is comparatively a new concept because of which students chose to go for neutral choice.

- For autistic students, VR seems to encourage social interaction. Math tools in virtual learning can help learners with math difficulty or dyscalculia to overcome common Math anxiety [24].

- Accommodations such as reader, writer, prompter, use of assistive technology can help special education students address their needs according to their limitations. This will also contribute to making learning accessible for them.

- National Education Policy [25]has proposed several progressive reforms in the education system. The flexibility of curriculum and continuing education at any point are some of the highlights in the domain to engage more girls, special education needs, and students from marginalized sections in STEAM education.

- CBSE has launched projects such as UDAAN, Digital Gender Atlas,etc., which provide a platform to girls that empowers them, facilitate their aspiration of joining engineering institutions and hence contributetothe development of the country in the future. (Digital Gender Atlas For Advancing Girl's Education, n.d.)

- According to Right to Education, all private schools have to admit 25% of children from weaker sections and disadvantaged groups from their neighborhoods for free education. If this regulation is being followed strictly, it can help in making it possible for marginalized sections to access STEAM education.

- Buddy teaching strategy can help in ensuring learning in STEAM education as students learn best with and from their peers.

- Making marginalized elementary STEAM education a mandatory part of Community Service Projects can, on the one hand, help in empowering students to take their learning to the next level and, on the other hand, enable the maximum reach of STEAM education for marginalized sections even for the students who are not officially enrolled in schools.

Result

The above methodology and survey results stated, which includes STEAM integrated with UDL and supported by educational technology and accommodations and provisions to address the needs of girls, marginalized students,and students with special education needs,can be considered as an effective education model for learning in India too. Such a curriculum that has all the standards and practices in place to address the needs of each learner can be a future curriculum for India which will ensure that no child is left behind and acquiring education is an enriching and engaging experience for students where they will be seamlessly able to translate their learning in future job options. They will not have to go through the process of unlearning and relearning again.

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The Editorial Board had used the Urkund – a Swedish anti-plagiarism software tool which is a fully-automatic machine learning text-recognition system made for detecting, preventing and handling plagiarism and trusted by thousands of institutions across worldwide. Urkund is GDPR compliant with privacy by design and an uptime of 99.9% and have trust to be the partner in academic integrity. https://www.urkund.com] tool to check the originality and further affixed the similarity index which is {7%} in this case (See below Annexure-I). Thus, the reviewers and editors are of view to find it suitable to publish in this Volume-12, Issue-4, October-December, 2020

Annexure 1

Submission Date	Submission Id	Word Count	Character Count
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Urkund Analysis Result

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Instances where selected sources appear: 16

Reviewers Comment

Reviewer Comment 1: The significance of the study can be seen from the fact that concept of STEAM is new in Indian scenario and has not yet been explored much. Whereas, the COVID 19 pandemic witnessed the huge demand for virtual learning has made it more relevant in the context.

Reviewer's Comment 2: The paper is planned on a very appropriate and relevant theme and is well presented and structured in a lucid manner. The study offers a further scope to be explored by the other researchers via conducting some quantitative or qualitative research on the theme.

Reviewer's Comment 3: The paper lacks of a strong review of academic literature done in recent and past. Inclusion of the would have improved the novelty of the work done. Yet the paper is supported with a good number recent and updated facts and figures that is commendable on the part of the authors.

Editorial Excerpt

The article has 7% of plagiarism which is the accepted percentage as per the norms and standards of the journal for the publication. As per the editorial board's observations and blind reviewers' remarks the paper had some minor revisions which were communicated on a timely basis to the authors (Gunjan & Vineeta) and accordingly all the corrections had been incorporated as and when directed and required to do so. The comments related to this manuscript are noticeably related to the theme "**Making STEAM Accessible for Inclusive Classroom**" both subject-wise and research-wise. STEAM is an inquiry-based learning approach that integrates Science, Technology, Engineering, Arts, and Mathematics in a way that resembles real life. Technological Innovation of 21st century is making it imperative for all to adapt to and embrace technology and scientific way of thinking. To address this issue STEAM model makes learning accessible and comprehensible for all. The paper studies the possibilities of inclusive education in STEAM by creating a STEAM model integrated with tested methodologies. Overall, the paper promises to provide a strong base for the further studies in the area. After comprehensive reviews and editorial board's remarks the manuscript has been categorised and decided to publish under "**View Points**''category.

Acknowledgement

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