Fostering Gender Inclusion In Science Education Through Constructivist Approaches Under NEP-2020

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Abstract
Within the framework of India's National Education Policy 2020 (NEP-2020), this paper investigates how well constructivist approaches bridge the gender gap in science education. Understanding the enduring gender gaps in STEM disciplines, this study looks at how constructivist pedagogies could improve inclusion and gender equality in participation. Using a mixed-methods methodology, the research examines quantitative data from student performance measures and qualitative data from teacher interviews at many Indian schools that have included constructivist techniques in their science curriculum. The findings show that constructivist approaches, like project-based learning and collaborative teamwork, improve female students' engagement and performance in science classes. Together with helping students grasp scientific ideas more deeply, these strategies also help them become more self-assured and feel part of the community. The report points up several obstacles to the use of these tactics, such as a lack of resources and the requirement for in-depth teacher education. There are suggestions made for legislators, teachers, and curriculum writers on how to get above these obstacles and successfully apply constructivist approaches to promote gender equity in scientific education. The study also emphasises how important infrastructure improvement and customised teacher preparation programs are to the effective implementation of constructivist pedagogies under NEP-2020 in India.

Keywords: Constructivist Approach**,** Gender Gap**,** Science Education**,** NEP-2020**,** STEM**,** Inclusivity in Education**.**

1. Introduction: The National Education Policy (NEP) 2020, introduced in India, tries to close disparities in many areas, including gender, by reorganising the educational system with a focus on inclusive education practices and fair access (Kumar et al., 2020). One major worry is still the gender gap in science education, which affects STEM job options and chances (Swarup & Dey, 2020). This paper offers the constructivist strategy as a tactical way to reduce this gender gap. Constructivism may offer an equal educational setting that is friendly to all genders by actively involving students in learning via experience and reflection.

2. Background of Gender Inequality in Science Education and NEP-2020: The National Education Policy-2020 (NEP-2020), released by the Indian Government, is a groundbreaking initiative aimed at a comprehensive overhaul of the nation's educational framework. The report proposes significant proposals aimed at enhancing education by making it more transdisciplinary, adaptive, and aligned with the requirements of the twenty-first century(Kumar et al., 2020). The NEP-2020 prioritises equity and inclusion and incorporates specific strategies to mitigate disparities across all educational levels. The strategy prioritises providing targeted support to female and transgender students to ensure their access to and success in school. It also commits to focusing on enrolling children from all backgrounds, particularly those from Socio-Economically Disadvantaged Groups (SEDGs), in the education system (Government of India, 2019).
Gender inequality in science education is still a problem despite these progressive laws. Women account for a much lower percentage of undergraduate STEM students in India, according to a study from the All India Survey on Higher Education (AISHE 2018–19) (Ministry of Education, 2019). At esteemed universities like IITs and NITs, where female enrollment is far lower than that of males, this underrepresentation is especially apparent. Studies imply that this difference is a result of perceived gender biases in STEM education, lack of female role models, and socio-cultural norms (Dasgupta & Stout, 2014; Chandrasekhar, 2018). The gender gap in science education strongly impacts career paths in STEM professions and educational results. Less likely to seek further education and jobs in science, women who encounter obstacles in this area are losing out on chances in some of the fastest-expanding economic areas(Beede et al., 2011). Moreover, a lack of diversity in scientific research and technical innovation brought about by the underrepresentation of women in STEM might sustain gender prejudices in these and other domains. Closing this gap is necessary to guarantee the thorough growth of the scientific and technical industries as well as to empower women (Singh & Sharma, 2020).

3. Theoretical Framework: Constructivist Approach
3.1 Definition of Constructivism: Constructivism is a learning paradigm that posits that individuals construct their knowledge and comprehension of the world via active engagement and reflection. When individuals encounter something

unfamiliar, they must interpret it based on their prior views and experiences, either by modifying their beliefs or dismissing the new information as insignificant. Constructivism posits that learning is a dynamic and imaginative process in which pupils actively generate their own information instead of passively receiving it (Piaget, 1976).

3.2 Relevance to Science Education: The focus on active involvement placed by constructivism fits in perfectly with the fundamental necessity of scientific education for investigation and discovery. A major part of the constructivist method, inquiry-based learning encourages students to participate deeply by exploring, questioning, discussing, and reasoning. As an example, constructivist students could prepare and carry out experiments with different weights and heights to investigate gravitational laws, thereby physically and intellectually interacting with the ideas (Bruner, 1961). Students who use this approach are more likely to grasp scientific ideas contextually and in a way that relates to their past knowledge and experiences from real life.

3.3 Gender Sensitivity: By guaranteeing that learning opportunities are pertinent and available to all students, regardless of gender, constructivist approaches may be successfully adapted to advance gender equality in the classroom. This can include designing educational programs that question gender norms and provide boys and girls equal chances to pursue scientific research. To assist lessen current prejudices, for instance, make sure that the situations and examples used in scientific classes are gender-neutral or represent various gender viewpoints (Jones, et al., 2000). Furthermore, a typical constructivist strategy, group work, may be organised to guarantee mixed-gender cooperation, encouraging equitable involvement and appreciating the contributions of every student. This method aggressively combats the gender-based stereotyping of skills, which improves learning results by offering a variety of viewpoints.

4. Application of Constructivism to Bridge Gender Gap in NEP-2020

4.1 Curriculum: The requirement of inclusion and fairness is emphasised in the revolutionary agenda introduced by the National Education Policy 2020 (NEP-2020) in the Indian educational system. The gender gap can be considerably closed by including constructivist methods in the scientific curriculum. Collaborative projects and contextual learning can be used to apply constructivism, a learning theory that postulates students create knowledge via experiences and interactions. To encourage equitable involvement, for instance, create science projects that call for mixed-gender teams to tackle practical issues. Furthermore, context-learning exercises can improve relevance and promote gender inclusion, including researching the influence of female scientists in nearby communities. Through their active, socially engaged, and firmly rooted in the local context, these techniques guarantee that scientific education promotes a balanced gender viewpoint.

4.2 Teacher Training: Under NEP-2020, constructivist methodologies must be implemented with great emphasis on teacher education. The ability to use gender-sensitive constructivist pedagogies is a need for educators. Training courses should emphasise approaches that advance gender equality, like guaranteeing equitable participation in group projects and classroom debates. Teachers should also get training in identifying and resolving gender biases in interactions and teaching materials. This could entail instruction in leading conversations that dispel preconceptions as well as seminars on gender sensitivity and the use of terminology that is gender-neutral. Giving teachers these abilities guarantees them to be not only information carriers but also promoters of an inclusive learning environment that supports gender diversity.

4.3 Methods of Assessment: The evaluation procedures under NEP-2020 need to change to promote constructivist learning and provide equitable chances for all pupils. Many times, the breadth of capabilities and the depth of knowledge of pupils are not adequately captured by traditional tests. Rather, implementing ongoing feedback-focused formative assessment techniques can encourage learning as a process of progress. For example, using portfolios to which students continually update their work throughout the semester may show how each student, regardless of gender, has advanced and learned. Furthermore bolstering the constructivist approach are self- and peer-assessments, which can promote introspection and critical thinking. These strategies provide a fairer learning environment where every student's accomplishments are acknowledged and supported by helping to identify various learning styles and skills. Consistent with constructivist ideas, putting these assessment modifications into practice actively helps to narrow the gender gap in education.

5. Case Studies:

5.1 Successful Implementations: Gender inequalities in many educational contexts have shown promise to be reduced with constructivist methods. The studies mentioned below show how inclusive constructivist pedagogies may create settings that support gender equality in opportunity. Some studies conducted internationally as well as in the Indian context are mentioned below, which significantly reduced the disparity between boys and girls in STEM education:

i) Studies conducted at the International Level:

- Etuk et al. (2011) conducted an experimental research study on the performance and attitude of primary science students using a constructivist teaching approach. The study involved 180 students from 21 public primary senatorial districts in Nigeria, with data collected using the Primary Science Performance Test and Primary Science Attitude Scale. The results showed that students taught using a constructivist approach performed better on the tests than those taught with a traditional strategy.

- Kibos et al. (2015) examined the impact of the constructivist teaching approach on Chemistry students' achievement. The study used a quasi-experimental design, with 160 samples from a co-educational high school in Baringo. The experimental group was taught one chemistry subject chapter using the constructivist teaching approach (CTA), while the traditional instructional technique was employed in control groups.
- Qarareh (2016) studied the efficacy of using a constructivist approach to teach the light chapter of science on 8th-grade students' achievement and scientific reasoning. The study found significant differences in favor of the experimental group for the effect of the constructivist approach on performance and development of scientific thinking. However, there was no significant difference in the constructivist approach pertaining to gender regarding achievement and scientific thinking.
- Guven et al. (2020) examined the impact on scientific creativity, robotics attitude, and interest in science of students using Arduino-assisted robotics coding projects incorporated into the 5E learning paradigm. The study found that robotics coding exercises boosted students' creativity, attitude, and motivation levels, and it is recommended that students in 6th-grade science classes might benefit from Arduino-assisted robotics coding projects.

ii) Studies conducted in the Indian context:

- Sridevi (2013) investigated the effectiveness of a constructivist approach to science education on eighth-graders perspective of the nature of science.
- Sharma (2014) found a significant difference in students' conceptual grasp of work, power, and energy concepts, suggesting that teachers should be subjected to periodic programs to refresh and update their material and instructional aspects.
- Bhattacharjee and Mehera (2014) conducted a study to determine the effectiveness of a constructivist approach in teaching science at the primary school level. They used a non-equivalent control group design, splitting participants into two groups: the experimental group and the control group. The results showed that the constructivist learning method significantly affected students' performance in Science.
- Kaur and Kaur (2016) investigated the effect of a constructivist learning approach on academic confidence for sustained growth among secondary school pupils. They found that constructive instruction was superior than traditional instruction, reducing cramping and assisting students in self-exploration. They also discovered that when children were taught Science using a constructivist method, they had a strong interest in the topic.
- Chowdhury (2016) investigated the effectiveness of Constructivist 5E learning and math achievement. They used a quasi-experimental design, with 30 learners placed in the treatment group and 30 in the non-treatment group. The constructivist strategy enhanced math achievement above the traditional method, and it was more effective for boys and girls.
- Siddiqui (2016) conducted an empirical study on the constructivist approach (5E Model) to help learners with the 9th standard understand chapter colloids.
- Parveen (2017) conducted an empirical study to determine the benefits of the 5E model of education in elevating the academic performance of primary school kids with hearing impairment in the subject of Science. They devised a scientific test to evaluate the academic performance of pupils in grades eight through twelve with hearing impairments.
- Adak (2017) conducted a study examining the constructivist method's effects on secondary Science academic performance. They used the Conventional and Constructivist 7E Model for three weeks on both groups, and the results showed that students exposed to the 7E model scored higher at every IQ level than those exposed to conventional instruction.
- Pangat (2017) examined the impact of the constructivist approach on the academic performance of secondary school students in mathematics. The results showed that students who were taught using the constructivist approach had superior mathematical performance compared to those taught using traditional methods.
- Banu and Mahmood (2019) conducted a study to investigate the impact of a constructivist approach on the achievement of mathematics of ninth-grade students in a secondary school in the urban part of Warangal. The results showed no significant difference in correct responses per question, suggesting that these methods were influential during the pandemic.

5.2 Research Findings: Research supports the effectiveness of constructivist approaches work well to achieve gender equality in the classroom. According to studies cited above, gender prejudice in Indian schools has significantly decreased, and female students' involvement in science courses has increased. The present study analysed the Constructivist Approach in teaching STEM education, finding it effective in enhancing cognitive competency, reducing delayed performance, reducing gender gaps, and promoting retention of learning. Students, regardless of gender, showed a positive attitude towards the new teaching approach. The study suggests teachers can safely adopt these approaches to achieve Outcome-based education goals and ensure paradigm shifts in the educational process. These researches highlight the possibility of constructivist approaches to dispel and dismantle preexisting gender stereotypes and build schools where boys and girls may flourish equally. Constructivist techniques can thus help close the gender gap in scientific education when included in educational frameworks as envisaged in the NPE - 1986, POA – 1992, and NEP – 2020.

6. Challenges and Limitations

6.1 Difficulties with Implementation: Within the NEP-2020 framework, constructivist approaches provide several difficulties. Among them, the infrastructure varies between Indian schools, which makes it difficult to use resource-

intensive constructivist techniques consistently. Furthermore, constructivist methods could not be aligned with the current conventional assessment systems, necessitating significant changes in evaluation procedures. Another important consideration is teacher preparedness; not all teachers will be ready or able to switch right away from conventional to student-centred teaching strategies.

6.2 Limitations of constructivism: Critics of constructivism bring its shortcomings, particularly in big, varied educational systems like India's. One of the main complaints is that, in overcrowded public schools with big class numbers and few resources, constructivism frequently necessitates small class sizes and highly specialised attention to each student. Inconsistencies in educational results might also result from the subjective character of constructivist learning, which makes it difficult to guarantee uniform knowledge acquisition between socioeconomic classes and geographical areas.

7. Suggestions: The present study offers the accompanying suggestions:

- **For Policymakers**: The NPE - 1986, POA - 1992, and NEP - 2020 emphasise the importance of outcome-based teaching-learning processes. Constructivist and Thematic is considered suitable for achieving this objective educational process. Policymakers must prioritise constructivist methodology integration in the NEP-2020 implementation plans. They should provide funds, especially for adapting school infrastructures to accommodate constructivist pedagogies and teacher training in these approaches.

- **For Teachers**: Constructivist 5E learning approaches can enhance Achievements in STEM education by promoting understanding of concepts and skills, eliminating misconceptions, and fostering a positive attitude towards science practicals and teachers. Teachers are to use chances for professional growth to become proficient in constructivist techniques and also to emphasise establishing cooperative, welcoming classroom settings that invite involvement from all students, regardless of gender.

- **For Curriculum Developers**: Curriculum Developers should make sure all genders can relate to the project-based and problem-solving exercises in the curriculum, which should represent real-world concerns. Innovative teaching methods, including group activities, daily experiences, concept mapping, reflection charts, and technology use, have the potential to revolutionise education and improve learning experiences.

8. Conclusion: The study explores the Constructivist Approach, which has positively impacted STEM education, particularly in reducing gender gaps. It suggests that faculty members in Tripura, the North Eastern Region of India, and abroad may adopt these new teaching approaches for qualitative improvement in the learning process. The constructivist method fits very nicely with the objectives of NEP-2020 and has great potential to address the gender gap in scientific education. Constructivism promotes equitable participation and successfully tackles gender inequalities by creating an interactive and context-driven learning atmosphere. Using these suggestions can improve the efficacy of educational changes meant to use constructivist methods to achieve gender equality in scientific teaching.

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