



## 2. Effect of Students' Perceptions and Beliefs towards Gender on Mathematics Learning

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### Abstract

*This study aimed to investigate the gender perceptions and beliefs of students and to examine their influence for learning mathematics. A qualitative meta-analysis of twelve relevant studies carried out during 2003-2022 on students' perceptions and beliefs towards gender and effects on mathematics learning was conducted. Thematic analysis suggested by Braun & Clarke (2006) was used as a method and findings drawn from the review work were associated with the major themes such as: teacher's support and expectations, cooperation of peers and parents, nature of mathematics and its usefulness, self-efficacy and confidence, learning environment and classroom setting. Some of the recommendations for practice to the concerned stakeholders to enhance gender parity and to reduce undesirable effects in mathematics learning are suggested in this study.*

**Keywords:** beliefs, effects, gender parity, perceptions, synthesis

### Introduction

Students' motivation, engagement in learning activities and overall learning environment play a major role in learning mathematics. The engaged learning process, active participation in class activities, asking questions, regular practice, and taking ownership of their learning are considered as important activities on the part of students for learning. However, views on an object can differ based on individual experiences as each learner is unique individual. (Naidoo & Kapofu, 2020). Students enter into the classroom with their prior perceptions, beliefs and pre requisite knowledge which are the foundation for the new knowledge and constructs. No doubt, students are the primary concerns in the learning process and so as in mathematics learning. Education would be nothing without the students who are its most important stakeholders and they are primarily influenced by any educational reform (Kaur & Prendergast, 2021). Their perceptions and beliefs towards gender and conceptions about mathematics may shape their attitudes towards the subject. Hence, positive aspects of students' perceptions and beliefs undoubtedly enhance the enjoyment and self-confidence of students and hence directly and indirectly influence on mathematics learning.

Perception is the process of understanding something through the senses whereas belief is an obvious acceptance of something without proof. Perceptions shape beliefs towards gender and beliefs shape attitudes towards mathematics. Students' perceptions towards gender, mathematics, and self as a learner influence their beliefs, behaviors and attitudes towards the subject. Combination of personality, beliefs, values, behaviors, and motivations determine an attitude of a person (Giannoulas & Stampoltzis, 2021). Similarly, Kunwar (2020) has defined that attitude towards mathematics combines feeling, belief, and performance. Attitudes, beliefs and behaviors towards mathematics are linked with either positive or negative emotions, leading to either high or low achievement.

Gender is different social identities of males and females. It is constructed by various societies with different images and roles of males and females which are determined by various



cultures, economic and academic standards and political access of males and females. Fennema (2012) has pointed that gender disparities remain in complex mathematics, beliefs, and career choices, influenced by socio-economic status, ethnicity, school, and teacher. Underrepresentation of females in mathematics learning has attracted research attention since long. Students, schools, teachers, teaching, and the home and societal environments all have essential roles in affecting students' attitudes towards mathematics (Yang, 2013). Among them, students are the first variables in mathematics learning and their perceptions and beliefs towards gender play crucial role and greatly influence in learning mathematics. In this regard, the study to explore the gender perceptions and beliefs of students and to analyze their effects on learning mathematics is significant.

Higher privileges for boys in learning mathematics at home, school and society create gender discrimination in mathematics learning. Clear gender disparities favoring boys are seen in participation level, achievement level, enrollment in higher education with mathematics and mathematics related subjects, and in the job and career choices in the future, in most of the countries of the world. Many intervention programmes for teacher education to help teachers to treat boys and girls equally are unfortunately, not successful to eliminate of gender differences in mathematics (Fennema, 2012).

In the context of Nepal, result of mathematics in examinations of different grades in schools and different levels of university are not satisfactory. The situation of females is more backward than males. Students themselves, teachers, educational institutions, family, society, etc. are responsible for it. Among them, one of the prominent factors may be the students and their perceptions and beliefs towards gender and such perceptions and beliefs may cause such failure in mathematics and may enhance the discrimination in mathematics learning. Achievement in a subject can be affected by a multitude of factors, such as resources available in schools, the background of students, instructional methods of teachers, and students' attitudes toward the subject (Nyaumwe et al., 2004). Moreover, gender inequalities are prevalent in the Nepalese society due to its patriarchal nature, which is reflected in numerous social and cultural norms. Related influential effects are obvious in learning mathematics. On the other hand, there is lack of literature related to students' perceptions towards gender issues in mathematics learning. Thus, the purpose of this study is to support a profound discussion about gender sensitivity of the mathematics learning. Hence, the significance of this study for mathematics educators and teachers lies in its ability to promote a positive attitude towards mathematics and consequently promote gender parity in overall achievements in the subject.

The goal of education is to help both boys and girls to be competent and qualified individuals creating supportive learning atmosphere. The goal can be achieved only if gender equity in mathematics learning be promoted. In this scenario, adequate researches were found on students' perceptions, beliefs and attitudes towards mathematics and its various aspects such as classroom settings, homework, use of calculator and other information technology, teaching methods, use of instructional materials, etc. But no empirical research has considered, at local level or internationally, on students' perceptions and beliefs towards gender and impacts of such gender perceptions and beliefs on mathematics learning. Gender issues are an intricate and challenging global concern. The effects of such gender perceptions and beliefs on mathematics learning cannot be ignored. In this sense, this study is unique and it is believed



that it will reinforce the recent tendency towards an increasingly equal representation of both genders in mathematical schooling and be very useful for mathematics educators, mathematicians, students, mathematics teachers, parents, educationist, education policy makers and other concerned stakeholders to develop gender sensitive teaching method, investigate gender balanced teaching processes, evaluate gender responsive intervention programmes, create gender promoting social justice.

### Research Questions

The main purpose of this study is to explore students' perceptions and beliefs towards gender and their effects on mathematics learning. To achieve this objective, the study attempts to seek the answer of the following research questions:

- i) What are the students' perceptions and beliefs towards gender?
- ii) How do gender perceptions and beliefs of students influence mathematics learning?

### Methodology

A meta-analysis of existing research studies on students' perceptions and beliefs related to gendering in mathematics learning, conducted between 2003 and 2022, was carried out in an organized manner. The aim of this systematic review was to ensure adherence to the four essential characteristics of a systematic review: clear set of objectives, a systematic search meeting the eligibility criteria, validity of the included researches and systematic presentation and synthesis of the included studies (Liberati et al., 2009). Researches were searched through a web search engine- Google Scholar, electronic database- Education Research Information Center (ERIC) and a digital library JSTOR for relevant literatures on students' perceptions and beliefs towards gender and their effects on mathematics learning.

The search involved the use of different key words: 'students' perceptions', 'students' beliefs', 'gender issues in mathematics learning', 'effects of gender perceptions in mathematics learning', etc. All the studies were collected during the three months, February to April, 2023. The last search was done on 29<sup>th</sup> April, 2023. All searches were made against article abstracts. Thousands of results of the initial searches were filtered and the duplications were removed. Search criteria were used to match the filtering limits. All the empirical studies (quantitative, qualitative and mixed methods) focusing on the research questions of the current study are chosen for the inclusion. Eventually, only 12 studies were retained after screening.

The summary of the included 12 studies is given in the following Table 1:

S.N.	First author	Published year	Country	No of participants (male + female)	School grade/ Level	Method	Findings/Students' perceptions
1	Gomleskiz	2012	Turkey	1558(925+633)	6 <sup>th</sup>	Quantitative	Males consider that learning science and technology more necessary and important than females, Males were not satisfied with classroom practices of teachers
2	Huang	2019	USA	152(73+79)	7 <sup>th</sup>	Quantitative	The level of mathematics proficiency of students had a direct influence on their mathematics anxiety, attitude, and



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							interest among boys, while girls' mathematics anxiety had a direct effect on their career interest.
3	Kaur	2022	India	55(38+17)	7 <sup>th</sup> and 8 <sup>th</sup>	Mixed method	Both boys and girls viewed writing as a beneficial way of communicating in a mathematics classroom.
4	Mutodi	2014	South Africa	124(51+73)	10 <sup>th</sup>	Quantitative	Males and females exhibited notable divergence in their views and convictions regarding mathematics.
5	Plante	2009	Canada	984(441+543)	6 <sup>th</sup> , 8 <sup>th</sup> and 10 <sup>th</sup>	Quantitative	Students other than 6 <sup>th</sup> grade boys did not perceive mathematics as a male domain; it was clear that language was regarded as a female domain.
6	Sarouphim	2017	Lebanon	692(339+353)	7 <sup>th</sup> , 8 <sup>th</sup> , 9 <sup>th</sup>	mixed method	There are no significant differences in either achievements or attitudes towards mathematics
7	Dhakal	2016	Nepal	256(123+133)	9 <sup>th</sup>	Quantitative	Gender appears to have a significant impact on both the degree of teacher support and student cohesiveness.
8	Giannoulas	2021	Greece	145(80+45)	Engineering, 1 <sup>st</sup> year	Quantitative	The engineering mathematics curriculum should be redesigned to effectively teach all students, increasing their mathematical confidence and motivation.
9	Kunwar	2020	Nepal	527(211 + 316)	9 <sup>th</sup>	Quantitative	There are no remarkable gender differences in students' attitudes and mathematical self-efficacy towards mathematics
10	Naidoo	2020	South Africa	30	11 <sup>th</sup>	Qualitative	Teachers are the key persons to improve female learners' performance in mathematics and to alleviate learners' negative perceptions of learning geometry
11	Nyaumwe	2004	Zimbabwe	2150	o level	Quantitative	To promote problem solving skills in students, teachers should utilize student-centered teaching methods.
12	Samuelsson	2016	Sweden	6758	9 <sup>th</sup>	Quantitative	Boys feel that they participate in group work and perceive



							mathematics to be more important than girls do.
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### Eligibility Criteria

To address the research questions, researches that are peer-reviewed and published in a scholarly journal during 2003 to 2022 in English with no restriction on geographical locations, are included in this study.

### Validity

A rubric was used to evaluate the quality of each research using seven criteria: objectives and purposes, literature reviews, research gap, theoretical frameworks, participants, methodology, results and discussions. The rubric was applied to the full-text contents and confirmed that all included studies met the criteria. All the retained researches were studied thoroughly again and again and agreed on a preset criterions to establish the standard of this study.

### Data Analysis

A method of thematic analysis proposed by Braun and Clarke (2006) has been noted for its usefulness and flexibility when it comes to conducting qualitative research in the field of psychology and beyond. It was used to identify, analyze and report several themes found in the included studies and present them in gist as essence in this study. Codes and sub codes are created to keep the similar messages focusing the key objectives of this study and then thematic analysis and interpretation was presented. The thematic findings of this study were interrelated with the major themes which are associated with students' perceptions and beliefs towards gender in learning mathematics and recommendations were given on the basis of effects of gender perceptions and beliefs of students on mathematics learning. The major themes were: teacher's support and expectations, cooperation of peers and parents, nature of mathematics and its usefulness, self-efficacy and confidence and learning environment and classroom setting.

### Results and Discussion

#### Teacher's Support and Expectations

Teachers play an important role in supporting students to be successful in mathematics. Girls and boys should be treated equally and given equitable access to resources, support and guidance. Girls should be encouraged to participate in mathematical activities and given the same expectation of success as their male peers. Males generally attribute their success in mathematics to their own capability, whereas females tend to attribute their failure to their inability and the complexity of the task (Leder, 1993). Supporting the same, Sarouphim & Chartouny (2017) added that students blame those teachers giving twice as much attention to boys and attributed their male students' success in mathematics to their ability, while attributing their female students' success to their effort. Teachers should be aware of gender-based biases that may be present in the classroom and differentiate instruction and create activities that are engaging and stimulating for all students to reach their potential.

#### Cooperation of Peers and Parents

Girls and boys both benefit from cooperative learning in mathematics. Girls can benefit from the support of their peers in helping them to stay motivated and confident in their mathematics abilities. Parents can provide additional support and guidance by helping to establish a study routine, and providing more individualized instruction if necessary. In their study, Kaur and



Prendergast (2022) found that family background and support had a positive effect on students' mathematics achievement. They can provide books and other resources for the betterment and can serve as a source of emotional support and encouragement to build confidence and foster a positive attitude towards mathematics learning. In this regard, Mutodi (2014) has reported that parents and teachers significantly shape their students' perceptions and attitudes towards mathematics and it is recommended not to discourage. Further, importance of peer and teachers' co-operation is supported by Samuelsson & Samuelsson (2016) that academic attitudes, achievement, emotions, learning, motivation and self-efficacy are positively influenced by teacher and peer support.

### **Nature of Mathematics and its Usefulness**

Students' perceptions and beliefs towards gender on nature of mathematics and its usefulness in mathematics learning vary significantly. While many students may view mathematics as a "male-dominated" field, others may view it as a gender-neutral subject. Plante, et al. (2009) has claimed that western societies have traditionally viewed mathematics as a "male domain" and language as a "female domain." However, recent studies have suggested that gender stereotypes privileging boys in mathematics appear to be waning, and are being replaced with those that give girls an advantage. Some students may believe that men are better at mathematics than women, while others may believe that both genders have equal ability. Additionally, some students may view mathematics as a useful tool for problem-solving and logic, while others may view it as a tedious and difficult subject. The students (both girls and boys) acknowledged that mathematics was challenging and took up a large amount of time, with many struggling to solve the same mathematics problem, often without achieving the desired result (Naidoo & Kapofu, 2020). Ultimately, it is important to recognize that students (both boys and girls) have different perceptions and beliefs towards nature of mathematics and its usefulness in mathematics learning, and that these beliefs can be influenced by their experiences, culture, and education.

### **Self-Efficacy and Confidence**

Students' perceptions, beliefs and attitudes towards mathematics are shaped by their personal feelings, experiences and practices of the academic achievement. An individual's attitude toward mathematics is a combination of knowledge, beliefs, ideas, feelings, and emotions (Mutodi, 2014). Self-efficacy, enjoyment and confidence towards mathematics can vary significantly between genders. Generally, there tends to be a lower confidence level and enjoyment of mathematics among girls than among boys. Girls often report lower self-efficacy towards mathematics compared to boys, and they are also more likely than boys to develop negative attitudes towards mathematics and view it as a difficult subject. It has been revealed through research that students who have faith that their hard work will increase their performance are more likely to boost their academic success (Mutodi, 2014). In the same way, boys tend to have more confidence in their mathematical abilities and find it more enjoyable. Girls are more likely to report feelings of anxiety, frustration and lack of confidence in mathematics compared to boys. At adolescence, female students experience a drastic decline in their self-esteem, while males become more self-assured as they get older. Simultaneously, girls lose the confidence and self-awareness they usually had at a younger age (Mutodi, 2014). Further, Huang et al. (2019) have added that girls who experience mathematics anxiety may be



more likely to have a lower level of math self-efficacy, which could subsequently decrease their interest in mathematics and science-related careers. Similarly, boys with a growth mindset may develop a higher level of mathematics self-efficacy, which may lead to increased interest in mathematics and science-related careers.

### **Learning Environment and Classroom Setting**

The ideal learning environment and classroom setting for mathematics learning should be comfortable and inviting, with ample resources available to students. The space should be organized and free of distractions, with comfortable furniture and plenty of natural light. The physical infrastructure and psychosocial aspects of a mathematics classroom both contribute to improving the learning and teaching environment for mathematics. (Dhakar, 2016). Male students tend to have a more positive attitude towards learning mathematics when they have a comfortable and organized classroom environment. Female students, on the other hand, often prefer a more relaxed and nurturing environment when learning mathematics. The girls' decline in performance was linked to their negative feelings towards mathematics based on their opinion of the classrooms being unattractive, uncomfortable, and hostile. (Samuelsson & Samuelsson, 2016). In this regard, Gomleksiz (2012) has opined that students should have access to a stimulating and supportive learning environment where teachers use prior experience, interact effectively with students, and apply appropriate teaching techniques. Teachers should strive to create an atmosphere of respect, where students feel safe to ask questions and discuss their ideas without fear of judgement. In one study of Yang (2013), girls did not view their classroom learning environments more positively than boys, but boys reported feeling more involved and having more chances to conduct inquiry activities. Teachers should be familiar with different psychological theories and various audio-visual instructional materials to make the class effective and learning meaningful for all students in mathematics. Having a range of instructional materials available for students to use enables them to gain a conceptual understanding of mathematics. (Nyaumwe et al., 2004).

### **Recommendations**

Teachers should provide support and encouragement to all students, regardless of gender. They should have willingness and ability to answer questions, provide guidance and celebrate successes, in an effort to foster a positive and productive mathematics learning environment. By providing students with motivational rewards and encouraging them to have a positive outlook on the subject, teachers can nurture their self-esteem and avoid labeling mistakes (Nyaumwe et al., 2004). Girls with supportive teachers and a positive learning environment tend to have higher levels of interest and motivation in mathematics than boys.

Teacher should focus on providing meaningful instruction and engaging activities to motivate and inspire students and should manage effective classroom setting based on the situation tactfully. To create an atmosphere to achieve best in mathematics, teachers should foster a supportive environment for group work, ensure active participation of both girls and boys, and encourage them to work independently in the classroom.

Several psychological and cognitive factors, such as anxiety, motivation, and learning approaches, have a strong influence on students' attitude and perception towards mathematics. (Giannoulas & Stampoltzis, 2021), teachers should implement learning strategies that aim to



foster engagement in mathematics among both male and female students to reduce the gender gap in mathematics attainment.

New and improved pedagogies should be considered so that students of all genders and different academic levels are benefitted and be able to improve their mathematical performance. Kunwar (2009) has suggested to promote a positive attitude towards learning mathematics, teaching learning strategies that foster learning, technologies that make learning enjoyable and motivational orientations should be employed.

Curriculum should be created to explain mathematical concepts, encourage students' enthusiasm and certainty in studying mathematics. Additionally, schools should create strategies concerning instructor preparation that concentrate on how to provide more mathematical knowledge in an improved manner to increase fairness in mathematics education.

It is essential for mathematics teachers, educators, and parents to recognize and counter any preconceived idea that girls do not enjoy mathematics or view it as a male-dominated subject. All female students should be given the same level of support and encouragement, so that they may reach their full potential in mathematics. Perceptions of mathematics as a male domain, as well as beliefs held by teachers that boys are more naturally capable of performing mathematical activities than girls, are now obsolete (Nyaumwe et al., 2004).

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- References marked with an asterisk (\*) indicate studies included in the systematic review.
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