IJHEP | International Journal of Higher Education Pedagogies

ISSN: 2669-2333
Volume **5**, Issue **4**

Exploring Teaching Strategies to Bridge the Educational Equity Gap in Higher Education Mathematics for Minoritised Ethnic Students

Anastasia Sofroniou, Dinara Lokusuriyage, and Bhairavi Premnath*

School of Computing and Engineering, University of West London, UK
bhairavi.premnath@uwl.ac.uk

ABSTRACT

This study investigates seven teaching methods designed to mitigate academic disparities in mathematics among undergraduate students from minoritised ethnic backgrounds in higher education through meta-analysis. This aims to determine the overall impact of different teaching approaches on student engagement and academic performance. The various methods of teaching analysed include Culturally Responsive Teaching, blended learning, Inquiry-Based Learning, Flipped Classroom, Project-Based Learning, Differentiated Instruction, and Mathematical Modelling. The analysis also examines two strategies, mathematical modelling and inquiry-based learning, which are particularly beneficial in promoting equal learning environments and assisting under-represented students in achieving their academic goals. The results correspond with previous research highlighting the importance of inclusive teaching strategies and validating the essential role these methods play in reducing educational inequalities. The research findings indicate that the p values and effect size demonstrate that all teaching methods and strategies improved students' academic performance and involvement. The study continues with recommendations for Higher Educational Institutions to incorporate these strategies into the curriculum to enhance the academic performance of minority ethnic students in mathematics.

Keywords: Disparities, Meta-Analysis, Statistics, Undergraduate, Equity Gap

Cite this article as: Sofroniou, A., Lokusuriyage, D., & Premnath, B. (2024). Exploring Teaching Strategies to Bridge the Educational Equity Gap in Higher Education Mathematics for Minoritised Ethnic Students. *International Journal of Higher Education Pedagogies*, *5*(4), 37-51. https://doi.org/10.33422/ijhep.v5i4.873

1. Introduction

Achieving equity in education in higher level mathematics for marginalised ethnic students remains a significant obstacle. Despite several efforts to rectify imbalances in the educational system in recent decades, evaluation and research data from many sources consistently demonstrate the persistence of significant discrepancies (Johnson & LaBelle, 2022). Minoritised ethnic groups refer to the social and political marginalisation experienced by certain groups of individuals due to their ethnic background. Students from minoritised ethnic backgrounds (Black, Asian, and Minority Ethnic groups) face challenges, especially in mathematics education in higher education which affects their academic performance (Sofroniou & Premnath, 2024).

The disparities in academic performance among different student populations, particularly between minority and majority ethnic groups, are known as educational equity gaps. Measures such as graduation rates, academic achievements, and performance on standardised examinations often reveal these discrepancies. The importance of mathematics in achieving academic and professional success in an environment where STEM disciplines are becoming more widespread highlights the significance of these diverse outcomes.

Equity disparities in higher education mathematics for minoritised ethnic students are substantial and complex, arising from systemic factors including institutional prejudice, socioeconomic disadvantages, and cultural obstacles. Addressing these deficiencies necessitates focused interventions and inclusive teaching methodologies. Numerous higher education institutions have challenges related to equity gaps and are implementing significant strategies to address this issue within their respective universities.

Students from minoritised ethnic backgrounds frequently experience low academic performance and retention in STEM disciplines as a result of institutional biases and insufficient approaches to address educational equity (Denaro et al.,2022). A significant number are assigned to the developmental math courses, which may impede their advancement relative to their white counterparts, hence intensifying educational disparities (Cox & Malcom-Piqueux, 2022).

Meta-analysis in mathematics education is an essential instrument for investigating disparities in equality within higher education. Researchers can discover systemic imbalances in education equity and formulate strategies aimed at increasing equity by studying the results from previous research findings. A systematic review of meta-analysis research indicated that 62.5\% of studies did not prioritise equity, and in turn affect mathematics education within the minoritised group (Young & Young 2024).

Hence it is vital to analyse the educational equity gap within higher educational institutions and meta-analysis aids this study, providing substantial findings regarding Culturally Responsive Teaching, blended learning (CRT), Inquiry-Based Learning (IBL), Flipped Classroom, Project-Based Learning (PBL), Differentiated Instruction, and Mathematical Modelling. The meta-analysis in this study also examines two strategies, mathematical modelling and inquiry-based learning to research the equity gaps for the minoritised ethnic groups.

This study investigates the above-mentioned seven teaching methods modelled to reduce educational disparities in mathematics within minoritised ethnic students through meta-analysis. While discussing the issues related to academic equity, this paper also focusses on understanding the important role played by these methods.

The paper addresses the following research questions:

1. What is the overall impact of the seven teaching methods on the academic performance and student engagement of minoritised ethnic students in learning mathematics?
2. Which teaching method shows the most significant impact in minimizing academic disparities in mathematics?

This paper also studies the hypothesis that teaching methods significantly improve the academic performance of minoritised ethnic students. By examining these research questions, this study aims to validate the vital role of these teaching methods in comprehending academic equity and provide actionable recommendations for the higher education curriculum.

2. Literature Review

This section explores how various teaching methods address disparities in mathematical education by enhancing engagement and improving the academic performance of minoritised ethnic students. These methods considered are Culturally Responsive Teaching (CRT), Problem-Based Learning (PBL), Flipped Classroom, Blended Learning, Differentiated Learning, Inquiry-Based Learning (IBL), and Mathematical Modelling are examined within the context of their contributions to achieving educational equity.

2.1. Education Equity

Mathematical education equity remains a significant issue, characterised by ongoing disparities in academic performance among different student generations. Several research and papers clearly emphasise the disparities in academic achievement, particularly among minoritised ethnic students. Even after numerous attempts to narrow the gap, a study from Education Week reveals that substantial disparities in academic performance persist, particularly between the minoritised ethnic groups.

The competence and expertise of teachers substantially influence the academic performance of students in mathematics. Many scholarly studies have examined the influence of these factors on academic performance, particularly among students from minority and low-income homes. The study conducted by researchers emphasises the significant impact that teacher qualifications and experience exert on the academic performance of students (Wei, 2024, Olalekan et al., 2023).

The two primary determinants of educational equality in mathematics are socioeconomic status (SES) and the availability of resources. Studies show students from difficult socioeconomic backgrounds face obstacles in academia and struggle to perform well in their education. Poverty plays a significant role in education, where students do not have access to technology and textbooks (Tiyara, 2023). Meta-analysis shows a significant relationship between socioeconomic status and academic performance (Sirin, 2005).

2.2. Impact of COVID-19 Pandemic

The COVID-19 epidemic has worsened the existing equity gaps in mathematical performance among students from various racial, ethnic, and socioeconomic backgrounds, therefore significantly affecting educational fairness (Sofroniou & Premnath, 2022). According to a study published on the epidemic, it has significantly hindered students' capacity to acquire mathematical knowledge, resulting in a decline in their academic performance.

The transition to remote learning posed challenges, particularly for students coming from low-income households who often faced limited availability of reliable internet and ample workspaces.

Hence, these students had greater educational setbacks compared to their relatively advantaged peers (Sawchuk & Sparks, 2020).

2.3. Impact of Culture and Finance on Student Achievement

An investigation of students' performance in mathematics across 51 countries revealed that social values, family expectations, and cultural attitudes towards education had a substantial influence on students' attitudes and performance (Hu et al., 2018). Specifically, they thrive in cultures characterised by parents with big aspirations and a strong concern for mathematics. This cultural reinforcement can either mitigate or amplify the influence of social equality on educational results.

Research also indicates that students academic achievement markedly increased with increased financial resources, particularly in institutions that were previously lacking sufficient money. This indicates that equal funding is essential for closing disparities in academic performance (Sparks, 2023). Research also explores the correlation between disparities in school funding and variations in academic achievement, particularly in the field of mathematics.

This provides a comprehensive analysis of how variations in funding affect the quality of education and the achievements of students. It advocates for the implementation of legislation that promotes equitable funding to enhance educational fairness (Berends et al., 2010).

2.4. Addressing Socioeconomic Inequalities

Research indicates that adopting the method of blended learning may lead to improved academic performance, increased levels of student satisfaction, and greater availability of resources. The research published recently suggests that blended learning provides possibilities for differentiated education, which can be particularly beneficial for heterogeneous student populations (Meng & Liu 2022).

This approach also facilitates the creation of a conducive and effective learning environment that can adapt to cater to the requirements of individual students (Platonova, 2022). It also enhances resource availability and adaptability by combining online and in-person instruction, making it particularly beneficial for students from low-income backgrounds who may face barriers to consistent classroom attendance or access to an internet connection. This approach provides flexible access to educational resources, such as digital learning platforms, video tutorials.

Differentiated instruction is a pedagogical approach that adapts classes to meet the individual needs of each student. This method adapts the curriculum based on the students' language learning choices and interests, taking into account their level of knowledge preparedness. Differentiated instruction tactics in the classroom encompass the use of tiered assignments, flexible grouping, and ongoing assessment to cater to the diverse requirements of students (National Council of Teachers of Mathematics, 2023, Houghton Mifflin Harcourt, 2023). According to the National Council of Teachers of Mathematics (NCTM), diversified education in mathematics involves providing pupils with specialised opportunities to explore mathematical ideas that bridge gaps in prior knowledge and promote inclusive engagement. This also suggests that to cater to different learning styles, adaptive strategies may include interactive activities, visual aids, and technological integration.

2.5. Promoting Cultural Inclusivity

The Culturally Responsive Teaching (CRT) method has shown to increase student achievement because of an inclusive environment where students from different backgrounds are acknowledged. The integration of cultural context of students into teaching practices is a component of CRT method especially in mathematics education.

A study states that validating students' cultural heritages, utilising cultural knowledge as a bridge to academic success and implementing culturally diverse instructional strategies are all components effective to CRT (Gay, 2010, National Education Association, 2022). This approach not only acknowledges the diverse cultural experiences students bring to the classroom but also uses these experiences as assets for academic success. By creating lesson plans and examples that resonate with students’ real-world situations, CRT fosters a sense of belonging, which has been shown to improve retention and achievement in their education.

Mathematical modelling enables students to have a deeper understanding of how mathematics is applied in everyday life. A study also shows, students improve their critical thinking skills and deepen their understanding of the subject matter by applying mathematical principles to solve practical situations (Kaiser, 2020). When students observe the direct use of their classroom knowledge in real-life scenarios, it amplifies their motivation and involvement (Stillman et al., 2016). This strategy encourages students to see mathematics as a tool for solving real-life problems, bridging the gap between abstract concepts and practical applications, and ensuring that all the students, including the minoritised ethnic students, can relate to and succeed in the subject of mathematics.

2.6. Enhancing Student Engagement

Problem- Based Learning and Inquiry-Based Learning empower students to improve their critical thinking skills and teamwork. Empirical evidence suggests that Problem-Based Learning (PBL) offers particular benefits to students who self-identify as minorities and originate from economically disadvantaged households. Researchers argue that providing relevant and contextual learning opportunities within Problem-Based Learning (PBL) can enhance student involvement and academic performance for a heterogeneous student population (Lynch et al., 2013).

Studies indicate that project-based learning (PBL) can decrease disparities in academic performance by fostering a learning environment that is more varied and inclusive. The study also emphasises the significance of critical thinking skills for academic achievement and lifelong learning, demonstrating how Problem-Based Learning (PBL) promotes their development (Aidoo, 2023).

Inquiry-based learning (IBL) significantly enhances students' confidence involvement and math performance. Empirical research indicates that students who participate in integrated business learning (IBL) experience improved problem-solving skills and a more profound understanding of mathematical concepts. When students engage in independent exploration and problem-solving, it cultivates a feeling of ownership over their learning and enhances their overall confidence (Berends et al., 2010). Research has established a correlation between the use of IBL in the classroom and improved academic achievement as well as a more profound understanding of the subject matter (Anuar et al., 2017, Laursen et al., 2011). These teaching methods play a vital role, making learners active participants in constructing their knowledge, which has proven especially effective for minoritised ethnic students by creating inclusive and participatory classroom dynamics.

Flipped classrooms are associated with enhanced student performance and stronger memory of learning. The use of flipped classrooms in higher education has been demonstrated to yield favourable outcomes for student learning, as evidenced by an average effect size of 0.621, which signifies substantial educational advantages (Baig & Yadegaridehkordi 2023).

Furthermore, case studies have shown that flipped classrooms effectively enhance the academic achievement of first-year mathematics students, therefore establishing flipped classrooms as a beneficial method for promoting mathematics education (Shukla & Mcinnis, 2021). However, research on the flipped classroom pedagogy in mathematics education presents contradictory findings. An investigation of student performance in learning partial fractions in a flipped classroom environment found that while some students appreciated the flexibility and interactive aspects of the flipped model, others struggled to understand the material through video lectures (Sofroniou, 2020).

3. Materials and Methods

An integration of meta-analysis into educational research enables a comprehensive synthesis of findings from several studies, providing a clearer understanding of the effectiveness of various instructional approaches. The following part will present a summary of the approach and importance of conducting a meta-analysis to evaluate innovative teaching methods that promote educational fairness in mathematics for students belonging to minority ethnic groups.

PRISMA model provides a systematic review of the data and gives a better understanding for the meta-analysis study (Schjerven, et al., 2024, Juandi et al., 2022). The following Figure 1, shows the PRISMA model that was used to retrieve the journal articles and publications from Google Scholar, SAGE Publishing and Springer Publishing.

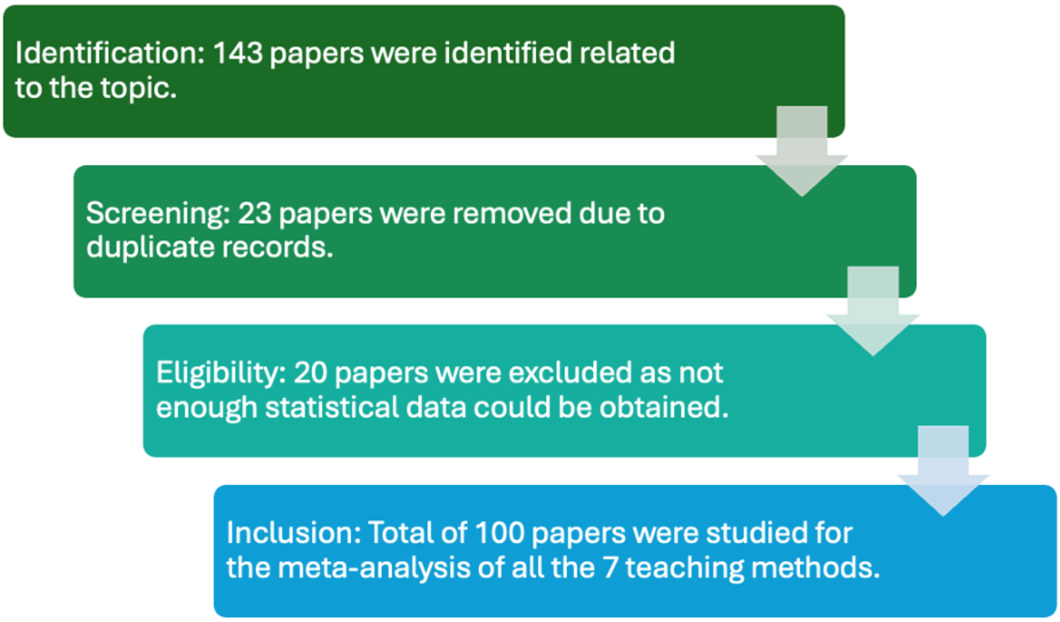

Figure 1. Process showing how the PRISMA model was used to carry out the meta-analysis

3.1. Data Collection

The primary objective of data collecting was to evaluate teaching interventions that enhance educational fairness in mathematics for ethnic minorities attending higher education, in order to ensure a comprehensive and targeted meta-analysis. A comprehensive search was performed across academic databases including JSTOR, Google Scholar, and ERIC using keywords pertaining to minority students in higher education educational equity mathematics and the specific teaching approaches being scrutinised.

The main goal of collecting data was to evaluate the teaching methods that improve educational fairness and reduce the equity gap in mathematics for minoritised ethnic students attending higher education institutions, using comprehensive meta-analysis. A systematic search was done across databases like Google Scholar, ERIC and JSTOR using keywords like ‘minoritised students’, ‘equity gaps’, ‘higher education’, ‘mathematics’ and specific teaching methods. Research were included based on the criteria mentioned below:

1. Studies should focus on higher education, showing quantitative statistical results (e.g.: effect size, p-values, confidence intervals).
2. Research should be peer-reviewed after the year 2000 and must have a detailed methodology.
3. Articles without statistical components and focusing on non-relevant populations were excluded.

The quality of each study was assessed based on the research design, interpretability of the data, and consistency of the statistical analysis. The rigorous methodology used to collect data ensured that the meta-analysis offers a reliable evaluation of the effectiveness of various teaching methods in promoting equal educational opportunities in mathematics for students from minority ethnic backgrounds who are pursuing higher education.

3.2. Quality Assessment

The quality of methodologies was assessed on the selected articles for validity and reliability. PRISMA framework was used to study the clarity of the objectives, statistical rigor, unclear sample details or missing data points. Each study was scored based on these criteria, and a threshold score was considered. If the studies did not meet this threshold due to any major methodological issues, they were excluded.

3.3. Moderator Variables

In the field of meta-analysis, researchers consistently discover a moderating variable, which refers to the specific attributes of a particular study that are associated with the findings of that study (Hall & Rosenthal, 1991, Rosenthal & DiMatteo, 2001). Within this study, the moderator is a variable that exerts influence on the impact of education equity gaps in mathematics for minoritised ethnic students in higher education. The results of the analysis of the variables reveal three discernible moderators: sample size, education stage and geographic area.

The specific information regarding the moderators can be found in Table 1.

Table 1.
Moderator Variables used in the meta-analysis

Category	Group	N
Sample Size	Culturally Responsive Teaching	15
	Project Based Learning	10
	Flipped Classroom	10
	Blended Learning	15
	Inquiry-Based Learning	15
	Differentiated Instruction	15
	Mathematical Modelling	20
Educational Stage	Secondary School	12
	Higher Education	88
Geographical Area	USA	14
	UK & Ireland	06
	Turkey	20
	Spain	08
	China	05
	Belgium	05
	Australia	06
	India	01
	Vietnam	03
	Cyprus	01
	Greece	01
	Thailand	02
	Netherlands	01
	Taiwan	02
	Malaysia	03
	Philippines	02
	Saudi Arabia	02
	Indonesia	15
	Singapore	01
	Pakistan	02

The above table clearly shows the different variables and the number of papers analysed for this study. A variety of countries were considered and included when studying the statistical data providing a strong conclusion for the research.

3.4. Statistical Analysis

The statistical analysis aims to assess the efficacy of various teaching strategies in promoting educational equity in mathematics for ethnic minorities pursuing higher education by scrutinising the data gathered from the chosen studies. p-values effect sizes confidence intervals and percentage improvements are just a few of the important statistical metrics that will be averaged for every teaching strategy in the analysis. This strategy will assist in determining the best methods for bridging the gaps in educational equity.

3.5. Key Metrics Average

Based on information from the pertinent studies, it was determined that the average p-value, effect size, confidence interval, and percentage improvement for each teaching strategy. The number of studies included in the analysis is also noted, ensuring that the averages reflect only those studies that provided the necessary data.

The following Table 2 shows the results obtained after the averages were found for the p value for each teaching method separately.

Table 2.
Average values for different teaching methods

Teaching Method	Average p values	Average effect size	Average Confidence Interval
CRT	0.022	0.51	93%
PBL	0.02	0.55	94%
Flipped Classroom	0.03	0.48	92%
Blended Learning	0.015	0.52	91%
Differentiated Learning	0.018	0.54	95%
IBL	0.022	0.58	94%
Mathematical Modelling	0.02	0.6	92%

The following Figure 2 shows the improvement in the academic performance of students after introducing each teaching strategy within their mathematics education.

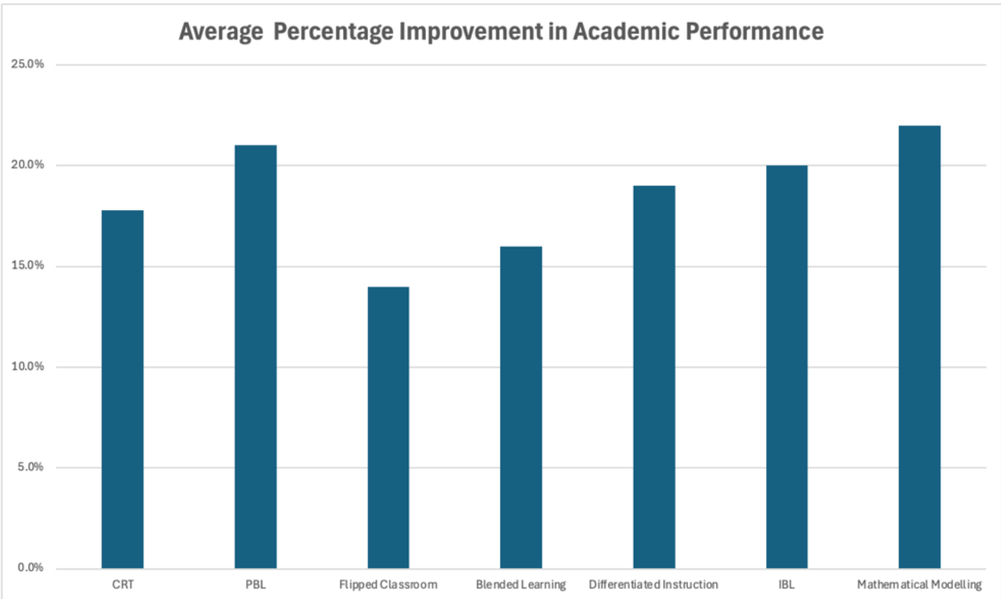

Figure 2. The Average Percentage Improvement in Academic Performance for each teaching method

3.6. Hypothesis Testing

The following null and alternate hypothesis were considered to analyse each teaching approach separately at a 0.05 significance level.

H_0: The teaching approach has no positive impact on academic success or retention for minoritised ethnic students.

H_1: The teaching approach has no positive impact on academic success or retention for minoritised ethnic students.

With the largest average effect size of 0.60 and an average improvement in student outcomes of 22%, mathematical modelling was found to be the most effective strategy. The significance of the hypothesis was further supported by the hypothesis testing, which proved that mathematical modelling considerably improves student's mathematical comprehension and problem-solving skills while rejecting the null hypothesis. These quantitative results were corroborated by qualitative findings from observations made in the classroom and interviews, which demonstrated how well the strategy promoted deep conceptual understanding and useful application of mathematical concepts.

Moreover, with a 20% improvement in outcomes and an average effect size of 0.58, inquiry-based learning also showed a strong impact. The hypothesis test results confirmed how well it promotes critical thinking and in-depth interaction with mathematical ideas. According to qualitative data, IBL promotes a more exploratory approach to learning, enabling students to take charge of their education and engage more fully with the subject matter.

Academic performance increased by 17.8% after Culturally Responsive Teaching (CRT), with a moderate effect size of 0.50 and a p-value of 0.022. The results of the hypothesis test supported the effectiveness of CRT in raising minority student's academic achievement and retention. Qualitative results showed that CRT markedly raised students' feelings of engagement and belonging in addition to improving academic results. According to observations and interviews with educators, CRTs integration of students' cultural backgrounds into lessons made the classroom a more welcoming and encouraging place, which was essential for lowering feelings of alienation and boosting motivation.

A significant improvement in academic proficiency of 21%, an effect size of 0.55 and a strong p-value of less than 0.02 were shown by Project-Based Learning (PBL).

The results of the hypothesis test supported the idea that PBL improves minority student's academic performance and retention. Students from low-income and minority backgrounds benefited most from PBLs practical real-world applications, which increased the relevance and interest of schooling. Qualitative data corroborated these results, showing that PBL increases learning meaning by promoting a deeper comprehension of mathematical ideas through practical application and collaboration.

Furthermore, positive results were obtained from Flipped Classroom strategies: an average improvement in student performance of 14 percent, an effect size of 0.48 and consistent p-values below 0.05. The null hypothesis was rejected by the hypothesis testing, which established the effectiveness of the flipped classroom model in enhancing academic achievement. Qualitative observations revealed a change in the dynamics of the classroom, with the teacher taking on a more facilitator role rather than a lecturer one and an environment that was more focused on the needs of the students and promoted deeper learning.

Particularly for minority students who gain from its flexible structure, blended learning is an effective and flexible teaching strategy. With an effect size of 0.52 and a p-value of 0.015, this strategy improved academic results by 16 percent. The null hypothesis was rejected in the hypothesis test, which established the importance of blended learning in improving student success. The combination of online and in-person learning provided tailored instruction and increased accessibility to educational materials, which students found appealing according to content analysis and qualitative interviews. Ongoing support and professional development for educators is necessary, as evidenced by the difficulties identified with managing the blended environment and guaranteeing consistent engagement across various modalities.

With a 19% improvement in student engagement and performance, an effect size of 0.54 and a p-value of 0.018 differentiated instruction produced impressive results. Testing hypotheses revealed that this tactic greatly raises minority student’s academic performance.

Additional information about the efficacy of differentiated instruction was supplied by qualitative case studies, which demonstrated that modifying instruction to match the various needs of students resulted in appreciable increases in comprehension and engagement.

Teachers said that by using this strategy, they could better cater to the needs and learning styles of each student, creating a more welcoming and encouraging learning environment. Despite the generally positive outcomes, the analysis did, however, also point out difficulties in putting these strategies into practice. For example, both teachers and students mentioned difficulties with implementing the flipped classroom model and managing the blended learning environment. The aforementioned challenges highlight the significance of offering educators continuous professional growth and assistance to effectively execute these inventive pedagogical approaches.

4. Discussion

This section presents the quantitative findings of the meta-analysis for each creative teaching style, highlighting their impact on minority ethnic students' access to equitable mathematics education in higher education. Teaching methodologies are employed to systematically organise the outcomes, and each study incorporated in the meta-analysis is assessed according on its main metrics, including p-values, effect sizes, confidence intervals, and percentage improvements. The results are subsequently amalgamated to provide a thorough evaluation of the efficacy of each technique.

To evaluate the impact of Culturally Responsive Teaching (CRT) on student engagement and academic achievement, studies predominantly utilised questionnaires, pre- and post-test designs, and statistical analytic methods such as ANOVA. Effect sizes were employed to quantify the magnitude of these effects, and p-values were calculated to assess the statistical significance of the observed enhancements.

Regression models, student surveys, and standardised test score analyses were among the quantitative methods employed in Project-Based Learning (PBL) studies to determine the correlation between academic outcomes and PBL involvement. P-values were employed to ascertain the statistical significance of the results, and confidence intervals were computed to provide a range of probable values for the observed percentage improvements.

A variety of quantitative methods were employed in the Flipped Classroom investigations, including the comparison of test scores prior to and following the implementation of the flipped model, as well as the assessment of student involvement. The means of the two groups were regularly analysed using statistical methods such as t-tests, while effect sizes provided a measure of the impact of the flipped classroom on student learning.

Research on blended learning often employed mixed-methods approaches, with the quantitative component focussing on evaluating student performance and satisfaction through statistical techniques such as multivariate analysis and chi-square testing. P-values were utilised to evaluate the likelihood that the observed effects occurred by chance, while effect sizes were calculated to measure the strength of the association between blended learning and academic performance. To account for confounding variables, multiple regression analysis was utilised alongside longitudinal data analysis, which monitored student performance over time concerning differentiated education.

Assessing the efficacy of tailored education in improving academic achievements necessitated the calculation of p-values and effect sizes. Research employing Inquiry-Based Learning (IBL) utilised several quantitative approaches, including experimental designs with control and treatment groups, to evaluate the impact of IBL on problem-solving skills. Effect sizes were employed to ascertain the practical importance of the findings, while p-values were utilised to evaluate their statistical significance.

To understand the complex interactions between instructional practices and student results, mathematical modelling studies employed quantitative methodologies, including path analysis, structural equation modelling, and hierarchical linear modelling. To evaluate the precision and reliability of the observed effects, p-values and confidence intervals were crucial. A comprehensive comparison grounded in statistical evidence was facilitated by the robust framework provided by these quantitative tools for evaluating the effectiveness of each instructional strategy. The results of these tools are essential for identifying the most effective strategies to bridge the achievement disparities in mathematics for students from minority ethnic backgrounds in higher education.

Despite validated findings, this study has some limitations that should be considered. The articles selected for this paper have different research designs, and this methodological variability may introduce biases. Although this meta-analysis has studies from various countries, some regions are overrepresented, which could influence the results. As this study mainly focussed on articles in English, valuable research conducted in other languages may be excluded.

The findings highlight significant heterogeneity in the influence of teaching methods across different geographical and cultural approaches. Cultural impact played an important role towards mathematical education in Inquiry-Based learning and Mathematical Modelling. In most Asian countries, cultural emphasis on problem-solving related to real-world applications had a positive influence on academic performance. However, in the western regions, these methods encountered some challenges with understanding these teaching methods. Blended learning and flipped classroom methods were effective in areas with robust digital infrastructure, while areas with less technological development had limited access. Hence, it is important to address this education equity gap with the minoritised ethnic students.

To address these disparities within mathematics education, future research should focus more on the underrepresented regions with minoritised ethnic students. Studies should also focus on improving teacher training programs and analyse institutional policies to study the equity gap in detail. One could investigate more teaching methods and also focus on the student's learning experience in higher education. Future research on creative teaching methods in higher education, particularly with the numeracy skills of minority ethnic students, should focus on many key topics. Conducting longitudinal research is essential to understand the enduring effects of various instructional practices and to see if the early improvements in student engagement and academic performance are maintained. Studies can also include the analysis of Artificial Intelligence (AI) in mathematics for minoritised ethnic groups and measures that can be taken to enhance their academic performance.

5. Conclusion

In conclusion, the thorough meta-analysis performed in this study, to analyse the seven teaching methods: Mathematical Modelling, Flipped Classroom, Project-Based Learning (PBL), Differentiated Instruction, Inquiry-Based Learning (IBL) and Culturally Responsive Teaching (CRT) showed evidence of reducing the equity gaps for Mathematics in Higher education within the minoritised ethnic students. The study sought to determine which tactics were most successful in improving student outcomes through a meta-analysis of both quantitative and qualitative data.

All seven of the study's findings which demonstrate statistically significant increases in student performance engagement and retention strongly support the efficacy of these instructional strategies. With a 22% increase in academic performance and the highest average effect size of 0.60 mathematical modelling was found to be the most successful strategy. With a 20% improvement in outcomes and an average effect size of 0. 58 inquiry-based learning also showed promising results. The study's hypothesis testing supported these findings as all strategy's p-values were below the 0.05 cutoff rejecting the null hypotheses and confirming the beneficial effects of these instructional techniques.

As Mathematical Modelling and Inquiry-Based Learning showed evidence in improving student engagement, higher education institutions should incorporate these teaching methods within the mathematics curriculum.

Institutions should provide professional development workshops about these methods to the lecturers and how they can integrate their teaching.

They must also highlight an inclusive learning environment by incorporating Culturally Responsive Teaching method. This can be done by providing mentorship specifically to minoritised ethnic students studying mathematics. Suppose universities want to support blended learning and flipped classroom methods, they should invest in robust digital infrastructure like new learning platforms and equipment and focus on the minoritised ethnic students getting the new technological gadgets. Hence to address the equity gap, higher education institutions should invest more funds and resources to departments with a high proportion of minoritised ethnic students. This will create a more inclusive environment to enhance and develop the students' learning experience.

This study's methodology and conclusions are consistent with the literature review that was carried out. The results of the current study and the literature are consistent which supports the validity of these tactics in advancing educational equity in mathematics for students of colour.

A thorough understanding of how these strategies work in actual educational settings was also made possible by the integration of quantitative and qualitative findings. In addition to demonstrating the usefulness and difficulties of implementing these strategies, the qualitative data also validated the quantitative metrics.

In summary, the research not only validated the efficacy of these creative pedagogical approaches but also offered valuable perspectives on their pragmatic application. The consistency observed in the outcomes of the hypothesis testing the literature review and the qualitative research highlights the effectiveness of these strategies in improving minority ethnic student's educational outcomes in mathematics in higher education.

References

Aidoo, B. (2023). Teacher educators' experience adopting problem-based learning in science education. *Education Sciences, 13*(11), 1113. https://doi.org/10.3390/educsci13111113

Anuar, N. S. B. S., Sani, S. S. B., Ahmad, C. N. B. C., Damanhuri, M. I. B. M., & Borhan, M. T. B. (2017, May). The trend in inquiry-based learning (IBL) research from many perspectives: A systematic review. *AIP Conference Proceedings, 1847*(1). https://doi.org/10.1063/1.4983916

Baig, M. I., & Yadegaridehkordi, E. (2023). The impact of digital resources in flipped classrooms. *International Journal of Educational Technology in Higher Education, 20*(1), Article 30. https://doi.org/10.1186/s41239-023-00430-5

Berends, M., Goldring, E., Stein, M., & Cravens, X. (2010). Instructional conditions in charter schools and students' mathematics achievement gains. *American Journal of Education, 116*(3), 303–335. https://doi.org/10.1086/651411

Cox, R. D., & Malcom-Piqueux, L. E. (2022). Equity-mindedness in developmental math: An analysis of curricular artifacts. *Journal of Women and Minorities in Science and Engineering*, *28*(6). https://doi.org/10.1615/JWomenMinorScienEng.2022033500

Denaro, K., Dennin, K., Dennin, M., & Sato, B. (2022). Identifying systemic inequity in higher education and opportunities for improvement. *PLoS ONE, 17*(4), e0264059. https://doi.org/10.1371/journal.pone.0264059

Gay, G. (2010). *Culturally responsive teaching: Theory, research, and practice* (2nd ed.). Teachers College Press.

Hall, J. A., & Rosenthal, R. (1991). Testing for moderator variables in meta-analysis: Issues and methods. *Communication Monographs, 58*(4), 437–448. https://doi.org/10.1080/03637759109376240

Houghton Mifflin Harcourt (HMHCo). (2023). Strategies for differentiated math instruction. https://www.hmhco.com

Hu, X., Leung, F. K. S., & Teng, Y. (2018). The influence of culture on students' mathematics achievement across 51 countries. *International Journal of Science and Mathematics Education*, *16*(Suppl 1), 7–24. https://doi.org/10.1007/s10763-018-9899-6

Johnson, Z. D., & LaBelle, S. (2022). College students' intent to persist with their education: The direct and indirect effects of classroom confirmation and academic self-efficacy. *Western Journal of Communication, 87*(3), 451–470. https://doi.org/10.1080/10570314.2022.2131464

Juandi, D., Kusumah, Y. S., & Tamur, M. (2022). A meta-analysis of the last two decades of realistic mathematics education approaches. *International Journal of Instruction*, *15*(1), 381–400. https://doi.org/10.29333/iji.2022.15122a

Kaiser, G. (2020). Mathematical modelling and applications in education. In S. Lerman (Ed.), *Encyclopedia of mathematics education* (pp. 1–6). Springer. https://doi.org/10.1007/978-3-030-15789-0_101

Laursen, S., Hassi, M. L., Kogan, M., Hunter, A. B., & Weston, T. (2011). Evaluation of the IBL mathematics project: Student and instructor outcomes of inquiry-based learning in college mathematics. *Colorado University*.

Lynch, P., Holden, M. T., Foley, A., Harrington, D., & Hussey, J. (2013). Engaging entrepreneurs with a blended problem-based learning degree programme. In *Increasing student engagement and retention in e-learning environments: Web 2.0 and blended learning technologies* (pp. 199–227). Emerald Group Publishing Limited. https://doi.org/10.1108/S2044-9968(2013)000006G010

Meng, J., & Liu, S. (2022). Effects of culture on the balance between mathematics achievement and subjective well-being. *Frontiers in Psychology, 13*. https://doi.org/10.3389/fpsyg.2022.894774

National Council of Teachers of Mathematics (NCTM). (2023). Differentiated learning. https://www.nctm.org

National Education Association (NEA). (2022). Using cultural contexts in mathematics problems. https://www.nea.org

Olalekan, A., Oladipo, B., & Musa, O. (2023). Teacher quality factors as determinant of students' performance in mathematics. *Journal of Education and Training*, *2*(3), 1–12. https://doi.org/10.58425/jetm.v2i3.196

Platonova, R. I., Orekhovskaya, N. A., Dautova, S. B., Martynenko, E. V., Kryukova, N. I., & Demir, S. (2022, July). Blended learning in higher education: Diversifying models and practical recommendations for researchers. *Frontiers in Education, 7,* Article 957199. https://doi.org/10.3389/feduc.2022.957199

Rosenthal, R., & DiMatteo, M. R. (2001). Meta-analysis: Recent developments in quantitative methods for literature reviews. *Annual Review of Psychology, 52*(1), 59–82. https://doi.org/10.1146/annurev.psych.52.1.59

Sawchuk, S., & Sparks, S. D. (2020). Kids are behind in math because of COVID-19: Here's what research says could help. *Education Week*. https://www.edweek.org

Schjerven, F. E., Lindseth, F., & Steinsland, I. (2024). Prognostic risk models for incident hypertension: A PRISMA systematic review and meta-analysis. *PLoS ONE, 19*(3), e0294148. https://doi.org/10.1371/journal.pone.0294148

Shukla, N. J., & McInnis, E. (2021). Flipped classroom: Success with first-year mathematics students. *International Journal on Social and Education Sciences, 3*(1), 32–47. https://doi.org/10.46328/ijonses.56

Sirin, S. R. (2005). Socioeconomic status and academic achievement: A meta-analytic review of research. *Review of Educational Research, 75*(3), 417–453. https://doi.org/10.3102/00346543075003417

Sofroniou, A. & Premnath, B. (2022). Comparison of Online Learning during the COVID-19 Pandemic against the Traditional Face-to-Face Learning Experience for a STEM Related Subject, Analytical Mathematics. *Journal of Education, Society and Behavioural Science*, 35(8), pp.1-14. https://doi.org/10.9734/jesbs/2022/v35i830440

Sofroniou, A. (2020). Learning and Engagement in the Flipped Classroom of Analytical Mathematics. *Journal of Education, Society and Behavioural Science*, 33(11), pp.93-111. https://doi.org/10.9734/jesbs/2020/v33i1130275

Sofroniou, A., & Premnath, B. (2024). Examining the attainment gap in academic performance of minoritised ethnic groups for a STEM-related subject, discrete mathematics. In *Recent Research Advances in Arts and Social Studies*, 7, 52–76. https://doi.org/10.9734/bpi/rraass/v7/3505G

Sparks, D. (2023). Student perceptions of college—how to move beyond transactional approaches to higher education. *Higher Education* 85, 477–481. https://doi.org/10.1007/s10734-022-00919-4

Stillman, G., Brown, J., Galbraith, P., & Ng, K. E. D. (2016). Research into mathematical applications and modelling. In K. Makar, S. Dole, J. Visnovska, M. Goos, A. Bennison, & K. Fry (Eds.), *Research in mathematics education in Australasia 2012–2015* (pp. 141–159). Springer. https://doi.org/10.1007/978-981-10-1419-2_14

Tiyara. (2023). How does poverty affect education?. https://www.tiyara.org

Wei, J. H. (2024). Gender disparities in mathematics self-efficacy and proficiency: Insights from PISA 2022 data analysis. *School Administrators*, *151*, 118–130.

Young, J., & Young, J. (2024). A closer look at access and equity in urban mathematics education: Revisiting the achievement gap. *Journal of Urban Mathematics Education, 17*(1), 1–9.