International Journal of Learning, Teaching and Educational Research
Vol. 22, No. 3, pp. 160-174, March 2023
https://doi.org/10.26803/ijlter.22.3.10
Received Nov 28, 2023; Revised Mar 5, 2023; Accepted Mar 9, 2023

"Supporting our Lost Boys": A Research on Gender-based Science Education's Hidden Curriculum in Malaysia

Nurfarahin Nasri*, Nik Mohd Rahimi, Harwati Hashim, Nurfaradilla Mohamad Nasri
Faculty of Education, Universiti Kebangsaan Malaysia, Malaysia

Abstract. Malaysia has had tremendous success in increasing women participation in science-related fields by diffusing empowering values into the formal school curricula. A subliminal effect of these female empowerment campaigns, however, is that male students are beginning to lag behind in science education, giving rise to the phenomenon known as "The Lost Boys." In light of the potential for a hidden curriculum to support gender-sensitive or gender-responsive science education, this research was aimed at exploring the hidden curriculum in science education and its impact on boys in science education. This research used the classical Delphi method involving 84 experts, whereby two rounds of questionnaires and one round of qualitative commentaries were used to gather information from a group of experts. Gender-biased notions were found in science education's hidden curriculum, including the proliferation of feminist messages through outside classroom activities, the lack of gender awareness in teaching and training, and the centering of female mentoring in the field. This research further recommends strategies to explicitly address gender-biased issues in science education's hidden curriculum to benefit both female and male students' participation in science. It is hoped that this research serves as a guide for policy makers, school leaders and teachers to achieve gender equity in science education.

Keywords: gender; gender equity; science education; hidden curriculum; Delphi methodology

1. Introduction

Students learn through a formal curriculum which is often highly organised and governed by the teachers, schools or governments. Within this system, students are expected to master content knowledge, at the same time develop a certain level

* Corresponding author: *Nurfarahin Nasri, nurfarahinnasri@yahoo.com*

of skills or competency sets. However, researchers communicate the need to acknowledge that students' learning goes beyond the prescribed curricula, but rather such a process is grounded in a contextual learning environment and greatly influenced by other elements. This statement therefore alludes to the idea of the "hidden curriculum", which is best defined as the unsaid sets of beliefs, actions, or values that present in any learning environment (Abroampa, 2020; Giroux & Penna, 1979). While hidden curriculum is not explicitly written, it is empirically known to influence students' expectations, skill sets, knowledge, and social process which can either help or hinder their participation or achievement at school. According to a study by Erickson (2022), when effectively addressed, hidden curriculum can entice students to understand scientific concepts and encourage their attrition in science-related subjects at schools and even after schooling. Thus, the main focus of this research is to understand hidden curriculum, in particular the influential elements that interact with and around the learning environment in schools to support a more inclusive and high-quality science education.

2. Literature review

Recent years have witnessed an interesting occurrence in Malaysia as the government focuses on advancing innovation and sustainable growth in science to propel its way to becoming a high-income and developed nation in the year of 2024 (World Bank, 2021). Following various initiatives to empower women in education and workforce, Malaysia records a significant increase of female to male participation ratios in science-related fields (DOSM, 2022). Despite the positive outcome, a subliminal impact on male's participation rate in science gradually surfaces. The country predicts a major gender imbalance in the science-related fields, especially when it comes to male and female students' enrolment in science education at schools. More specifically, the ministry reported that less than half of the students in all science-related subjects in Malaysia are male, indicating poor male participation in science education (MOE, 2016). Therefore, this research argues that boys in Malaysia are in imminent danger of being side-lined if no further actions are being undertaken to identify its roots and support their participation in science education.

However, incorporating gender-sensitive or gender-responsive approaches in the formal curriculum is not always easy as this approach is commonly undervalued and misunderstood by school teachers (Sainz et al., 2021; Fuertes-Prieto et al., 2020). The main cause of teachers' lack of knowledge about gender-responsive teaching may be that this strategy was not heavily emphasised during teacher training or professional development programmes, which caused the majority of teachers to hold many stereotypes about both male and female students that might affect how they interacted with their students (Achyut et al., 2016). Considering the high student-teacher ratios in Malaysia, a single teacher could have a substantial impact on a significant number of students; therefore, the potential for hidden curriculum to support a gender-sensitive or gender-responsive science education has prompted the researchers to look into this possibility. In a similar sense, numerous international initiatives are carried out to assure that high quality education is available for all levels and populations. The

United Nations, for instance, specifies a number of sustainable development goals (SDG), including SDG Goal 4: Quality Education, which aims to promote inclusive and equitable quality education with a focus on eradicating gender inequities in education. As part of the goals of Millennium Development and Vision 2020, Malaysian educators are urged to address gender equity in science education (Goy et al., 2018). Ismail et al. (2019) also suggested the importance of investigating science education towards achieving gender equity. However, both researchers highlighted the scarcity of literature that provides a systemic solution for supporting male students' participation in science education.

A careful analysis of the literature demonstrates that the majority of hidden curriculum theories centre on how students interact with an unwritten curriculum. From the perspective of a functionalist sociologist, schools serve as a place of socialisation where it helps students become accustomed to the values and norms of the general society (Lawson et al., 2009; Feinberg & Soltis, 2009). Moreover, nurture theory explains hidden curriculum as it states that the learning environment has an impact on how students act, experience and understand (Carl, 2013). Although the formal curriculum overtly provides a standardised form of instruction for teachers to use, students may be acquiring potent insights from hidden curriculum, such as those about gender. Schools or teachers therefore, do more than transmit content knowledge (Giroux, 2001; Concannon-Gibney, 2021), but they may also be communicating social norms, cultural values and gender stereotypes (McQuillan & Lininger, 2020). Consequently, this research defines the notion of hidden curriculum as the learning and teaching concept that lies outside the context of the formal curriculum which significantly affects how students perceive learning, particularly in the context of science education.

Science teachers impart scientific knowledge or skills by using a variety of tools, namely models, prototypes or experiments. Teachers also transmit to students a wide range of behaviours, beliefs, and attitudes even though they may not have been aware that they were doing so (Strom & Viesca, 2021). Here, the teachers can be instructing the students on how to formulate thoughts or build an understanding of their surroundings. Hansson (2018) stated that the hidden curriculum in science education may cover topics such as how to complete assignments successfully, how to interact with others and exchange ideas, how to participate in experiments or problem-solving, or how to get good grades. The unintentional and non-scientific elements that make up the hidden curriculum have the potential to have a significant impact on how students view science and develop their attitudes toward it (Kim & Song, 2009). In addition, the hidden curriculum may contain assumptions about daily life that are not always consistent with how the formal curriculum addresses the topic.

Within the classroom environment, a teacher may have pushed female students to take lead in group study sessions or a female teacher may have a propensity to use only feminine contexts when describing scientific principles. For example, Kerger et al. (2011, p. 626) described how science teachers might employ a feminine context such as "discuss the dangers of smoking" or a masculine context like "examine which poisons have an effect on the nervous system." Although this may be unconscious or unintended by the teacher, the male students in this case may not benefit the most from these practices (Chetcuti, 2009). More importantly, these practices may cause the male students to lose interest in science and seriously harm their engagement in the process of learning and teaching science. Since hidden curriculum is described as more effective than the formal curriculum especially in developing students' attitudes or values (Yüksel, 2005; Elliot et al., 2016), this research argues that more should be done to examine how hidden curriculum influences male students' participation in science education. Even though the nature of hidden curriculum is complex since it reflects the planning and practice of teaching, further understanding on how it can improve the overall teaching and learning in science and students' learning experiences serve as the main focus of this research.

Students' enrolment in science-related subjects or more commonly known as science, technology, engineering, and mathematics (STEM) in Malaysia has grown exponentially as a result of extensive governmental initiatives. However, this impressive progress has given rise to a unique sequela where boys participation in science education shows a downward trend. The Malaysia Educational Statistics 2019 reported that boys' participation in STEM at upper secondary level is only 44% (MOE, 2019). Furthermore, in tertiary education, statistics show that only 40.4% STEM undergraduates represent boys which decreased by almost 4% from upper secondary level participation – creating a phenomenon of the "Lost Boys". The Malaysia Education Blueprint 2013-2025 specifically mentioned that Lost Boys is a potential source of social instability and should be urgently addressed (MOE, 2015). For instance, young men from low-income families may be disproportionately impacted by the gender gap in education because they are more likely to be socialised to accept unfavourable gender stereotypes, which prevents them from participating fully in academic life and enrolling in universities, leaving them with lower wages upon entering the labour market (Tienxhi, 2017).

In this research context and from a gender point of view, it is worthwhile to note that most attending schools in Malaysia have a female-dominated teaching environment. A percentage of 70.5% of the teacher population in Malaysia consists of female teachers (MOE, 2019). Systematic review of literature on gender in teaching revealed that in a female-dominated teaching environment, female teachers tend to design learning activities that are more female-centric (Sabbe & Aelterman, 2007). It further explained that as a result of female-centric teaching, boys would find difficulties in relating and understanding the learning (Sabbe & Aelterman, 2007). This argument is also shared by Ismail et al. (2019) who conducted a qualitative study to explore students' preferences in STEM learning reported that male and female teachers have different teaching approaches. Therefore, this situation can significantly place boys in danger of being left-out due to irrelevant or stereotyping pedagogy (Lee et al., 2019). Informed by the findings from the literature review and the identified research gaps, this research contributes to knowledge building by identifying pertinent dimensions of gendered hidden curriculum in science education by consolidating and analysing opinions from a group of science education' experts. The followings are the research questions:

1. What are the components of the hidden curriculum in science education across Malaysian primary and secondary schools?
2. What are the pertinent gender-based issues identified in the hidden curriculum in science education?
3. How do these issues influence male students' participation in science education?

3. Methodology

This research employed a classical Delphi method to explore hidden curriculum in science education with a group of field experts. The Delphi method is an iterative, multi-step procedure created to bring divergent viewpoints together and produce a consensus. While the classical Delphi method featured four rounds, more recent research suggests that either two or three rounds can be utilised to obtain consensus among experts (Hasson & Keeney, 2011). This method was selected due to its distinctive characteristics, which included enabling participation from a wide range of experts, boosting the likelihood of saturation, efficient use of cost and time with greater emphasis on the process of preparing the questionnaire, avoiding loss of important information through iterative process and preserving anonymity to encourage genuine, real-life responses (Saffie & Rasmani, 2016; Niederberger & Spranger, 2020). Moreover, the classical Delphi Methodology was considered to be highly effective in defining and researching multidimensional, complicated, or context-specific areas such as hidden curriculum.

The classical Delphi method was aimed at seeking knowledge and reaching a consensus with a group of 84 experts (science school teachers, lab instructors, science lecturers/professors) who were selected through snowball sampling and met several predetermined selection criteria. The selection criteria were: 1) had teaching experience in science education for at least ten years, 2) had completed postgraduate studies in fields related to science education, or 3) had received professional training in gender-sensitive or gender-responsive science education. These criteria were carefully developed in order to ensure that only subject matter experts with substantial teaching experience and content knowledge were selected to provide relevant contributions to this area of study. Prior to participating in the research, the experts were required to submit informed consent forms. After receiving the experts' consent, they were requested to answer questionnaires and reach a consensus on the responses they gave.

This research was conducted in three phases as illustrated in Figure 1. Phase 1 served as the backbone for this research, involving the recruitment of the experts and the development of the first round Delphi questionnaire. During this phase, the experts received a questionnaire via email consisting of ten general, open-ended questions to explore the nature and describe the components of the hidden curriculum in science education. The written responses were then analysed using thematic analysis using constant comparative method (Brady, 2015). Similar issues were coded, grouped and categorised following their associated themes. A systematic list of gender-based issues in hidden curriculum was developed using the responses from 84 experts (50 females and 34 males) which were later used in the next phase. In Phase 2, the findings from the first round Delphi questionnaire were presented to the experts, so they could see the wide range of viewpoints regarding hidden curriculum in science education offered by other experts, including ones they had not previously described. The experts were requested to score the issues using a Likert-type scale survey as to their agreement regarding the importance and impact on the hidden curriculum. Each issue had a minimum score of 1 and a maximum score of 8. A total of 75 experts with a retention rate of 89.3%, provided their responses for this second round. In the Phase 3 and final round of the classical Delphi method, the experts were invited to express their agreement or disagreement with the issues and rankings that the researchers had obtained from the analysis of the data of previous rounds. Moreover, the experts were also required to provide more in-depth, qualitative commentary on the emerging picture of a hidden curriculum based on gender-sensitive or gender-responsive approach in science education. During this round, a total of 63 experts with a 75% retention rate reviewed and verified the themes that were generated from the data analysis performed by the researchers.

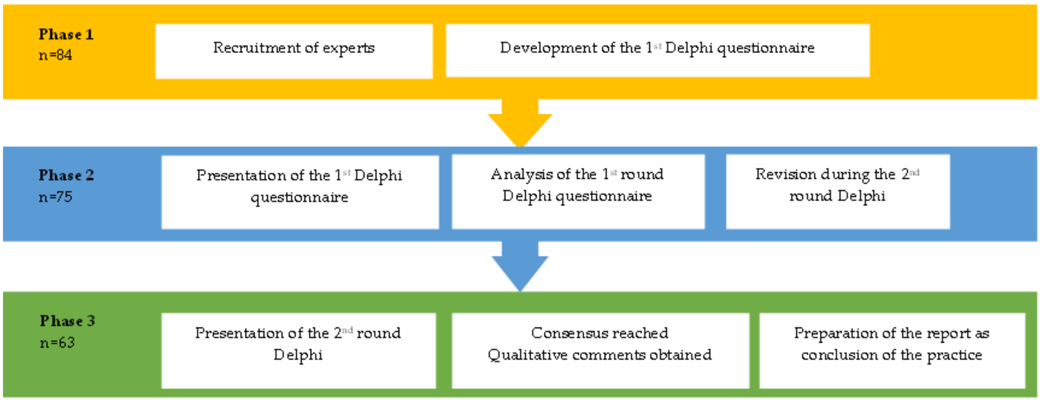

Figure 1. Illustration of research phases; comprising of Phase 1, Phase 2 and Phase 3

4. Findings

Based on the findings from the Delphi method, this research identified several gender-biased notions which were often perpetuated within the hidden curriculum in science education. Table 1 details the issues or concepts rated highest by the experts during the second Delphi round which were previously identified in the first round. The scores for each issue were first added, and then the total added score was divided by the total number of responses. The issues with the highest scores were later tabulated, ranked and arranged according to relevant themes. The findings revealed many highly ranked pervasive gender-based themes in the hidden curriculum of science education including Theme 1: The proliferation of feminist messages through outside classroom activities, Theme 2: The lack of gender awareness in teaching and training and Theme 3: The centering of female mentoring in the field.

Table 1: Themes and ranking of gender-based issues present in the science education's hidden curriculum

Themes	Gender-based issues	Score
Theme 1: The proliferation of feminist messages through outside classroom activities	Explicit support for female students' inclusion in science-related activities	7.8
	Prioritisation of female students as leaders in science groups	7.5
	Grouping of students according to gender	7.6
	Emphasis on having female representation in science club	7.4
	Single-gender science competition carries higher weights	7.8
	Female-oriented extra-curricular activities	7.4
Theme 2: The lack of gender awareness in teaching and training	Negative gender stereotypes by school teachers and school leaderships	7.5
	An orientation that favours female-oriented teaching approach	7.7
	Teaching styles that fail to account for gender of students	7.6
	Excessive focus on female students who were perceived to be more at risk	7.3
	Inadequate training to support gender-sensitive pedagogy	7.8
	No value in gender-sensitive or gender-responsive teaching	7.5
	Outnumbering of female science teachers	7.7
Theme 3: The centering of female mentoring in the field.	Media messages on female empowerment in science	7.9
	Female role-modelling in science programs	7.4

Theme 1: Proliferation of feminist messages through outside classroom activities
The experts placed a strong emphasis on issues connected to the propagation of feminist messages, especially as they pertained to extracurricular activities. First and foremost, it was evident that feminism was well represented in this type of activities, namely participation in science clubs, contests, and field trips. This particular theme attracted special attention because the majority of the activities were created with a powerful signal to empower more female students to participate in them. This purposeful feminist approach was deemed fair because it complemented or supported the nation's efforts to increase the participation of women in science-related fields.

> *"Most of the activities outside the classroom are designed based on other factors or to support national agenda… So I'm assuming that most of these programs are made either to support the government's policy or to say that the school is doing something to help the female students."* (EXP32L22-25)

With the purpose of encouraging female participation in science activities outside the formal school curriculum, most of these activities as shared by the experts were set with pre-established rules or regulations. For instance, in order to promote to a higher district or national level, a school-level science competition was required to achieve a high participation ratio of male to female students.

Similar to this, several of these activities only allowed registration or further advancement to student groups with a higher number of females. Consequently, male students could not easily participate in these activities due to the rules since they would either be underrepresented in the groups or completely absent throughout the entire activity. One of the experts brought up this grave worry after observing that her male students were reluctant to take part in these activities because they felt excluded due to the overwhelming presence of female participants. Additionally, it was shown that groups with exclusively or more female members received extra points, giving them a greater advantage in the finals. It was also a common practice for many science competitions to allocate a special reward or a specific prize for the female category. As a result, male students began to rethink and question whether the competitions were even fair.

> *"There is certainly a specific reward for girls, but there is no distinct award for the boys category. Sadly, we fail to take into account the effects on boys when we want to empower girls."* (EXP21L15-17)

All experts concurred that single-gender science competitions, in particular girls only, were frequently made to appear or appear to have a larger weighting in terms of achieving the school's key performance indicator. Several experts noticed this issue when they looked into why some schools were very selective in choosing student representatives for girls-only competitions but were less vigilant when selecting student representatives for mixed-gender competitions. Furthermore, the experts stated that single-gender science competitions had greater reputation due to the amount of rewards they offered, major sponsorships, corporate or government partnerships, and the lineups of contestants from top-performing all-girls boarding schools. By only selecting the best students, who were often female, the teachers were thus constrained to exclude the participation of the male students in these scenarios.

> *"Single-gender competitions are frequently well-regarded or one of the year's most highly anticipated events. Participating in these competitions will help the school become more well-known."* (EXP57L32-38)

Theme 2: The lack of gender awareness in teaching and training

From the perspective of studying science in the classroom, the experts firmly agreed that the gender-sensitive or gender-responsive approach to science education was not highly recognized by the school leadership and science teachers. Some of these experts suggested that this might be caused by the teachers' lack of formal training, while others held that school leadership frequently viewed this strategy as a "reversal" of what they had formerly preached or practised. Most of the time, schools or teachers had a slight misunderstanding of gender-sensitive teaching, considering it as going against their existing views or values of supporting female students to study science. Also emphasised by these experts was the fact that many teachers assumed gender-sensitive teaching as a threat which could risk female students' engagement in science. In relation to this same issue, Achyut et al. (2016) strongly advocated the importance of administrative support especially in promoting gender-responsive pedagogy which was underscored by many educational stakeholders. In the same vein, (Beasley & Fisher, 2012) also agreed that highly motivated teachers might not be able to effectively implement gender-responsive pedagogy without school administrators' and other teachers' support.

> *"Gender-sensitive or gender-responsive teaching in science is quite new here. Personally, I don't see a lot of exposure to this concept, and if there is any sort of course related to it, it was not readily or easily accessible for all science teachers."* (EXP4L22-27)

Another concerning issue in this theme was the current teaching style adopted in science classrooms which really reflected the demographic profiles of the science teacher population. The experts believed that there was an imbalance in the gender of school science teachers considering the fact that the number of female science teachers were significantly higher than male teachers. This helped to explain why female students did so well in science because female teachers were more likely to provide examples of scientific application through daily life routines, which the female students could relate to more easily. The experts specifically mentioned that female teachers often utilised activities like cooking, hair perming, nail polishing and laundry to illustrate scientific concepts. One expert who stated that her teaching was a "moving and spontaneous art" agreed with this claim. Despite having meticulously prepared her science lesson before class, she was unaware that her teaching style had discriminated against a particular gender group due to real-time adaptations and changes made in the classroom. Due to this teaching style, the male students might not be able to directly relate to the teacher's explanation, making it difficult for them to develop a clear understanding of the overall concept.

> *"It's actually pretty typical for female teachers to present examples with which they can identify. And as a result of their everyday interactions with those examples, the female students are better capable of relating and understanding those examples. Not so much for the boys who do not really engage in these activities."* (EXP66L39-42)

Based on the experts' experiences as science students, their observations of science teaching and their science teaching experiences, the experts saw a distinctive aspect of how the teachers managed the classroom when they were teaching science. These experts claimed that the teachers showed higher preference to handle a classroom with more female students since the girls were disciplined and respected them as the authority in the class. In contrast, the teachers might find it harder to control a classroom when there were more male students because the latter frequently caused disruptions by making noise and disturbed others' learning. Several experts remarked that male students often brought disciplinary or behavioural issues into the class, which the teachers typically dreaded. Due to the teachers' gender preconceptions that they had formed based on their own teaching experiences, it was understandable that the teachers would react more favourably or be more receptive to engaging with the female students in comparison to the male students (Lindner et al., 2022).

> *"Naturally, a teacher is more relatable to students who pay attention in class and maintain order. So, teachers are more uptight around the boys*

and more easy going around the girls. The teachers' unfavourable reactions to the boys may communicate to the students that the teacher is not really paying attention to them." (EXP41L26-29)

Theme 3: The centering of female mentoring in the field
Female positioning as mentors or leaders in science-related fields was widely promoted via the mass media through podcasts about women empowerment in science, a social media page dedicated to female engagement in science as well as documentaries on getting more women involved in science. This specific portrayal of female figures in science had a direct implication on both female and male students, and it was concerning that each gender might have had a different reaction to it. The former might feel more empowered as they found other females were experiencing similar challenges and thus, were more likely to turn to other female figures so that they could advance their education in science. The latter, meanwhile, might view science as a field they should avoid because their problems were not specifically addressed and their struggles were kept "unseen" and "unheard" from the public. As a result, the male students might not perceive the value of science learning and were more likely to not engage in science education. This perspective is comparable to that of Atkins et al. (2020), who found that students appreciated mentors with whom they associated on the basis of demographic similarities or shared values, and which in the context of this research refers to the gender.

"We see everywhere that female students in science are considered at risk. Both globally and locally. You see it in the newspaper, TV, social media, YouTube... It's easy for the girls to feel very empowered through this public message, but the boys would definitely feel left out. Their challenges were not addressed and highlighted with similar emphasis like what had been done with the girls." (EXP2L17-25)

The impact of female mentorship in the field was reinforced later as the female experts revealed their individual experiences of being invited to speak and mentor students in science at various Malaysian schools. The female students who received this type of mentoring were introduced to a variety of programs and career paths in science that they could take in the future. This helped the female students to stay positive about their decisions to study science and work in fields related to it. On the other hand, the male students did not have similar mentoring experience and would remain unclear about how science could affect their future learning pathways and career choices. Since they were unable to establish a long-term goal for learning science, the male students could become disinterested in science and would not participate in science education.

"I have personally been invited to be science mentors at schools. However, there is no similar mentoring program like that for the boys. In addition, these boys don't have a target that they should work for. They are unaware about career options in science. More often than not, they would later question why they need to study science as science will not help them land a job." (EXP73L9-12).

5. Discussion

The research has most importantly made systematic identifications of important gender-biased issues from inside of the hidden curriculum, which is the first step in the country's pursuit of gender equity in science education. These rarely discussed gendered issues are brought to light not to openly address the shortcomings on the part of the teachers or schools, but rather to highlight the significance of being aware of the numerous factors of hidden curriculum which have a greater impact on the engagement of male students in science (Park et al., 2018). Therefore, this research emphasised that in order to reduce the participation and achievement inequalities between male and female students in science education, one can now adopt a different approach by looking outside of the formal school curricula and exploring the potential and reality of its hidden curriculum.

The findings from this Delphi research demonstrate how the hidden curriculum in science education could have a significantly positive effect on supporting female students' attrition in learning science, while at the same time, causing an unfavourable impact on male students' participation in science. Von Schönfeld et al. (2019) contended that despite careful planning, formal curriculum often falls short of realising their full potential and achieving their intended goals. This is especially true given that learning is a social process that is complex where numerous factors are at play. Although these factors are frequently outside the control of the teachers and schools, it is important to keep in mind that they nonetheless have a significant impact on how students form their attitudes and belief systems when learning science (Kim, 2016).

In relation to the findings of the research, despite the fact that male figures continue to dominate leadership positions in science-related professions (Puteh & Mohamad, 2018; Neubauer & Kaur, 2019), it is interesting to see how it does not translate at the school-levels. This may be because schools or teachers here serve as crucial gatekeepers by providing a forum for interactions between female scientists and female students, but barely do the same for male scientists and the male students. This situation highlights how influential the role of schools or teachers is in shaping science education's hidden curriculum to improve students' attitudes and beliefs towards the subject. Our findings closely align with those of Kerkhoven et al. (2016), who also maintained the existence of numerous roles or forces that can have opposing effects on students of different genders. Furthermore, there is evidence that some teachers unconsciously include gender preconceptions or stereotypes into their classroom teaching. Despite the fact that similar gender stereotypes can be seen in subjects other than science (Alan et al., 2018), the impact of these stereotypes is more obvious and pronounced in science education. Even more, this research reveals that these gender stereotypes are not only confined within the four walls of the classroom, but also pervasive outside classroom activities. For example, since female students are sometimes perceived to be easily discouraged, the majority of rules and regulations enforced in science competitions may sometimes relate to strengthening their competitive spirits in addition to promoting their engagement.

The main strategy proposed by this research to explicitly address gender-biased issues in the science education's hidden curriculum is to convey an understanding that these issues, which create unique challenges in the teaching and learning of science, are in fact the outcomes of the socio-cultural values, as well as the larger academic field. The findings of this research expose the need for school leaders and teachers to continually self-evaluate their practice in order to improve the transparency of rules and expectation, which can grab male students' attention while inspiring them to enrol in science education. That being said, schools and teachers must be able to provide a safe space to encourage students to express their ideas and thoughts. This will enable both school and classroom activities to be more inclusive of all students and less exclusive of a select few.

At a higher level of administration, the ministry and all teacher education providers are recommended to pay serious attention in recruiting more male science teachers to promote male role models in science at schools. Additionally, it is timely to revise curricula for teacher training programs as well as professional development courses to place a higher emphasis on inclusive and equity in education. These updated curricula should also be targeted for school leaders so that they remain aware of these issues and can provide adequate support for teachers to pursue gender-sensitive or gender-responsive approaches when promoting science learning both in the classroom and in its hidden curriculum. Most significantly, these curricula should be effective at informing school leaders and teachers to see the value of hidden curriculum in fostering male students' positive attitude or interest for science education.

6. Conclusion

This research delivers an exemplar on how hidden curriculum in science education in Malaysia can have conflicting effects on the participation of female and male students in the subject. More importantly, this research views hidden curriculum as attaining a wealth of promise in supporting male students' participation in science education through the promotion of gender-sensitive or gender-responsive approaches. The findings of this research is hoped to serve as a reference or guide for policy makers, school leaders and teachers to achieve gender equity in science education. The researchers also hoped that the lessons learned by Malaysia are helpful for other countries that experience similar issues, by prompting them to tap into the potentials of hidden curriculum in science education.

Acknowledgement

This research expresses gratitude for the awarded fund under the Ministry of Education, Malaysia, grant no. FRGS/1/2020/SSI0/UKM/02/16.

7. References

Abroampa, W. K. (2020). The Hidden Curriculum and the Development of Latent Skills: The Praxis. *Journal of Curriculum and Teaching*, *9*(2), 70-77. https://doi.org/10.5430/jct.v9n2p70

Achyut P., Bhatla N., Verma H., Uttamacharya, Singh G., Bhattacharya S. and Verma R. (2016). *Towards gender equality: The GEMS journey thus far.* New Delhi, International Center for Research on Women. https://www.icrw.org/wp-content/uploads/2016/12/GEMS-report-Jharkhand.pdf

Alan, S., Ertac, S., & Mumcu, I. (2018). Gender stereotypes in the classroom and effects on achievement. *Review of Economics and Statistics*, *100*(5), 876-890. https://doi.org/10.1162/rest_a_00756

Atkins, K., Dougan, B. M., Dromgold-Sermen, M. S., Potter, H., Sathy, V., & Panter, A. T. (2020). "Looking at Myself in the Future": how mentoring shapes scientific identity for STEM students from underrepresented groups. *International Journal of STEM Education*, *7*(1), 1-15. https://doi.org/10.1186/s40594-020-00242-3

Beasley, M. A., & Fischer, M. J. (2012). Why they leave: The impact of stereotype threat on the attrition of women and minorities from science, math and engineering majors. *Social Psychology of Education*, *15*(4), 427-448. https://doi.org/10.1007/s11218-012-9185-3

Brady, S. R. (2015). Utilizing and adapting the Delphi method for use in qualitative research. *International Journal of Qualitative Methods*, *14*(5), 1609406915621381. https://doi.org/10.1177/1609406915621381

Carl, J.D. (2013). *Think Social Problems* (2nd ed.). Pearson Education Inc.

Chetcuti, D. (2009). Identifying a gender-inclusive pedagogy from Maltese teachers' personal practical knowledge. *International Journal of Science Education*, *31*(1), 81-99. https://doi.org/10.1080/09500690701647996

Concannon-Gibney, T. (2021). Moving beyond the transmission of knowledge in the lecture hall: a self study. *Professional Development in Education*, 1-13. https://doi.org/10.1080/19415257.2021.1876152

Department of Statistics Malaysia (DOSM). (2022). *Key Statistics of Labour Force in Malaysia, July 2022*: https://www.dosm.gov.my/v1/index.php?r=column/cthemeByCat&cat=124&bul_id=VWRxNmR3UVhEMHJSN0RQcExRaTdodz09&menu_id=Tm8zcnRjdVRNWWlpWjRlbmtlaDk1UT09

Elliot, D. L., Baumfield, V., Reid, K., & Makara, K. A. (2016). Hidden treasure: Successful international doctoral students who found and harnessed the hidden curriculum. *Oxford Review of Education*, *42*(6), 733-748. https://doi.org/10.1080/03054985.2016.1229664

Erickson, S. S. (2022). The game of grades and the hidden curriculum. *The Physics Teacher*, *60*(5), 398-399. https://doi.org/10.1119/10.0010403

Feinberg, W., & Soltis, J. F. (2009). *School and society*. (5th ed.). Teachers College Press.

Fuertes-Prieto, M. Á., Andrés-Sánchez, S., Corrochano-Fernández, D., Urones-Jambrina, C., Delgado-Martín, M., Herrero-Teijón, P., & Ruiz, C. (2020). Pre-service teachers' false beliefs in superstitions and pseudosciences in relation to science and technology. *Science & Education*, *29*(5), 1235-1254. https://ui.adsabs.harvard.edu/link_gateway/2020Sc&Ed..29.1235F/doi:10.1007/s11191-020-00140-8

Giroux, H. A. (2001). *Theory and resistance in education: Towards a pedagogy for the opposition*. Greenwood Publishing Group.

Giroux, H. A., & Penna, A. N. (1979). Social education in the classroom: The dynamics of the hidden curriculum. *Theory & Research in Social Education*, *7*(1), 21-42. https://doi.org/10.1080/00933104.1979.10506048

Goy, S. C., Wong, Y. L., Low, W. Y., Noor, S. N. M., Fazli-Khalaf, Z., Onyeneho, N., ... & GinikaUzoigwe, A. (2018). Swimming against the tide in STEM education and gender equality: a problem of recruitment or retention in Malaysia. *Studies in Higher Education*, *43*(11), 1793-1809. https://doi.org/10.1080/03075079.2016.1277383

Hansson, L. (2018). Science education, indoctrination, and the hidden curriculum. In *History, philosophy and science teaching* (pp. 283-306). Springer, Cham. https://doi.org/10.1007/978-3-319-62616-1_11

Hasson, F., & Keeney, S. (2011). Enhancing rigour in the Delphi technique research. *Technological Forecasting and Social Change*, *78*(9), 1695-1704. https://doi.org/10.1016/j.techfore.2011.04.005

Ismail, K., Hassan, S. S. S., & Sudan, S. A. (2019, December 21). Exploring Young Malaysians' preferences in Stem-Oriented Career Paths. In *Langkawi International Multidisciplinary Academic Conference* (pp. 115).

Kerger, S., Martin, R., & Brunner, M. (2011). How can we enhance girls' interest in scientific topics?. *British Journal of Educational Psychology*, *81*(4), 606-628. https://doi.org/10.1111/j.2044-8279.2011.02019.x

Kerkhoven, A. H., Russo, P., Land-Zandstra, A. M., Saxena, A., & Rodenburg, F. J. (2016). Gender Stereotypes in Science Education Resources: A Visual Content Analysis. *PloS One*, *11*(11), e0165037. https://doi.org/10.1371/journal.pone.0165037

Kim, H. Y. (2016). Talking to learn: The hidden curriculum of a fifth-grade science class. *English for Specific Purposes*, *43*, 1-12. https://doi.org/10.1016/j.esp.2016.02.002

Kim, M., & Song, J. (2009). The effects of dichotomous attitudes toward science on interest and conceptual understanding in physics. *International Journal of Science Education*, *31*(17), 2385-2406. http://doi.org/10.1080/09500690802563316

Lawson, T., Heaton, T., and Brown, A. (2009). *Education and Training* (2nd ed.). Bloomsbury Publishing

Lee, J., Rhee, D. E., & Rudolf, R. (2019). Teacher gender, student gender, and primary school achievement: Evidence from ten Francophone African countries. *The Journal of Development Studies*, *55*(4), 661-679. https://doi.org/10.1080/00220388.2018.1453604

Lindner, J., Makarova, E., Bernhard, D., & Brovelli, D. (2022). Toward Gender Equality in Education—Teachers' Beliefs about Gender and Math. *Education Sciences*, *12*(6), 373. https://doi.org/10.3390/educsci12060373

McQuillan, M. T., & Leininger, J. (2021). Supporting gender-inclusive schools: educators' beliefs about gender diversity training and implementation plans. *Professional Development in Education*, *47*(1), 156-176. https://doi.org/10.1080/19415257.2020.1744685

Ministry of Education (MOE). (2013). *Malaysia Education Blueprint 2013-2025*. https://www.moe.gov.my/menumedia/media-cetak/penerbitan/dasar/1207-malaysia-education-blueprint-2013-2025/file (Accessed on 8 October 2022)

Ministry of Education (MOE). (2019). *Malaysia Educational Statistics 2019*. https://www.moe.gov.my/menumedia/media-cetak/penerbitan/quick-facts/2722-quick-facts-2019/file

Ministry of Education Malaysia (MOE) (2016). *Implementation guide for science, technology, engineering, and mathematics (STEM) in teaching and learning*. Putrajaya: MOE.

Neubauer, D. E. and Kaur, S. (2019). *Gender and the Changing Face of Higher Education in Asia Pacific*. Springer International Publishing. https://doi.org/10.1007/978-3-030-02795-7

Niederberger, M., & Spranger, J. (2020). Delphi technique in health sciences: a map. *Frontiers in Public Health*, *8*, 457. https://doi.org/10.3389/fpubh.2020.00457

Park, H., Behrman, J. R., & Choi, J. (2018). Do single-sex schools enhance students' STEM (science, technology, engineering, and mathematics) outcomes?. *Economics of Education Review*, *62*, 35-47. https://doi.org/10.1016%2Fj.econedurev.2017.10.007

Puteh, F., & Mohamad, N. (2018). Leadership and gender in the public sector: The mediating effect of job satisfaction. *Journal of Administrative Science*, *15*(2), 99-117. https://jas.uitm.edu.my/images/2018_DEC/JAS8.pdf

Sabbe, E., & Aelterman, A. (2007). Gender in teaching: A literature review. *Teachers and Teaching: Theory and Practice*, *13*(5), 521-538. https://psycnet.apa.org/doi/10.1080/13540600701561729

Saffie, N. A. M., & Rasmani, K. A. (2016, July 24-27). Fuzzy delphi method: Issues and challenges. In *2016 International Conference on Logistics, Informatics and Service Sciences (LISS)* (pp. 1-7). IEEE. https://doi.org/10.1109/LISS.2016.7854490

Sáinz, M., Solé, J., Fàbregues, S., & García-Cuesta, S. (2021). Secondary School Teachers' Views of Gender Differences in School Achievement and Study Choices in Spain. *SAGE Open*, *11*(3), 21582440211047573. https://doi.org/10.1177/21582440211047573

Strom, K. J., & Viesca, K. M. (2021). Towards a complex framework of teacher learning-practice. *Professional Development in Education*, *47*(2-3), 209-224. https://doi.org/10.1080/19415257.2020.1827449

Tienxhi, J. Y. (2017). The Gender Gap in Malaysian Public Universities: Examining the'Lost Boys. *Journal of International and Comparative Education (JICE)*, *6*(1), 1-16. https://doi.org/10.14425/JICE.2017.6.1.0116

von Schönfeld, K. C., Tan, W., Wiekens, C., Salet, W., & Janssen-Jansen, L. (2019). Social learning as an analytical lens for co-creative planning. *European Planning Studies*, *27*(7), 1291-1313. https://doi.org/10.1080/09654313.2019.1579303

World Bank. (2021). *Malaysia to Achieve High Income Status Between 2024 and 2028, but Needs to Improve the Quality, Inclusiveness, and Sustainability of Economic Growth to Remain Competitive.* https://www.worldbank.org/en/news/press-release/2021/03/16/aiminghighmalaysia (Accessed on 8 October 2022).

Yüksel, S. (2005). Kohlberg and Hidden Curriculum in Moral Education: An Opportunity for Students' Acquisition of Moral Values in the New Turkish Primary Education Curriculum. *Educational Sciences: Theory & Practice*, *5*(2). https://www.semanticscholar.org/paper/Kohlberg-and-Hidden-Curriculum-in-Moral-Education%3A-Y%C3%BCksel/7f819afc6f42c83ed3c3b29047ac83ccaf56e62a