**TO WHAT EXTENT DO CULTURAL AND SOCIAL NORMS AFFECT GIRLS’ DECISION TO CONTINUE IN STEM ACROSS NORTH AFRICA**

**Gulsah DOST[[1]](#footnote-1)**

**ABSTRACT**

This paper seeks answers to two questions: Do cultural and societal norms influence girls’ decision to continue in Science, Technology, Engineering and Mathematics (STEM) across North Africa? If yes, to what extent?The effect of social and cultural norms, traditions and patriarchy on girls’ access to STEM in North Africa is analysed at a macro level by adopting Bronfenbrenner’s ecological model and evaluated by correlating these findings with the Trends in International Mathematics and Science Study (TIMSS) results of the country.Although the proportion of women in STEM education at North African universities is high, they are a minority in the STEM workforce. It is the case that all societal and cultural norms affect those individuals living within the society and culture hence it is important to interrogate in what ways these have an impact. The results of this study show that social and cultural norms have an influential role in North African society. When TIMSS results of North Africa are considered, girls are more successful than boys in science and mathematics. Even if these girls complete their higher education and work in STEM fields, they are presented with many barriers and they do not have equal opportunities like men. Either girls must relinquish their professions or switch professions deemed appropriate for women to be accepted by society.This study brings together two macro level tools used in scientific studies -one as a conceptual framework and the other as a macro level assessment tool- to examine the impact of social and cultural norms, patriarchy and traditions on access of girls to STEM in North Africa.

**Keywords** Social norms, cultural norms, patriarchy, TIMSS, STEM education, North Africa.

**INTRODUCTION**

Women's participation in STEM fields is crucial to productivity as well as economic innovation (Mann and DiPrete, 2013; Corbett and Hill, 2015; Prinsley, Beavis, and Clifford-Hordacre, 2016). However, gender inequalities in STEM have been stated in the literature for decades (Heybach and Pickup, 2017; Ceci and Williams 2010; Hedges and Nowell, 1995; Smith *et al.,* 2018). Researchers are divided into two parts on how significant these gender differences are, with some arguing that the differences are small but still noteworthy (Reilly, Neumann, and Andrews, 2015), while others describe these gaps as in fact very small or insignificant (Hyde *et al*., 2008). International reports and research have shown evidence of the shortage of women at every stage of the science pipeline, particularly in science professions (Polkowska, 2013; Holman, Stuart-Fox, and Hauser, 2018; European Parliament, 2015; UNESCO, 2015; Williams, 2018; Stuit, 2016). The World Economic Forum (2015) highlighted that although the access of young women to higher education has expanded worldwide, girls\women are still underrepresented in science degrees. Statements of gender differences in STEM choices have traditionally centred on academic performance or ability, but is this alone enough? Extensive research shows that the gender gap in STEM cannot be attributed solely to such inequalities (Mann and DiPrete, 2013; Card and Payne, 2021; Wang and Degol, 2017). Indeed, the causal factors responsible for women's underrepresentation in STEM fields are controversial and complex (Ceci and Williams, 2011). They are often based on deep structural inequalities in communities that identify the educational choices of women and men, boys and girls (UNESCO, 2019).

Social norms, traditions and patriarchy continue to be major barriers for education of girls in many countries including North Africa (Solati, 2017; Moghadam, 2020; Chamlou, Muzi, and Ahmed, 2011; Assaad and Roudi-Fahimi, 2007). Expectations and perceptions of the role of men and women in the labour market, in the family and in wider society cause girls and boys to be valued differently, which in turn affects parents' schooling decisions (UNICEF, 2014). Such harmful social norms can promote women from being seen as partners and caregivers while also preventing a change in education. According to World Values Survey conducted from 2010 to 2014 in 51 countries, more than a quarter of people believe that ‘a university education is more important for a boy’. This may lead to underrepresentation of women, especially in STEM fields. In different parts of Africa, for example, girls are less supported in many fields, including science, creating a major barrier to them going on to further study of science, or to pursue science as a career (Akwei, 2016; UNESCO, 2012). Living in an environment in which traditional gender role beliefs and social norms are widespread can attract boys to STEM fields, while alienating girls (Legewie and DiPrete, 2014). For this reason, this study had adopted the use of Bronfenbrenner's ecological model (1977, 1979) (special emphasis was placed on the macrosystem) to analyse to what extent cultural and social norms influences girls’ retention within STEM fields in North Africa. In addition, these norms were linked with the Trends in International Mathematics and Science Study (TIMSS) results of the country to provide a more detailed perspective was provided.

**METHODOLOGY**

This study applied Bronfenbrenner’s (1977, 1979, 1992) ecological model to direct the study as this model not only helps researchers and educators gain in-depth understanding into how to create an environment which can enrich academic progress of students but also allow a multi-dimensional in-depth study of the barriers to education. Bronfenbrenner (1977, 1979) suggested that development and behaviour of a person could be affected by the ecological environment, which is considered to be a part of the interconnected and interrelated structures. A person is an integral part of multiple interrelated systems that shape adolescent developmental processes, including the microsystem (the relationships of individuals with instantaneous settings), the mesosystem (interrelationships between microsystems), the exosystem (settings that do not directly affect the individual), and the macrosystem (cultural or subcultural models) (Bronfenbrenner 1977, 1979). Ecological model of Bronfenbrenner is in a whole and encompasses five subsystems that cannot be described separately. More precisely, ecological environments can be perceived as a cluster of sub-systems of different sizes and nested with each other, from smaller to larger (see Figure I). Moreover, each construct can represent an important context for girls to stay in STEM or identify barriers to girls remaining in STEM. Specifically, the macro system was identified as broad social values, cultural beliefs, political ideologies and traditions that incorporate the microsystem, the mesosystem, and the exosystem (Bronfenbrenner, 1977).

MACROSYSTEM

Social Norms Cultural Norms

Traditions Patriarchy

EXOSYSTEM

MESOSYSTEM

MICROSYSTEM

Individual

 CHRONOSYSTEM transition

Figure I. Conceptual framework adapted from Bronfenbrenner’s Ecological Model

Based on Bronfenbrenner's (1977) ecological model, one of the main sources of understanding the barriers to accessing and continuing in STEM lies in the macro system of an individual. That is, it lies in the cultural and social context of the societal group of a person. The macro system appeals to the general values ​​and traditions that portray a particular social group, providing a framework for connections between the individual and the social context like teachers at school or the family (Bronfenbrenner 1977, 1979). Hence the strength of this study lies in the more ecological approach envisaged in the Bronfenbrenner (1977) model. It is non-individualistic and it is essential given the literature to see the girls/young woman in wider context, so this is the model that can best exemplify what the context might look like for the purposes of examining it in research. This approach may provide more insight into the societal barriers to girls' STEM choices, interactions at school and their immediate environment, and stereotypes. Considering the macro system and its values, this study is limited to North African regions only, as the barriers in accessing STEM professions or majors may differ between cultures and societies (Else-Quest *et al*., 2010). In this study, science and mathematics achievement scores between eight grade girls and boys by the TIMSS 2019 in North African Countries were also examined (TIMSS, 2019). TIMSS was used in this study because it is a macro-level assessment tool and provides macro-level data. Together with Bronfenbrenner's ecological model, it allows the examination of the extent to which social and cultural norms have an impact on girls in North African countries from a large-scale macro-level perspective.

**Social and Cultural Norms**

Social norms are regarded as unwritten expectations or rules of behaviour shared by members of certain groups or society in general. (Cialdini and Trost, 1998). These norms are dynamic and subject to change over time as new norms emerge to replace the old ones. While some norms promote well-being and social development in general, others can be oppressive to some community members or only beneficial to certain members (UNESCO, 2016). Social norms are followed for social approval and, when violated people face the disapproval (UNESCO, 2016). These norms have a greater impact on young women e.g., the expectation that a woman cannot be better qualified or earn more than her future husband earns (Tole, 2017). All this allows her to take care of her husband so that there is minimum of conflict; this causes women to be seen not as equal partners in a shared journey, but as lesser individuals compromising their interests for the sake of family harmony (Tole, 2017). It also reveals how, given the traditional and cultural parameters, girls are not allowed to attend school because they are expected to do housework and take care of their siblings (Pande, 2006). For example, in Moroccan societies a girl is never allowed to forget that her school life is secondary and her main role is to take care of younger siblings and to make bread at home (Herouach, 2020). When a girl goes to school, it is usually short-lived. She is reminded that school is temporary, that being a homemaker is her true destiny and women have to be submissive to fulfil their duties (Herouach, 2020). Moroccan parents also seem to believe that extended time periods of education inevitably delay marriage for many women because they cannot get married while attending school. When Moroccan women from average/middle to lower class remain single in advanced age (single until their thirties), they can be rejected from society, and the situation leads to their social exclusion (Herouach, 2020). Even if girls complete their education, most of them are not allowed to work (Khan, 2017). If they start working, they do not have equal opportunities with men in society (Qudsi and Behera, 2019). This situation causes women to work longer hours for less wages and have restricted options compared to men. These inequalities are both a cause and a consequence of girls' unequal access to education and performance (UNESCO, 2003). The sixth round of the World Values ​​Survey conducted between 2010 and 2014 in 51 countries stated that half of the respondents agreed or strongly agreed that children suffer when a woman works for pay (UNESCO, 2019; Inglehart *et al*., 2014). 63% of the respondents agreed that ‘being a wife is just as fulfilling as working for pay’, while more than 80% adopt this view in Central Asia, West Asia, North Africa and Eastern Europe (UNESCO, 2019). Such beliefs can lead to a vicious circle of diminishing opportunities in education and employment. For example, cultural and social norms multiply the barriers girls face in their pursuit of education, resulting in lower literacy and enrolment rates for women in Morocco compared to other regions with similar earnings levels (Boutieri, 2016).

**Patriarchy in North African Regions**

The term of patriarchy (from the Greek) "rule of father" (Mies, 1998, p.11) or "chief of a race" (Ademiluka, 2018, p.339) encompasses a social system in which men have advantages over women in terms of status, property and moral authority (Benstead, 2020; Hadi, 2017). Patriarchy constitutes a system in which women must fulfil their wife and mother roles, obey the male head, brothers as well as uncles and cousins, and protect the interests and dignity of the family. Under the patriarchal system, the oldest men have absolute power and control the younger members of the family, comprising young women and men (Amawi, 2007; Appadorai, 2006; Glick and Fiske, 1997). Walby (1990) also defines patriarchy as the system of social structures in which men exploit and dominate women. For example, men control women's labour; men can prevent women from working outside or limit their work to part time restricting women from using their full capacity. Often, women are forced to work for very low wages (Hossen, 2020). Therefore, men obtain economic gains by exploiting women's labour force (Obaidullah, 2020). Although patriarchy is not just about men, it is about the persistent privilege of one way of being; knowing and doing things (Wadud, 2009). Wamue-Nagare and Njoroge (2011) describes patriarchal culture as “institutionalized through a rigorous socialization process in which every member of the community is aware of what duties, responsibilities and roles are expected from them which is perceived as the correct order crucial for family and communal harmony” (p.14). In addition, ‘classical patriarchy’ as defined by Kandiyoti (1988) is portrayed by obedience and manipulation, and this is common in agricultural societies with patrilocally expanded households such as those in North Africa (Benstead, 2020). Patriarchal values ​​are prevalent in North African society, where women are viewed lower in position than men and valued accordingly (Bastian, Sidani, and El Amine, 2018). At the macro level, the literature demonstrates how common cultural norms' penetrate into individuals’ cognitive social structures, while simultaneously affecting their beliefs and ideas about appropriate attributed behaviour in society (Achtenhagen and Welter, 2003).

North African societies have a patriarchal nature and are deeply immersed in gender-based assumptions about behaviour. While women are seen as intuitive and relationship oriented, men are seen as determinative (Omair, 2008; Bastian, Sidani, and El Amine, 2018). Further, women are seen as less efficient leader and business owner than men (Zamberi Ahmad, 2011), which causes women to be treated like minors under the tutelage of men (Lipigne and Lebbeau, 2005) and subjugated to male domination. Patriarchal phrases state that women cannot be leaders due to their culturally naturalized roles regarding their identity as mother or wife, which determines women's work, home and organizational leadership discourses in this direction (Dutta, 2018). In particular, these discourses play a big role in directing the education of girls and women. Patriarchal norms place little or no value on girls' and women's education and also restrict equal access to education (UNESCO, 2019). Approximately 27% of the World Values ​​Survey respondents in 51 countries from Sweden to South Africa believed that ‘a university education is more important for a boy than a girl’, approximately 50% of the population in Yemen, Algeria and Egypt hold this view (Inglehart *et al*., 2014). On average, men were about 10 percentage points more likely to agree with the statement, even in countries like Algeria where the majority of graduates (19%) were women (ibid). In general, women and girls continue to suffer from these injustices due to the prevalence of patriarchy in the societies.

**The Effect of Social and Cultural Norms on STEM**

Girls and boys tend to quickly learn cultural norms and stereotypes regarding gender typing of intellectual endeavours like science and mathematics (Reilly, Neumann, and Andrews, 2019). As a natural part of gender typing the fields of mathematics and science are shown as masculine, while reading and language are considered feminine by children, from an early age (del Rio and Strasser 2013; Halim and Ruble, 2010). This may cause the male stereotype of science/ mathematics and of a scientist/mathematician to be persistent at an early age. If boys have more traditional gender role norms, they make more gender stereotypical education selections in STEM domains (Van der Vleuten *et al*., 2016). These norms are generally passed on to children by the immediate environment of the child, namely families, teachers and wider communities (OECD, 2017). The data from PISA 2015 shows that parents are more likely to expect their sons to work in STEM professions, although their daughters perform equally well with their male classmates in science and mathematics (OECD, 2015; 2017). Gender-normative ideas persist: STEM domains are compatible with men and they are incompatible with female gender role behaviours (Carli *et al*., 2016; Cheryan, Master, and Meltzoff 2015).

On the basis of socio-cultural perceptions, professions deemed appropriate in society are classified into two categories; a) those that are perceived as suitable for women; and b) professions that are valued and highly respected in society (Labib, 2019). For example, Frome *et al*. (2006) investigated why women working in male-dominated professions leave these areas and the reasons why they switch to female-dominated professions. One of these reasons alluded is the community’s expectation for women to be the primary caregiver, suggesting that this expectation may serve to divert women to jobs with greater flexibility, like pre-school or elementary education. Findings of Frome *et al*. (2006) show that while women make professional choices in line with their aspiration, women are greatly influenced by the social roles assigned to each gender by society. These results demonstrate that the low value of women in science-related fields, as well as concerns about balancing career and family life, continue to push young women away from professions in traditionally male-dominated fields where their talents and ambitions may lie. Typically, female-dominated careers conform to cultural norms, allow work-family balance and offer a safe working environment. Parents discourage and disapprove for their daughters STEM fields and STEM careers that require physically intensive labour as well as many interactions with men (Houjeir *et al*., 2019; Labib, 2019). On the other hand, the proportion of women attaining STEM education is higher in many Arab countries, in contrast to Western societies. According to UNESCO (2018), the percentage of female researchers in Tunisia is 55.4 percent; in Egypt, 44.1 percent; in Sudan, 40.0 percent; in Algeria, 34.8 percent; in Morocco, 33.8 percent; and in Libya, 24.8 percent. These percentages mean that the share of women researchers in the North African region is above the European average of 33% and the developed country average of 26% and the world average of 22.5% (Sawahel, 2016). Tunisia, Egypt and Sudan are close to achieving gender equality with more than 40% of women researchers, as well as Tunisia being at the top of the Arab list with 55.4% female participation (ibid). The Turkey-based Statistical, Economic and Social Research and Training Centre for Islamic Countries (SESRIC) (2016) is aligned with UNESCO's Engineering: Issues, challenges and opportunities for development emphasized that the proportion of female engineers in Arab countries such as in Tunisia and Egypt varies between 24% and 50%, which is well above the global average. For example, this percentage is about 15% to 20% in the United States and 8% in the UK (SESRIC, 2016). In more than 120 countries, the share of female students in tertiary information and communication technology (ICT), engineering and manufacturing programs is just over 25%, and countries close to this parity include Algeria, Morocco and Tunisia (UNESCO, 2019). Female higher education graduates in Algeria are 54% for ICT and 41% for engineering; 45% for ICT and 46% for engineering in Morocco; 61% for ICT and 45% for engineering in Tunisia. On the other hand, the High Commission for Planning (HCP, 2017) stated that the illiteracy rate in Morocco in 2017 was 47.6% for women and 25.3% for men, 36.5% overall; and labour force participation of women was 25%. In 2018, the overall illiteracy rate in Algeria was 19%, Egypt 29%, Sudan 39%; in 2004, Yemen was 46% and Libya was 14% (UNESCO, 2020). It means that despite the high rate of female students in STEM fields compared to boys, the illiteracy rate is remarkably high in North African countries.

**TIMSS Result in North African region**

The results of international mathematics and science evaluations provide the opportunity to examine the contributions of many macro-level cultural factors like gender equality as well as being a guide for the education systems of countries (Else-Quest and Grabe, 2012). TIMSS studies, which have a regular cycle, organized once every four years beginning in 1995, provide countries with an unprecedented chance to get comparative and effective information about achievements of their students in science and mathematics (TIMSS, 2019). TIMSS evaluates pupils in a wide range of scientific fields (biology, chemistry, physics, and earth science) and a series of mathematical areas (number, algebra, geometry, probability).

Boys in Tunisia and Algeria had higher achievement level in mathematics (TIMSS, 2003; 2007). In 2003, boys’ score in mathematics was 423, girls’ was 399 in Tunisia; boy’s score in science was 416, girls’ was 392 in Algeria. In 2011, the scores of both girls and boys increased; however, the gender gap remained. By contrast, in Morocco and Egypt girls performed better than boys in science and mathematics. Only in 2019 and 2007, the opposite situation was observed in Morocco's TIMSS mathematic results; in 2007, girls’ mathematics result was 377 and boys’ was 385; similarly, in 2019, girls’ score was 386 and boys’ was 391 (see tableI). In addition, in 2007, TIMSS revealed the low performance of Moroccan students in science and mathematics. For this reason, Morocco ranked itself the lowest (34th/36 in science and 31st/36 in mathematics). The average score in science was 297 points (7 points less than in 2003), while the average score in mathematics was about 341 points (6 points less than 2003). However, Egypt followed a steady line in this regard from 2007 (when Egypt participated in TIMSS first time) to 2015 where boys outperformed girls in both mathematics and science. Egypt showed a slight improvement in mathematics in 2019 (girls' performance was 420 and boys’ performance was 404); nevertheless, their scores in science in 2019 were comparatively low compared to the other participating countries (the international average in science for girls was 495 and boys' was 485) and girls' score was 402 while boys' score was 374 (see tableI).

Parallel to the TIMSS results, the Egyptian General Secondary Education (EGSE) examination, which is Egypt’s formal, representative exam for higher education, indicated that girls performed better than boys in mathematics and science (El Nagdi and Roehrig, 2019). The percentage of girls who succeeded in passing the EGSE exams in 2016 was 92.3%, while it was 87.8% for boys; a year later (in 2017) it decreased to 87.7% for girls and 84.0% for boys (ibid). However, the 2014-2015 edition of the World Economic Forum's Global Competitiveness report assessed the overall quality of higher education in science and mathematics among 144 countries around the world, and Egypt ranked 136th on the basis of the quality of education, based on the quality of scientific research institutions it ranked 135th (Schwab, 2014). Egypt's education system ranks very low in terms of quality of education, it was rated 133rd within 137 countries in 2018 in terms of primary education quality and ranked 130th in education system quality as a whole (Global Competitiveness Report, 2017).

Table I. *TIMSS 2019 International Results in Mathematics and Science in Egypt and Morocco*

|  |  |  |
| --- | --- | --- |
| **2019 TIMSS RESULT** | ***8th Grade Mathematics*** | ***8th Grade Science*** |
| *International Average* | *Boys*  | *Girls* | *Boys* | *Girls* |
| 488 | 491 | 485 | 495 |
| *Egypt* | 420 | 487 | 374 | 402 |
| *Morocco* | 391 | 386 | 393 | 395 |

Source: TIMSS 2019 International Results in Mathematics and Science.

Figure II*.*

*TIMSS 2019 Eight-Grade Mathematics and Science Result in North Africa*

Source: TIMSS 2019 International Results in Mathematics and Science.

While the difference in average science achievement between boys and girls remains constant in many countries, the overall increases or decreases in success from one assessment to the next occur similarly for both boys and girls (TIMSS, 2019). Some countries do not have a gender difference in TIMSS 2015; in other countries like North Africa, where girls consistently getting an average better score than boys, illustrates a gap in favour of girls (ibid). In Morocco, the gender gap in science education in favour of girls was closed (TIMSS, 2015). Although Morocco’s scores have increased compared to four years ago, it is still at the bottom of the TIMSS 2019 rankings (see figureII). With 394 points, Morocco stood nearly 250 points below Singapore (618), which showed the strongest scores in TIMSS 2019.

***Gender Gap***

The Global Gender Gap Report, published by the World Economic Forum (WEF) (2015), explored the existing gap between key factors such as economic inclusion, access to education, political empowerment, health and survival. Gender differences arise largely because of archaic cultural norms, specifically in rural sphere where traditional gender roles are widespread (Ennaji, 2018). The vast majority of rural individuals do not yet grasp the meaning and importance of educating their daughters (ibid). Due to early marriages and patriarchal ideologies, low enrolment rates and high school dropout rates are prevalent (Ennaji, 2018). It shows that the lowest 20 countries among 142 countries include also four North African countries, which are Morocco, Egypt, Algeria and Tunisia. This means that although social and cultural norms prevail in these regions, girls have shown great success by closing the gender gap, but the science and mathematics rankings of these regions are at the bottom compared to other countries (Ranani and Kharazmi, 2017).

More than half of women are illiterate in rural areas; women are affected more than men in conditions caused by illiteracy (Ennaji, 2018). In these rural areas, only one out of ten girls enrol in secondary education, and there is a lack of implementation of compulsory education in these areas, especially in Morocco, which remains a huge obstacle that Moroccan authorities need to overcome (Auletto, 2017). Only 26% of girls attend school in rural areas, compared to 79% for boys. Evidence shows that school enrolment rates and literacy patterns are strongly divided by gender lines (Boutieri, 2016). In particular, the gender equality criteria for enrolment in secondary education, Morocco ranks 113th among 130 countries and 53% of girls and 59% of boys participated in secondary education (World Economic Forum, 2015). In 2015, the majority of countries (78 out of 130) investigated by the World Economic Forum found more girls than boys enrolled in secondary education, and nine countries achieved gender equality in secondary education enrolment (World Economic Forum, 2015). As such, among North African countries Morocco lags severely behind in girls' opportunities to participate in primary and post-primary education, compared to other countries. In addition, women in Morocco are almost seven times more likely to work in unpaid jobs than men (Auletto, 2017).

**CONCLUSION**

Harmful norms and stereotypes are deeply embedded from law to popular culture, politics to religion, corporate culture to family life (Baldner and Pierro, 2019). Social and cultural norms can lie behind the underestimation or degradation of women's economic activities in rural areas, in the urban informal sector and in the home. Parents make decisions on the education of their daughters, influenced by patriarchal ideas. Bronfenbrenner's ecological model helped to draw a frame in this study to examine the social and cultural norms faced by girls in North Africa at a macrosystem level. Considering this framework together with the TIMSS results, a more detailed analysis has emerged. Despite the decline in the literacy rates of girls due to all these social and cultural norms in the North Africa, girls achieved a better score than boys in TIMSS science and mathematics, but this score seems to remain below the international average curve. In addition, because of these norms, women still do not have the same opportunities in the workplace as men, and this can be seen as a major barrier to achievement of women. Harmful social norms and their accompanying outdated gender stereotypes have considerable consequences for women and girls; these can help create environments where girls may not be able to continue their education; women can receive lower wages despite doing the same job as men; taking on men's roles can delay women’s participation in housework and childcare. For these reasons, the inability of girls to play a role especially in STEM fields may cause a large gap in the qualified labour force resources of the countries. When women are free from this discrimination, they can be productive at work, transform their families and communities, and nurture their economies and can help the increase the welfare of the community. Therefore, forming more supportive or encouraging social norms and stereotypes can be an impactful drive for progression towards women's empowerment and gender equality in every field. It is important to tackle the underlying norms and stereotypes liable for many of the barriers faced by women, so that systemic change occurs that increases opportunities for all women not only in North Africa but everywhere. In addition, professional organizations serving STEM fields can create programs to educate women to ignore systemic and social gender stereotypes that would otherwise prohibit many women from launching negotiations for packages to assist their academic goals and starting salaries. Given the low completion and illiteracy rates, it is also important that low- and lower middle-income countries take into account how they can build their existing education systems and how conventional patriarchal systems limit their student outcomes.

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1. Ph.D. candidate, Durham University, United Kingdom, gulsah.dost@durham.ac.uk [↑](#footnote-ref-1)