UNDERSTANDING GENDER IMBALANCES IN STEM FIELDS IN RWANDA

A survey of secondary school students in Kayonza District, Rwanda

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KU LEUVEN

RAWISE
Rwandan Association for Women in Science and Engineering

vvob
education for development

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Summary

This report outlines the main results from a research project investigating gender gaps in secondary school students' perceptions of STEM in Rwanda. A survey of secondary school students was conducted in Kayonza District in the Eastern province of Rwanda in June 2021. A total of 915 students in grades S1, S3, S6 were randomly selected from a stratified, random sample of twenty schools (a mix of public, government-aided and private schools, serving both urban and rural communities) in Kayonza District. The students completed a survey questionnaire using tablet computers.

The survey revealed gender gaps in STEM interests, competency self-beliefs and attitudes. But in many respects, male and female secondary school students' experiences, beliefs and attitudes were found to be rather similar, more so than research on gender gaps in perceptions of STEM in high-income countries in Europe and North-America typically indicates.

- More male than female students showed an interest to pursue STEM fields. The field of life and health sciences attracts large numbers of both gender groups, and more female than male students.
- Gender gaps in preferences regarding fields of study may widen and narrow across grade levels, possibly reflecting that students at different ages have a different understanding of the content of, and the accessibility into, these fields of study, as well as different interests.
- Male students tend be more confident about course contents and tasks in (but not only in) the STEM domain, and especially in the domain of solving concrete and mechanical problems. Male and female students hold similarly high self-beliefs about tasks in the domain of personal and helping situations.
- Male students ranked learning about ICT as somewhat more importance to find a good job and get ahead in life than did female students. Female students ranked learning English as somewhat more important than did male students.
- Male students (more than female students) asserted male superiority in math, ICT, and language competence. Female students (more than male students) endorsed traditional gender roles in terms of childcare responsibility.
- Male and female secondary students strongly value (higher) education in general, for themselves and for others of both gender groups.
- Female students are no less eager than male students to join the formal sector workforce upon completing their education, but are less certain about their future job prospects when taking into account childcare responsibilities.
- Male and female students reported similar education experiences in terms of teacher interaction, feelings of safety at school, and parental involvement in education.
- Teacher interaction in the classroom appears to encourage both male and female students' aspirations and STEM interests. Parents' or guardians' interest in school affairs, on the other hand, seems to discourage female students to pursue STEM fields of study.

That some gender gaps in students' perceptions of STEM are not as problematically large as they could have been does not mean that teachers and parents or guardians do not have their proper roles to play. The strength of gender stereotypes and the differences in self-beliefs in particular are important challenges for the educational system. It is up to teachers to ensure that gender stereotypes are not perpetuated, and to encourage girls as well as boys to challenge themselves and pursue "hard" fields of study within the STEM domain.

Acknowledgements

This project was made possible by a KU Leuven Global Minds Multi-Stakeholder Grant for Young Researchers (ZKD9751), funded by VLIR-UOS.

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Thank you to the teachers and school leaders who facilitated the organisation of this project, and all the students who enthusiastically participated in the data collection.

1 Background

Governments around the world share a strong belief in education in science, technology, engineering, and mathematics (STEM) for long-term economic growth. Rwanda's Vision 2050 policy blueprint has set forth ambitious targets for economic and technological development, with an important role for affordable and high-quality education in general, and for education in STEM fields in particular (MINEDUC 2019).

As in most other countries, and despite significant improvements in gender equality in education participation and in other domains such as political empowerment (World Economic Forum 2021), and a wide range of initiatives to promote STEM to female learners, women remain underrepresented in STEM education and STEM occupations in Rwanda. According to the latest education statistics (MINEDUC 2020), 66% of male students and 51% of female students in upper secondary education were enrolled in STEM programs (as a total, across general, technical, and vocational education). In tertiary education, 51% of male students and 32% of female students were enrolled in STEM fields.

Most research on the drivers of gender gaps in STEM has been carried out in high-income countries in Europe and North-America (Hammond et al. 2020). There is a general need for further research in other countries around the world to establish whether and which findings from the literature on STEM gender gaps can be generalized. There are also lessons to be learned from countries in Sub-Sahara Africa. Compared to many high-income countries, attitudes towards STEM in general, and among girls in particular, tend to be much more positive.

This report outlines the main results from a KU Leuven Global Minds research project on secondary school students' perceptions of STEM in Rwanda. This research project was conducted by the Centre for Sociological Research at KU Leuven in collaboration with VVOB – Education for Development, and the Rwandan Association for Women in Science and Engineering (RAWISE).

The goal of this project was to gain a deeper understanding of gender imbalances in STEM education in Rwanda, and to inform the work of VVOB on professional development programs for teachers and school leaders, and the work of RAWISE on promoting female participation in STEM. In particular, the following two key research questions were formulated.

Research question 1: What are secondary school students' self-beliefs, attitudes, and interests with respect to STEM fields?

Research question 2: Are there differences between male and female students and across age groups?

To explore gender and grade-level gaps in secondary school students' perceptions of STEM in Rwanda, and to make a first step towards identifying some influencing factors, a survey of secondary school students was conducted in Kayonza District in the Eastern province of Rwanda in June 2021.

The full questionnaire and other data collection materials, and details on the sampling strategy, the questionnaire development, and an exploration of the sample quality and measurement quality, can be found in Wuyts, Meeusen and Draulans (2022). A summary is presented in the following section.

2 Methods

A total of 915 students, enrolled in secondary schools in Kayonza District in the Eastern province of Rwanda, were selected to participate in this study. The sample of survey respondents was drawn by strictly random probability methods, so that the sample is in expectation representative of secondary school students (who regularly attend classes) in grades S1, S3, S6 in Kayonza District.

The sample is composed of 368 students in grade S1 (of which 51% female), 338 students in grade S2 (of which 51% female), and 209 students in grade S3 (of which 47% female). The most recent education statistics (MINEDUC 2020) reveal that 53% of students enrolled in secondary education in Kayonza District is female. Although the sample looks reasonably well proportioned by gender, female students are thus slightly underrepresented, especially in the S6 sample, relative to secondary school enrolment figures. This may be due to differential school attendance, or simply to random sampling variability.

The survey questionnaire consisted of a short practice module (to familiarize students with the question formats and the use of the tablet computers to record their answers) and 80 questions about educational and occupational prospects and interests, gender stereotypes, technology, school experience and family background.

This report presents the main descriptive results of this survey, focusing on gender differences in educational aspirations and interests, competency beliefs and attitudes with respect to STEM. The reported results pertain only to the sample of 915 survey respondents from S1, S3 and S6 in Kayonza District, and may not generalize to other districts in Rwanda or to other grade levels. The data is weighted to correct for students' selection probabilities and for the gender ratio in secondary education enrolment.

Study population
Secondary school students enrolled in grades S1, S3, S6 in Kayonza District, Rwanda

Sampling
A stratified simple random sample of 20 secondary schools (public, government-aided and private schools, serving both urban and rural communities)

Up to 20 students randomly selected by the enumerators from those present on the day of data collection in class "A" in each eligible grade

Questionnaire
Instructions and survey questions presented simultaneously in English and Kinyarwanda

Questionnaire implemented in KoBoToolbox, a free and open-source software tool for mobile data collection developed by the Harvard Humanitarian Initiative (available from www.kobotoolbox.org)

Data collection
Data collection by two experienced enumerators (one male, one female)

Enumerator training and pilot in two class groups 17–19 May 2021

False launch in one school to test and fine-tune field procedures

Selected schools visited between 9 June and 30 June 2021

A total of n = 915 students used tablet computers to complete the questionnaire via the KoBoCollect Android app

Questionnaire typically took between 30 min. and 70 min. to complete

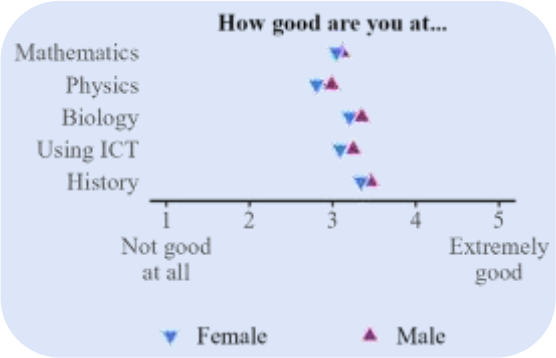
Adherence to COVID-19 regulations

3 Results

3.1 STEM self-beliefs

The survey results revealed modest gender gaps in secondary school students' self-concept and self-efficacy beliefs.[1] Male students were shown to have somewhat higher STEM self-concept and self-efficacy beliefs, but the differences between male and female students were not very large.

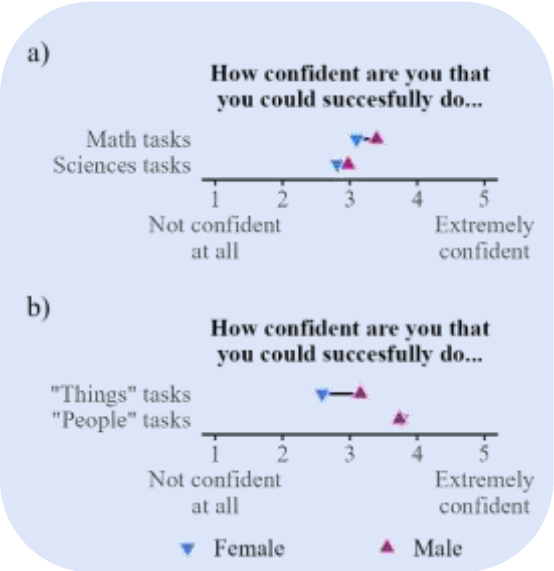
Figure 1. Self-concept beliefs



Male students on average rated themselves at marginally higher levels of competence not only for STEM subjects but also for other subjects such as history (Figure 1). These results suggest that male students are slightly more confident in their academic abilities throughout, not only within the STEM domain. Male students also rated themselves at (marginally) higher levels of confidence to do specific tasks in the math and sciences domains (Figure 2, panel a).

Looking to tasks beyond the school context, the survey results confirmed a gender gap only in one of two domains for which large gender gaps have previously been observed in studies in other countries. For tasks that involve solving concrete and mechanical problems such as building, installing, and repairing devices ("things" tasks), we found a relatively large gender gap (Figure 2, panel b). For tasks that involve personal and helping situations ("people" tasks), on the other hand, we did not observe any difference between male and female students' self-confidence ratings.

Figure 2. Self-efficacy beliefs



[1] Self-concept and self-efficacy represent beliefs about oneself. Self-concept concerns the self-assessment of *being* ("Who am I?") whereas self-efficacy concerns the self-assessment of *ability* to perform specific tasks ("Can I do this?").

3.2 STEM attitudes

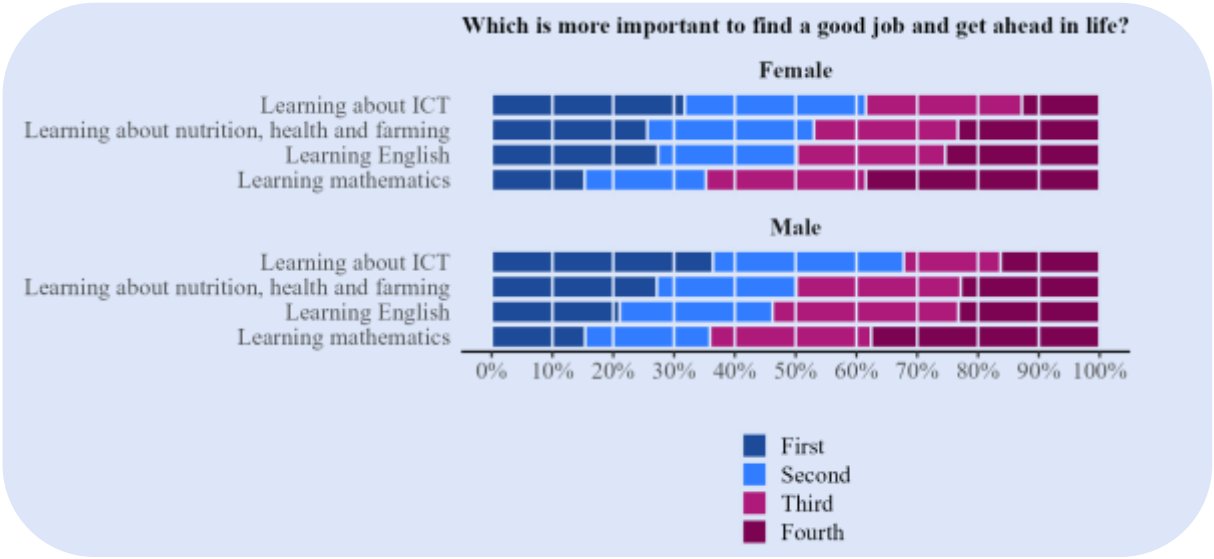
Asked to rank learning English, learning mathematics, learning about home economics, learning about ICT from most to least *important to find a good job and get ahead in life*, one in three students (34%) ranked learning about ICT first, and two out of three students (64%) ranked learning about ICT either first or second. Learning mathematics was ranked last of these four learning contents by 38% of students.

Male students ranked learning about ICT on average a little bit more important to find a good job and get ahead in life than did female students. Female students on average ranked learning English a little bit higher than did male students. Learning mathematics and learning home economics were ranked similarly by the two gender groups (Figure 3).

Asked to rank these same four learning contents from most to least *useful for daily life*, a similar pattern emerges with even smaller gender differences. Male students ranked learning about ICT on average a little bit more useful for daily life than did female students. Learning English, learning mathematics, and learning about home economics were ranked similarly by the two gender groups in terms of usefulness for daily life.

The survey results thus show moderate gender gaps in students' beliefs about the usefulness and importance (i.e., the *extrinsic* value) of different learning contents. We found no evidence for gender gaps in secondary school students' *intrinsic* value beliefs.[2] Male and female students alike reportedly enjoy solving math problems and writing in English.

Figure 3. Attitude towards math and ICT compared to other learning contents



[2] The *intrinsic* value of some activity is its value "for its own sake." The activity is its own reward. The *extrinsic* value of some activity is the external reward that derives from it (here: the practical usefulness for daily life and the importance to find a good job and get ahead in life).

3.3 Gender stereotypes

Gender stereotypes play an important role in boys' and girls' socialization experiences. The survey results confirmed that some traditional gender stereotypes are prevalent among, though not universally endorsed by, secondary school students in Kayonza District.

Male and female students alike tend to endorse gender equality when it comes to the importance of doing well in school and the importance of having a college or university degree. Few male students and even fewer female students considered education more important for men than for women. Actually, female students more than male students claimed that education is more important for their own gender.

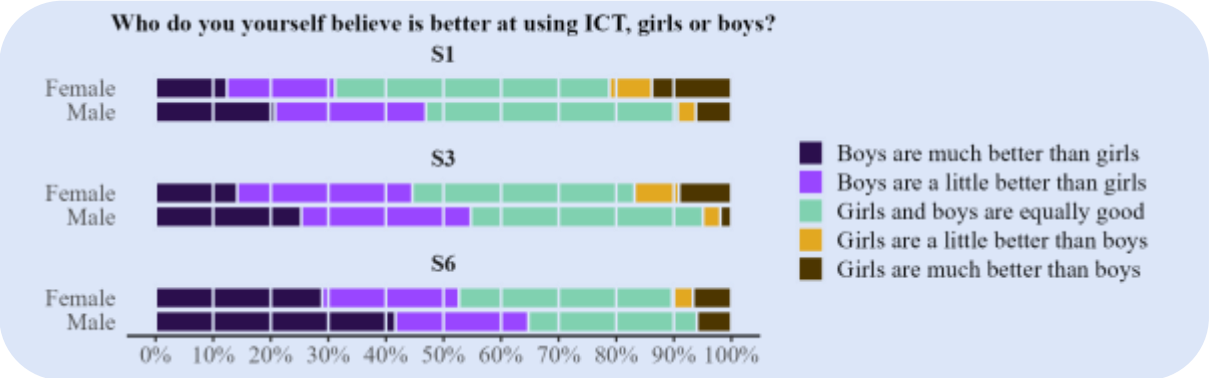
83% thinks a college or university degree is equally important for women and men

That the value of education is believed equally important for women and men does not mean that traditional gender roles and traditional competency beliefs do not persist. Just over half of the students (51%) asserted that women should spend more time taking care of the children in a marriage. Female students (55%) more than male students (47%) endorsed the desirability of traditional gender roles that demand women to spend more time taking care of the children than men.

Gender stereotypes also emerged when secondary school students were asked to judge boys' and girls' relative math and technical competence. Almost one in two students asserted male superiority in math (48%) and in using ICT (46%). Beliefs about boys' and girls' relative language competence were more divided. The numbers of students asserting female superiority, even in the classically male-stereotyped competence areas of math (18%) and ICT (13%), are not negligible, however. Some students appeared not only to reject traditional gender stereotypes (in favour of egalitarian beliefs) but to hold opposing gender beliefs.

More than half of male students and two in five female students asserted male superiority in math and ICT. Also, more students in the older grades than in the younger grades asserted male superiority, suggesting that either (male-dominant) stereotypes become more ingrained with age, or gender stereotypes were simply stronger in older age cohorts than they are in younger cohorts. Figure 4 illustrates this pattern for the ICT competence item. The distribution by gender and grade is very similar for the math competence item. Students' own stereotypes are also associated with their perceptions of adults' stereotypes. Among those that feel that adults think boys do better in math, 69% report they themselves think that boys do better in math (compared to 28% among those that feel that adults think girls and boys are equally good at math).

Figure 4. Gender stereotypes about competence in using ICT



3.4 School experience, perceptions of safety and absence from school

An important concern is whether teachers and parents interact differently with boys and girls. There may also be gender inequality in education through different barriers to school attendance and (real or perceived) unsafety at school. Students were therefore asked whether they had been absent or sent away from class on a school day in the past year, and how often they felt unsafe either at school or on their way to or from school. We found no evidence that these factors are drivers of gender gaps in education participation. Most students (72%) interact with teachers in the classroom on a daily basis, and most students (90%) at least sometimes discuss their future education with parents or guardians. Male and female students reported similar levels of interaction with teachers in the classroom and of parental involvement in education.

Close to one in two students (44%) reported that they had been absent from school in the past year because of unpaid fees or contributions. This was more often true for male students (50%) than for female students (40%). Similarly, close to one in three students (30%) reported that they had been absent from school in the past year because they lacked basic school supplies (pen, notebook or appropriate uniform). This was also more often true for male students (38%) than for female students (24%). If anything, it looks like male students are *more* rather than less likely to miss school because of financial constraints.

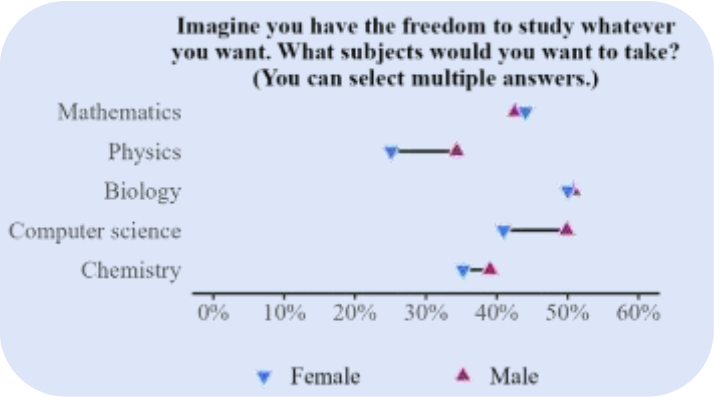
About one in three students (34%) reported that they feel unsafe several times a month or more, another one in three students (30%) that they feel unsafe more rarely, and the remaining one in three (36%) that they "never" feel unsafe. Male students appeared to feel unsafe at school or on the way to or from school about as frequently as female students.

3.5 Secondary education preferences

Male students on average expressed stronger preferences for STEM subjects in upper secondary education than female students. Asked to mark all subjects they would want (or would have wanted) to take in upper secondary, the median male student selected two STEM subjects (mathematics, physics, chemistry, biology, and/or computer science) out of three in total. Less than half (41%) of female students did likewise. One in three male students (33%) and one in four female students (27%) selected *only* STEM subjects. About one in six students (male and female alike) selected no STEM subjects at all.

Figure 5 shows the proportion of male and female students who selected each of five STEM subjects. More male than female students selected computer sciences and physical sciences, especially physics. There is no gender gap in the selection of biology, nor in the selection of mathematics.

Figure 5. Upper secondary education preferences



3.6 Educational aspirations

Secondary school students, male and female alike, were generally very optimistic about their future education, not only preferring to attain tertiary education, but also commonly *expecting* to do so, even when asked to keep in mind possible constraints to further education.

86% expects to attain tertiary education

Grade differences emerged for both the preferred and the expected level of education, but in opposite directions. The number of students who reported they *would like* to attain higher education increases across grades, from 85% of students in S1, over 89% of students in S3, to 98% of students in S6. The number of students who *expected* to attain higher education, meanwhile, decreases slightly, from 85% and 89% of students in S1 and S3, respectively, to 80% of students in S6.

3.7 Occupational expectations

More female than male students expressed certainty in their occupational prospects: 19% of female students and 13% of male students reported both that they *definitely* expect to work for a wage and that they *definitely* expect to work on family land or in a family business, and 39% of female students and 32% of male students reported that they *definitely* expect to work for a wage, but not necessarily work on family land or in a family business. Girls, in other words, see themselves at least as much as future members of the formal sector workforce as do boys.

A gender gap in occupation prospects nonetheless emerged when childcare is added to the equation. Female students have lower expectations than male students of having a paid job after they have children.

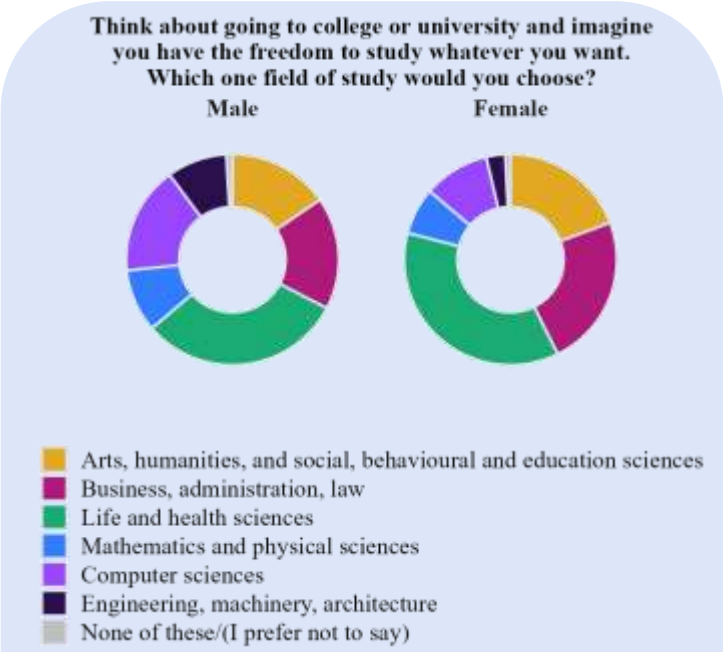
3.8 Higher education interests

Given that most students would like to attain higher education, which fields of study attract them? Figure 6 shows male and female students' preferred fields, provided that they can go to college or university and choose freely what to study.

Female students' preferred fields of study are life and health sciences (36%), business, administration, law (23%), and arts, humanities, and social, behavioural and education sciences (19%). These are also male students' preferred fields, though less decidedly so. Computer sciences, mathematics and physical sciences, and engineering, machinery, architecture together also attract one in three (35%) male students. These fields attract relatively fewer female students (20%).

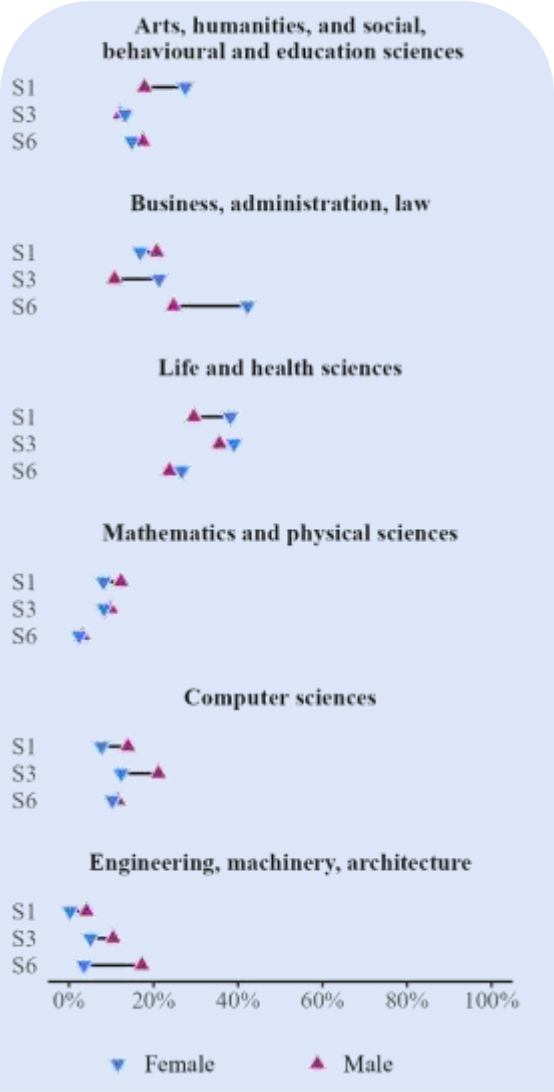
These results are very much in line with international research. In fact, the gender ratio of interest in engineering and the gender ratio of interest in mathematics and physical sciences neatly line up with the gender ratios of global enrolment in these respective fields as reported by Hammond et al. (2020). Remarkably, female students in Rwanda appear relatively *more* interested in computer sciences than their peers across the world.

Figure 6. Preferences for higher education



The gender gaps in higher education interests are not stable across grade levels. Among S1 students, more female than male students selected arts, humanities, or social, behavioural and education sciences, and more female than male students selected life and health sciences. Likewise, among S1 students, more male than female students selected mathematics or physical sciences, and more male than female students selected computer sciences. By S6, these gender gaps are closed. The gender gap in interest in engineering that was apparent among students in S1, narrowed among students in S3 but widened again in S6. The gender gap in interest in business, on the other hand, only emerged among students in S3 and widened in S6 (Figure 7).

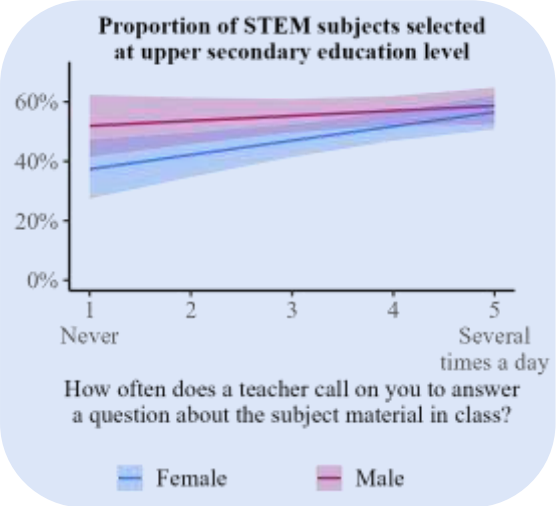
Figure 7. Preferences for higher education, by grade



3.9 Effects of school experience on educational aspirations and STEM interests

Interests in STEM subjects at the upper secondary level appear affected by teacher interaction in the classroom, at least among female students (Figure 8). Female students who reported more frequently being called on to answer questions about the subject material in class expressed a preference for a larger share of STEM subjects at the upper secondary level. Male students' upper secondary preferences appear unaffected.

Figure 8. Effects of teacher interaction



Among both male and female students, those that reported more interaction with teachers in the classroom were more likely to express a preference to attain tertiary education, and more likely to express a preference for a STEM field of study at that level (Figure 9 in appendix).

When it comes to female students' choice of field of study in tertiary education, parental involvement in education also emerges as a factor, though not entirely as one might expect. Female students who reported more parental involvement in current school content were *less* likely to express a preference for a STEM field of study (especially for computer sciences). There are no such adverse effects of parental involvement for male students. This suggests that parents may be inadvertently steering their daughters away from STEM fields (Figure 10 in appendix).

4 Conclusion

The main conclusion of this survey of secondary school students in Kayonza District of Rwanda is that male and female secondary school students' interests, beliefs and attitudes on the whole follow a similar path, but diverge in some critical respects.

Male and female secondary students strongly value (higher) education, for themselves and for others of both gender groups. Their education experiences in terms of teacher interaction, feelings of safety at school, and parental involvement in education, are also remarkably similar.

Male students, however, do appear more self-confident in mechanical and technological tasks, which translates in a stronger interest to pursue STEM fields like engineering and computer sciences. Though on the whole somewhat less self-confident and more negatively stereotyped, many female students too are interested to pursue STEM fields, especially but not exclusively within the life and health sciences.

Teacher interaction in the classroom matters a lot for aspirations and interests, especially among girls. The role of parental involvement in education may be more ambiguous, as parents or guardians may also be (consciously or involuntarily) discouraging female students from pursuing STEM careers.

5 Discussion

Adolescents at secondary school age draw on the judgements and counsels of parents or guardians, teachers, and the broader community when making decisions about their future education and careers. Parents or guardians and school staff should encourage girls as well as boys to challenge themselves, to pursue "hard" fields of study within the STEM domain, and in general to excel in their chosen fields.

Student interaction and involvement in STEM classes, and dedicated science and coding clubs may give female students confidence and show that STEM careers are feasible options. Female STEM teachers and other STEM professionals may act as role models. However, these efforts may fall short if friends and relatives are not also convinced that the pursuit of education and careers in STEM fields is a feasible and fruitful option also for female students. It is most notably in the field of computer sciences that we found that *less* frequently talking about school content with parents or guardians was associated with an interest at the tertiary education level. It is quite likely that parents or guardians are perpetuating gender stereotypes, not only as regards to boys' and girls' relative competences but also in assuming which education and career paths are proper or desirable for their sons and daughters. Obviously, the conclusion should not be that parents should stop talking to their children about school content and future education possibilities. Rather, gender stereotypes need to be addressed at home and at school.

Whether students pursue STEM careers will also critically depend on the STEM job market. Education in STEM fields is considered particularly challenging, and may not be very attractive to students who weigh the academic challenge against the small probability of subsequently finding a stable job. Female students tend to be more risk averse, may not wish to push up the career ladder, and may not even expect to stay in the formal sector workforce once taking up childcare responsibilities. The cost-benefit balance of educational choice may therefore tip in favour of business and administration rather than such STEM fields like mathematics and physical sciences especially for female students.
ICT has a unique position among STEM careers. The ICT job market is attractive to both female and male students. However, in this competence area, negative gender stereotypes are particularly prominent. Female students themselves and especially their male peers strongly assert male superiority in ICT competence (as well as in math competence).

Because of the cross-sectional design of this study, it is not possible to determine whether the observed age differences are due to age effects or cohort effects. Gender stereotypes becoming more ingrained with age should be particularly concerning. However, the observed age differences may likewise be due to gender stereotypes having become weaker in younger age cohorts. A follow-up study would benefit from a longitudinal survey design in order to identify age effects in gender gaps

The present study has two limitations that need to be considered when interpreting its findings. First, the sample was drawn among school students who were present on the day of data collection. Students who regularly miss class (and typically perform more poorly) will therefore be underrepresented. Second, though the questionnaire was carefully developed as a neutral, non-suggestive instrument, measurement bias from socially desirable responding cannot be ruled out. The questionnaire included several questions to assess the risk of social desirability bias in reported self-beliefs, attitudes, and gender stereotypes. We found that social desirability bias introduces bias in reported estimates, but on the whole to the same extent for male and female students, so that gender gaps are mostly unaffected. The results reported in this report do not control for social desirability bias.

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Appendix

Figure 9: Positive, parallel effects of teacher interaction on STEM interest at tertiary education level

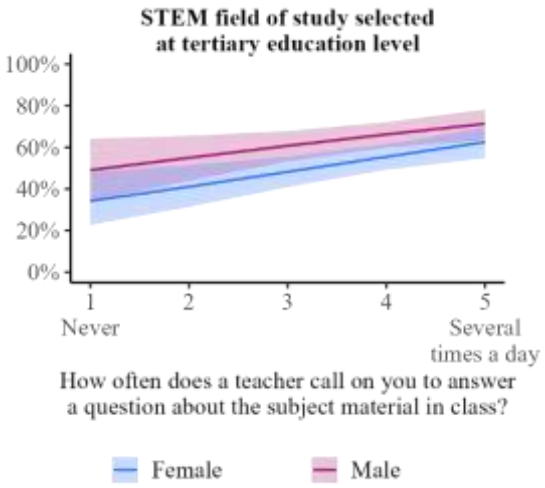
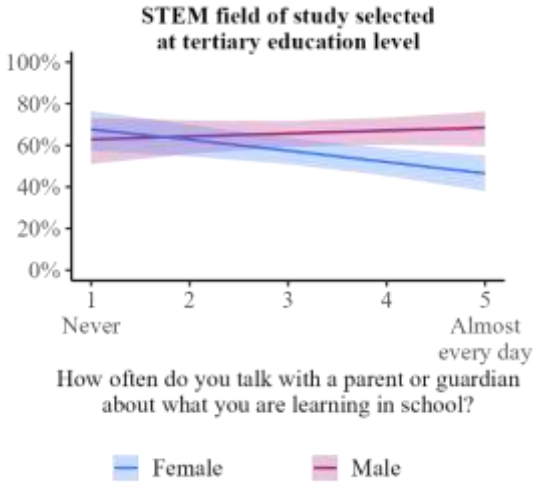


Figure 10: Adverse effects of parental involvement on STEM interest at tertiary education level



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