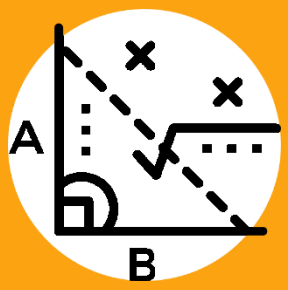

Why are you not looking forward to your next maths class?

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LYCÉE ERMESINDE | 2022/2023
DIRECTEUR: KEN VALLENDER

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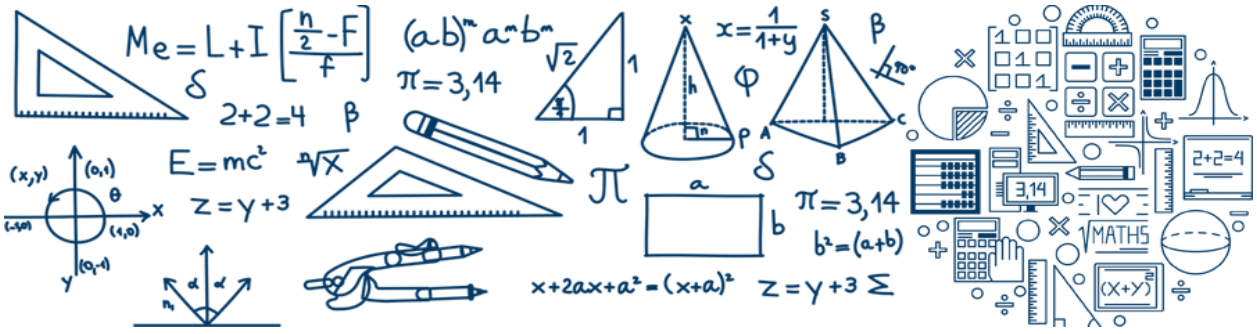
Introduction

As I dive into the deep and diverse universe of mathematics, I am overcome with wonder, excitement, and curiosity. I channel these positive emotions through riddles and puzzles on YouTube, charts and graphs in school textbooks and through engaging with the teacher in class. I have never second guessed my love for maths nor questioned where it stemmed from, how could you not want to solve a mystery by applying logic? Uncovering the answer to a problem after 30 minutes of trying several different methods has always been so rewarding for me, eager to get to the next example to further my knowledge and enhance my skills. Although as I became older, I began to realize that this curiosity was not shared by everyone, as I was racing ahead trying to voluntarily solve additional exercises, my fellow primary school classmates complained about the difficulty of the lesson. Many students disliked the lesson, and some even feared it, wishing they could drop it at such a young age already. This was bizarre and complexing to me because mathematics is omnipresent in every nook and cranny of our society. The subject of mathematics is however, a notoriously unpopular discipline with commonplace knowledge alleging it to be one of the hardest and most challenging fields to pursue later on as a career. To truly understand the gravity of the problem, almost half of first and second graders in the USA reported feeling moderately nervous or very nervous about maths at school. (Gerado Ramirez, 2013)



However, the importance of this subject cannot be underestimated as mathematics represents a global language that everyone is able to discover, use and develop regardless of nationality. Maths along with the first language are both main subjects which are taught to young children starting school, this is due to the fact that humans primarily need to communicate with each other and master basic mathematic principles such as counting. Other aspects of the subject such as learning to tell the time and spending money are all indispensable parts of everyday life. Given the profound prevalence of this subject and the need to use it throughout the course of life, it is somewhat baffling as to why so many students do not look forward to their next maths class.

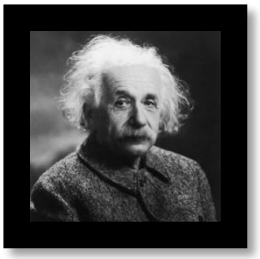
Even today as my high school years are coming to a close, the section that I have chosen which incorporates both mathematics and physics, is the most underrepresented section at my school and many others in terms of participation. Coupling my desire to pursue a teaching career in mathematics with the peculiar question as to why I only have 5 classmates in my mathematics class motivated me to uncover why so many students across the world do not look forward to their next maths lesson.

In this personal memoire I shall pair research with collecting my own stats, I plan on collecting data from students across many ages in my area to create an overview of the situation and to determine the gravity of the problem. In addition, the survey that will be created will serve as an excellent lesson in data collection and evaluation which represents an essential branch of the subject of mathematics as well as something I am passionate about. I plan to hold talks with mathematics teachers at my school to try and reveal why their students feel this way about their own subject. Are teachers aware of the issue, do they even agree with students? Depending on the data researched and collected, conclusions will be drawn in order to fully represent the issue. The ultimate goal consists of proposing solutions to tackle the issue and help more students embrace mathematics and hopefully encourage them to pursue related careers after having finished school.

Mathematics as a field and subject

Mathematics is a science created by humanity to find truth in complex problems by determining the answer to a simple question with each applied formula, equation, or algorithm: true or not true. The field of mathematics can be simplified to its base of simple and logically deduced axioms such as 'A number is equal to itself.'. Building up from these axioms, mathematicians are able to analyse patterns and make predictions for the future in medicine as well as the financial sector. Common subjects are optimization, probability, set theory, statistics, topology, and trigonometry.

Comparable with other sciences like biology, chemistry and physics, maths is still a very active field of research with careers being dedicated to help advance the subject. From these advancements and research, we can better understand the planet around us. Albert Einstein once said:



1. How can it be that mathematics, being after all a product of human thought independent of experience, is so admirably adapted to the objects of reality?

Albert Einstein *addressed the Prussian Academy of Sciences in Berlin on the 27 January 1921. The quote was taken from his speech on geometry and experience.*

The manner in which plants grow, the golden ratio and the symmetry of creatures can all be traced back to mathematics, because our reality is closely intertwined with the mathematical field of numbers. Overall mathematics is a science which builds upwards from dated knowledge towards new understandings.

Learning maths at school starts from a young age and consists of an essential part of child development. It begins with learning about numbers and the sequence that they can be placed in. As a subject maths is all about teaching young children problem solving skills, helping them engage their brains for mathematical and logical thinking.

Being an elemental subject maths allows for students to more easily comprehend other subjects which are slowly introduced after early education such as science, social studies, and music. After the first few years of getting to grips with numbers, the subject of mathematics evolves into a more complex and abstract subject which notoriously includes algebra and functions.

Exploring the gender inequalities present in and out of class

The statistics

One of the main and most apparent issues with mathematics lesson in schools across the world consists of a lack of gender diversity. Maths classrooms, secondary school specialisations and university degree courses are often oversaturated with male participants, with female students constantly representing a minority.

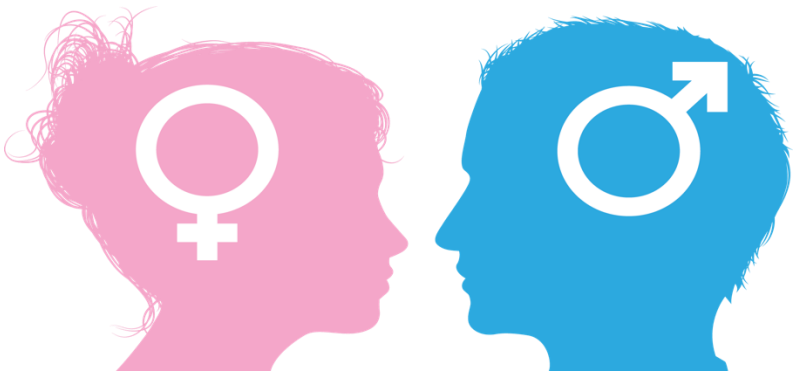
Girls, aged 13-17, are much less likely to pursue a maths career later on in life (11%), here adolescent boys are more than three times more likely to envision a STEM career (35%) as reported by the American Association of University Women. However, the disparity does not end here, throughout their entire schooling, women are put at a disadvantage and discouraged from studying maths.

Taking a look at the percentage of woman completing maths related degrees at the top universities in the US, the difference is yet again clear between the two main genders:

University	% Of bachelor students that are women	% Of PHD students that are women	% Of senior faculty that are women
Harvard	20	12	4
MIT	28	20	8
Yale	26	16	6
Princeton	15	13	7

Gender ratio of mathematics departments at top US universities (https://math.mit.edu/wim)

Not only do women account for a minority of the classroom in maths specific degrees, but it is men that much more frequently hold the lesson. In the USA there are over 40 000 employed maths professors and only 29,4% of which are female. A healthy and well-functioning lesson must include diversity, the lack of women in the classroom (students and teachers) directly leads to a potentially problematic mathematics lesson. This, however, is not the sole issue, girls appear to be consistently underperforming in maths exams in countries across the globe. Here are several causes for this gender disparity and gap in performance when it comes to mathematics within the classroom.



Biological dissimilarity

Historically, mentally demanding careers such as mathematicians, scientists, doctors have been dominated by men, partially due to the fact that women were not offered the same education. However, there existed (and still exists) a stereotype which states that the mind of a man is more capable in performing mathematical tasks. A woman's right to vote was often denied as they were deemed to 'lack the mental capacity'[1]. This is then often used as a reason as to why female students underachieve more in their maths exams compared to their male counterparts.

However, study after study has clearly outlined the fact that although male and female brains are wired slightly differently, maths capabilities are not affected. An example for this would be the 2018 study on gender differences in children. After using magnetic resonance imaging on the children's brain while they completed maths tasks and solved problems, the same brain regions were activated and stimulated. The study concluded that biologically seen 'boys and girls are equally equipped to reason about mathematics during early childhood.' (Kersey, 2018)

From this research it is evident that there are no biological indicators that could provoke a significant gap in mathematical achievement between male and female students.

Where and why do women underachieve

The Program for International Student Assessment (PISA) intends to gauge the intellectual capabilities of students around the world in areas such as science, mathematics and reading. The participants are all 15 years old and receive the same exam, which is then graded for each country; from this grading an international ranking is created.

Based on data collected, weighted, and analysed during the 2012 edition of this assessment from 56 countries the achievement gap between genders in mathematics was 'statistically significant and in favour of boys in 42 out of 56 countries.' This means that in exactly three quarters of countries assessed, boys performed visibly better than girls throughout their maths exam. In the remaining 14 countries the gap was either insignificant or girls outperformed the boys in their exam. So, if there is no biological advantage present for boys, why are girls consistently underachieving in maths?

The answer can quickly be deduced by taking the gender gap index (GGI) into account. This UN created index judges gender equality internationally and scores nations on economy, health, politics, and education. In the countries where women underachieve, the gender gap index tends to be higher, leading to a direct correlation between woman's rights and their performance at school.

Society's treatment of woman is directly reflected in the educational results of young girls, which should serve as an incentive for nations to pursue true and ultimate equality.

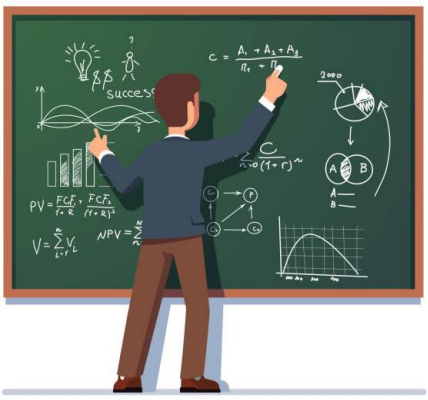
(Z. Eylem Gevrek, 2018)

[1] Taken from the national women's history museum (http://www.crusadeforthevote.org)

Furthermore, teachers are susceptible to treating girls differently from young ages onwards. Although girls may be performing equally as well as boys, teachers may require them to be better behaved and more hardworking in order to achieve the same grade as boys. (Lubienski, 2013)

All of these factors contribute to women (representing half of the world's population) being more likely to have a negative experience during their maths classes at school and at university. It should not be surprising that they are underrepresented at universities and mathematics related careers. One of the first steps to improving the mathematics class has nothing to do with mathematics itself but focuses on gender inequality. For students to have a positive experience in their maths classes, they must all be treated equally, regardless of background, gender, skin colour and any other characteristics. The same study could be realised for students of colour who are similarly and consistently mistreated at school.

The Role, Responsibilities, and Influence of a Skilled Maths Teacher



The role of the maths teacher is crucial in facilitating students' learning and success in math. A proficient maths teacher has the ability to simplify and enliven the subject matter, offer assistance and direction, and motivate students to reach their maximum potential. If a maths teacher is unable to convey the concepts and principles of maths effectively, students may struggle to grasp the material, resulting in inadequate knowledge and skills as well as a strong negative mental relationship with the subject.

Difficulties vs qualities

A maths teacher is confronted with the following issues during their lesson and must navigate them in order to avoid detrimental effects on students' learning and achievement in mathematics lessons.

- Maths can be challenging and demanding subject that requires logical and abstract thinking to solve problems and equations. It can be difficult for some students to grasp certain concepts given that not everyone is equipped with a mathematically orientated mind. This can make maths class stressful and frustrating for students who struggle with the subject.

- A majority of maths classes may be taught in a way that does not engage students or make the subject interesting. If the class merely consists of lectures or worksheets without any interactive activities, students will often find it boring and lose motivation, irrespective of mathematical competence. The maths lesson is particularly affected by this issue as it is considered as more of a theoretical subject.

- Similar to traumatic events, if students have had negative experiences with maths in the past, they may enter a maths classroom with a negative mindset, expecting to struggle or fail. This can make it difficult for them to approach the subject with an open mind and a willingness to learn. Furthermore, it can be challenging to reverse this engrained negative mindset. Many of my classmates struggle with this issue.

- Maths anxiety is a real and clearly documented phenomenon, some students may experience anxiety or stress when it comes to maths class. This can make it difficult for them to concentrate and learn effectively, as they strongly fear misunderstanding or even failing topics that they struggle with. This issue may affect all age categories.

- Finally, if students are unable to see the relevance of maths in their daily lives or future careers, they may not see the value in learning the subject, which can make them less motivated to engage with the material.

The large majority of these issues revolve around motivation and interest, which cannot be resolved solely by solving maths problems and learning theoretical aspects off by heart. Motivating students, outlining relevancy, and diminishing negative emotions and fear are all part of a teacher's responsibility. A maths teacher needs to be capable of far more than understanding and demonstrating mathematic concepts, the human aspect of teaching cannot be overlooked when offering the best possible lesson to students. A diversified skillset needs to be employed so that students can reach their full potential: (Aguilar, 2021)

- Maths teachers are responsible for providing instruction and explaining concepts in a way that students can understand. They must have a deep understanding of the subject matter and be able to transmit it effectively to students, which requires strong social as well as communicative skills.

- Identifying student needs is key in order to identify how far along each student is in their understanding of the subject and adjust their teaching style and pace accordingly to each new class. Teaching the same class in the same manner year after year is unacceptable. Recognising when a student is struggling and offering extra support and guidance is essential, if this cannot be achieved during the lesson, educators can offer extra help sessions or connect students with tutoring resources.

- Creating a safe and positive learning environment where students feel comfortable asking questions and taking risks can boost overall moral and limit anxiety. This can involve using a variety of teaching methods, such as group work or hands-on activities, to engage students and make the subject more accessible.

- Magnifying motivation amongst students is pivotal in encouraging students to learn and achieve their own personal goals. They can do this by setting high expectations, offering constructive feedback, and celebrating student successes.

(Sian L. Beilock, 2014)

Real – world insights: Exploring the Results of Pertinent Survey

Introduction

After having conducted research by consulting many scientific articles and online sources, I wanted to compare those theories and statistics with my own. Since the start I wanted to collect opinions, suggestions, and solutions from those surrounding me, which was made possible through creating an online survey for students attending my school. With a series of closed and precise questions I aim to gain a substantial overview of the situation to improve and revise my solutions that I will propose at the end of this study. I will lay out my hypothesises before showing the raw data collected which will then be thoroughly interpreted. Furthermore, the survey aspect of my study serves as an excellent example of collecting nonbiased data and creating statistics which are all valuable subjects in the field of mathematics.

The students attending the Lycée Ermesinde Mersch secondary school (roughly 650 students) are aged between 10 and 20 years of age spanning 7 individual years of education. Students in Luxembourg are known to be from all corners of the world, encompassing most ethnicities. The most notable foreign nationalities include Portugal, France, and Italy among others, this again allows for an improved overview with no nationalities strongly dominating the demographic. (Government, 2022) I decided against participating in my own survey.

The creation of surveys and statistics

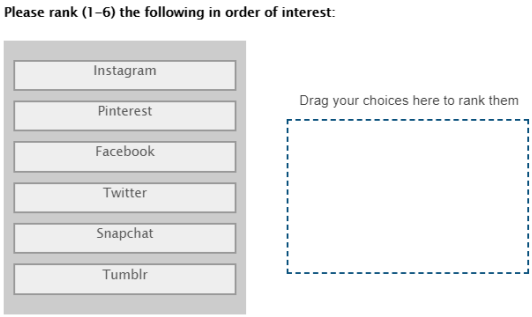
Before creating a survey or conduction an experiment to collect data and information, it is vital to understand how this should be done. Statistics consist of more than just pie charts and graphical representations. They are more than just numbers inserted into a chart. There are complex methods involved in creating these figures from start to finish, a lot of effort has to be put in to generate valid and trustworthy statistics. This chapter covers the different steps that need to be followed to produce a valid statistic as well as how to analyse and draw conclusions from a graphic or finished statistic. The creation of statistics can be separated into three main steps:

1. **Collection**
2. **Representation**
3. **Interpretation**

Collection

Data collection lies at the core of statistics because statistics represent the collected data. The first step of creating a statistic is the amassing of data and information. A poor collection of data could result in a ruined statistic. The amassing of data can either be performed by an observational study or by an experiment.

An observational study, more commonly referred to as a survey, consists of collecting data on individuals in a way that it doesn't affect participants. This means that simple questions are asked, and forms are filled out in a neutral way. In some cases, participants are selected at random but in other cases they are targeted because of their profession, age, interest and so on. Purposely selected participants then need to take part in a poll, where relevant questions are asked according to the criteria they were selected for. A lot can go wrong during observational studies, for example if questions are difficult to comprehend it is easy to end up with a lot of unwanted and useless data.



Example of poll used during an observational study on social media platforms

Bias vs quality data

One example of poor data collection is bias as this can nullify a statistic. The reason behind this is that bias data does not necessarily represent the whole truth, potentially making the result of the study irrelevant. Bias can be caused by a favouring of a certain group of participants in the hope to achieve a specific outcome of a study. The risk of bias entering a statistic makes quality data key. Annually a lot of money is spent on collecting quality data for experiments and observational studies. To avoid bias, the key principle is neutrality. Neutrality symbolises partiality during data collection. If a certain group of subjects is favoured during data collection, it will influence the end result of the statistic and invalidates the study in total. Bias can also surface during data collection; the way questions are posed and what choices are provided can also be manipulated to provide bias data. If only a certain number of choices is provided for a question, other possible answers are eliminated. This can be perceived as another form of bias, making the questions themselves just as important as the answers.

In the attempt to create a valid statistic, randomness plays an important role in combatting bias, which can be achieved using differing methods. Data collection is of major importance during the creation of a statistic, as it heavily influences both the representation and analysis. ((PHD), 2011)

Description and representation

After having collected good quality data the second step is to then show the results of the collected data in a manner that it can be understood and interpreted. This is done, as previously seen, by summarising researched results. This can be executed using different approaches:

Descriptive Statistics

Descriptive statistics summarise the collected data in the form of numbers, which is often referred to as raw data. Descriptive statistics still serve as an intriguing method of summarising data. They can describe a data set, accompanied by its important characteristics such as frequency, average, percentage, mean and standard deviation. An accompaniment of a graphical representation is optional.

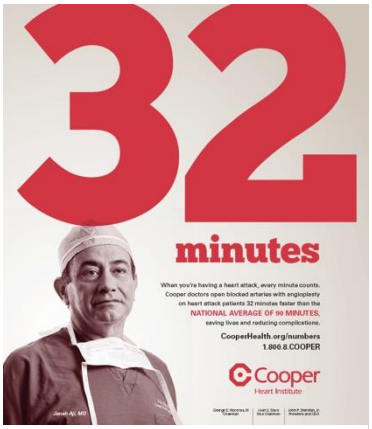


Figure 1: A descriptive statistic used in a medical advertisement campaign, using an average.

Graphical representations

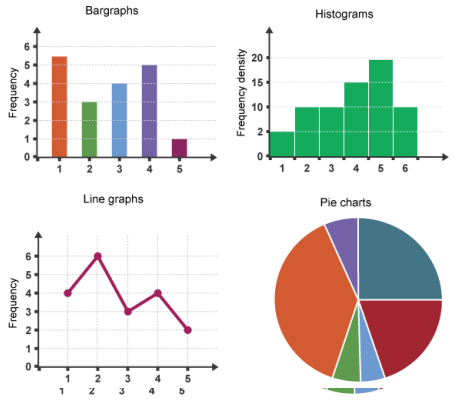


Figure 2: Different graphical representations (bar graph, histogram, line graph, pie chart)

The most common form of displaying and summarising data is by using graphical representations such as graphs and charts. This type of representation summarises data visually in the form of pictures and diagrams. Charts and diagrams need to clearly show the result of the experiment or survey instantaneously, with the intent that the chart can be easily understood. To be able to do this, the axes or key of a chart need to state the necessary descriptions. Upon looking at a graphical representation, the big picture is displayed and serves as quick information for the reader. Overcomplicated graphs are misleading and confusing.

Good, clear graphical representations lead to simple analysis and conclusions.

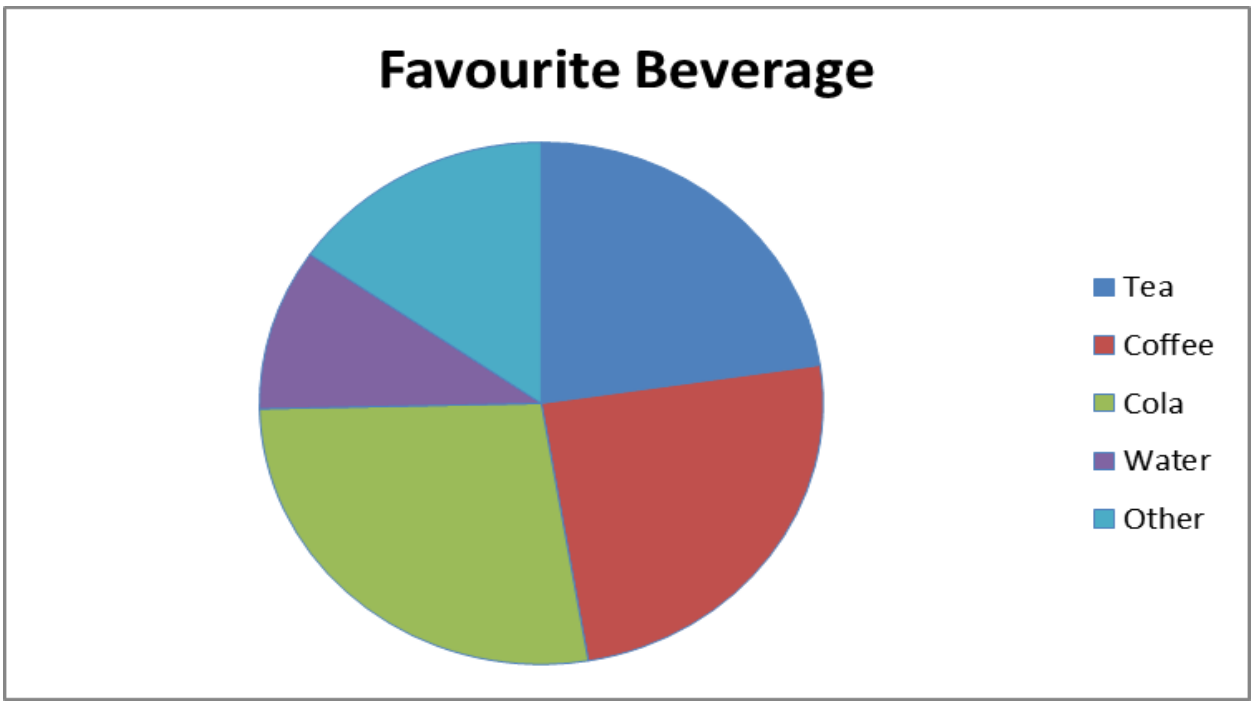
Analysis and interpretation

The last step to the creation of statistics is the analysis of a summarised data set, followed by conclusions drawn from the analysis. A misinterpreted statistic renders the whole study useless, making correct analysis extremely important.

Analysis can be performed after sets of data have been collected and summarised using either pictures or numbers, as previously explained. The analysis itself incorporates both the interpretation and the deductions that can be made from the visual of a statistic. The key point to focus upon when examining a representation is understanding what is being displayed, why and what it means. The whole process can be broken down into several fundamental steps:

1. Look at the graph.
2. Examine the title and axis/key.
3. Determine what type of information is being displayed.
4. Establish the result of the study, and what is being proven.
5. Deduce what the result means and incorporate separate thoughts about the cause of the result.
6. (Determine what aspects are missing, if any)

Example



1. It is a graphical representation in the form of a pie chart.

2. The title indicates the subject is favourite beverages and the key lists a few examples of diverse beverages.

3. During the survey, participants were asked to state their favourite beverage. It is not clear from the chart if the participants were given the choice of the five answers as depicted on the pie chart or if they were allowed to freely state any beverages they wanted to. The pie chart summarises the data collected, which means that it displays the most common favourite drink.

4. The pie chart visually shows that the most common favourite beverage is cola followed by coffee, tea, then other beverages and finally water.

5. The result is unsurprising as the most common answers of cola and coffee each contain an addictive substance (high amount of sugar and caffeine respectively), which causes dependency. This is the most likely cause of the result.

6. Missing are both the number of participants and who they were, where they came from etc. Furthermore, exact labelling of the clear percentages of each answer are not listed making the graph harder to comprehend.

(Stevens, 2021)

My survey

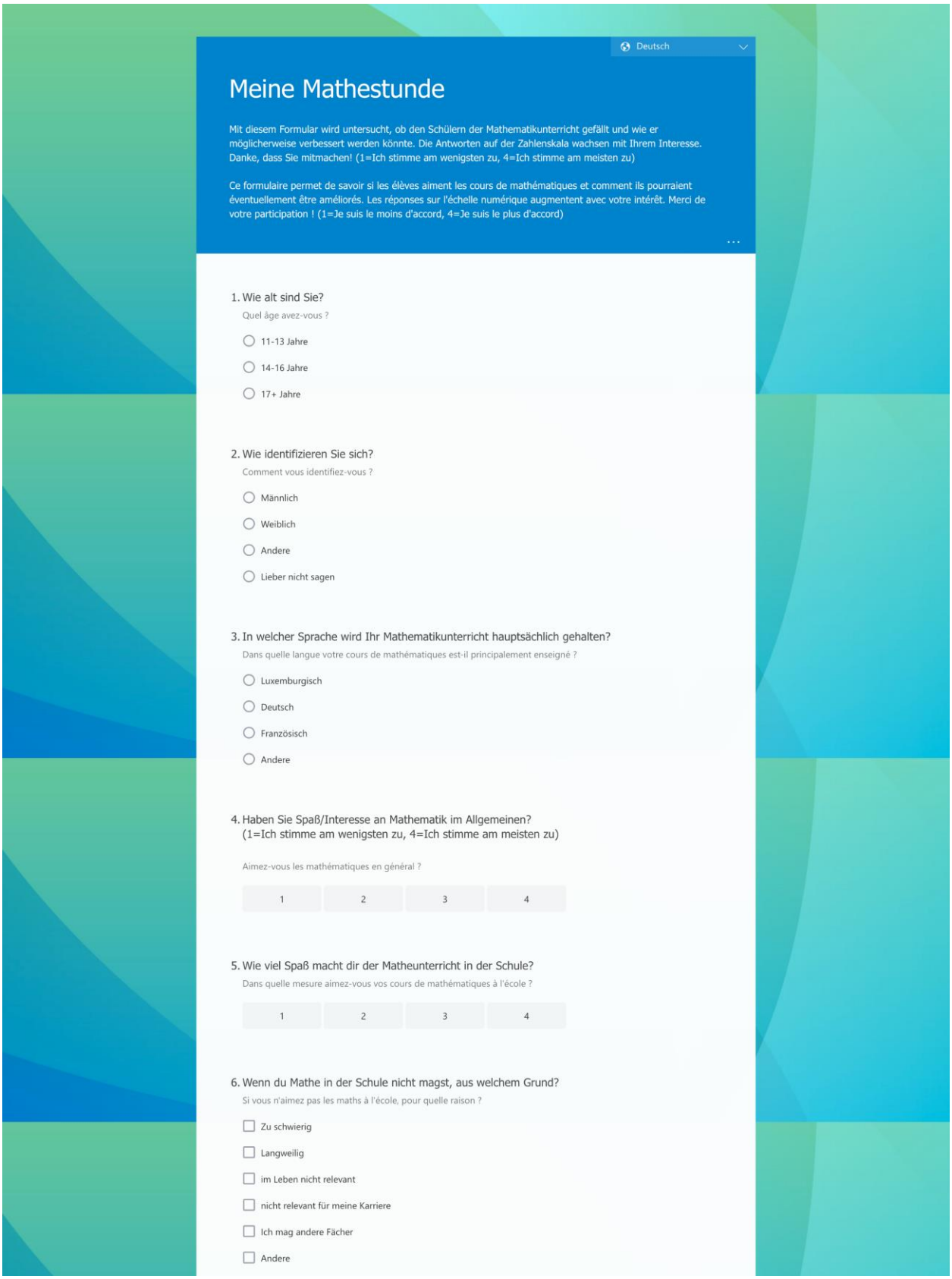
First steps

My self-created survey needed to be precise and understandable, especially due to the fact that it would be filled out by children and adolescents. There needed to be enough questions in order to obtain sufficient data, however, not too many as children are known to have short attention spans which could lead to uncompleted surveys. Given that our school strives to function not only in an 'in person' format but also as an online format, each student is equipped with a Microsoft Office 365 account. Each class communicates online through the Microsoft Teams platform which I exploited to create an online survey. Data collection is thus improved, resources are diminished, and efficiency is key.

I selected the Microsoft Forms app which was launched in 2016 and facilitates the creation of surveys with automatic data collection. I intend for the form to be shared into most if not all of the collective Microsoft Teams groups; this can be done by pasting a link into the chat and respondents can easily fill out the survey anonymously within a short time span.

Due to the international aspect of Luxembourgish students, I decided against creating the form in English, favouring German as the main language with French subtitles. This allows for optimum comprehension and thus maximising the number of the filled-out surveys. My survey is anonymous, and students may only fill out the survey once.

Here are the images of my blank survey, as it will be shown to potential respondents:


Deutsch
Meine Mathestunde
Mit diesem Formular wird untersucht, ob den Schülern der Mathematikunterricht gefällt und wie er möglicherweise verbessert werden könnte. Die Antworten auf der Zahlenskala wachsen mit Ihrem Interesse. Danke, dass Sie mitmachen! (1=Ich stimme am wenigsten zu, 4=Ich stimme am meisten zu)
Ce formulaire permet de savoir si les élèves aiment les cours de mathématiques et comment ils pourraient éventuellement être améliorés. Les réponses sur l'échelle numérique augmentent avec votre intérêt. Merci de votre participation ! (1=Je suis le moins d'accord, 4=Je suis le plus d'accord)
1. Wie alt sind Sie?
Quel âge avez-vous ?
11-13 Jahre
14-16 Jahre
17+ Jahre
2. Wie identifizieren Sie sich?
Comment vous identifiez-vous ?
Männlich
Weiblich
Andere
Lieber nicht sagen
3. In welcher Sprache wird Ihr Mathematikunterricht hauptsächlich gehalten?
Dans quelle langue votre cours de mathématiques est-il principalement enseigné ?
Luxemburgisch
Deutsch
Französisch
Andere
4. Haben Sie Spaß/Interesse an Mathematik im Allgemeinen? (1=Ich stimme am wenigsten zu, 4=Ich stimme am meisten zu)
Aimez-vous les mathématiques en général ?
1
2
3
4
5. Wie viel Spaß macht dir der Matheunterricht in der Schule?
Dans quelle mesure aimez-vous vos cours de mathématiques à l'école ?
1
2
3
4
6. Wenn du Mathe in der Schule nicht magst, aus welchem Grund?
Si vous n'aimez pas les maths à l'école, pour quelle raison ?
Zu schwierig
Langweilig
im Leben nicht relevant
nicht relevant für meine Karriere
Ich mag andere Fächer
Andere

7. Hast du Spaß daran, außerhalb des Klassenzimmers etwas über Mathematik zu lernen (Umgang mit Geld, Statistik, Backrezepte, ...) ?

Aimez-vous apprendre les mathématiques en dehors de la classe (gestion de l'argent, statistiques, recettes de cuisine, ...) ?

1	2	3	4

8. In welcher Sprache möchten Sie Mathematik in der Schule unterrichtet haben?

Dans quelle langue souhaiteriez-vous que les mathématiques soient enseignées à l'école ?

- ◯ Luxemburgisch
- ◯ Deutsch
- ◯ Französisch
- ◯ Englisch
- ◯ Andere

9. Der Lehrer beeinflusst mein Interesse am Matheunterricht.

L'enseignant influence mon intérêt pour le cours de mathématiques.

- ◯ Ich stimme zu
- ◯ Ich stimme einigermaßen zu
- ◯ Ich stimme eher nicht zu
- ◯ Ich stimme nicht zu

10. Ich glaube, dass das, was wir im Matheunterricht lernen, für das spätere Leben wichtig ist.

Je pense que ce que nous apprenons en cours de maths est important pour la suite de notre vie.

- ◯ Ich stimme zu
- ◯ Ich stimme einigermaßen zu
- ◯ Ich stimme eher nicht zu
- ◯ Ich stimme nicht zu

11. Mein Matheunterricht könnte in irgendeiner Weise verbessert werden.

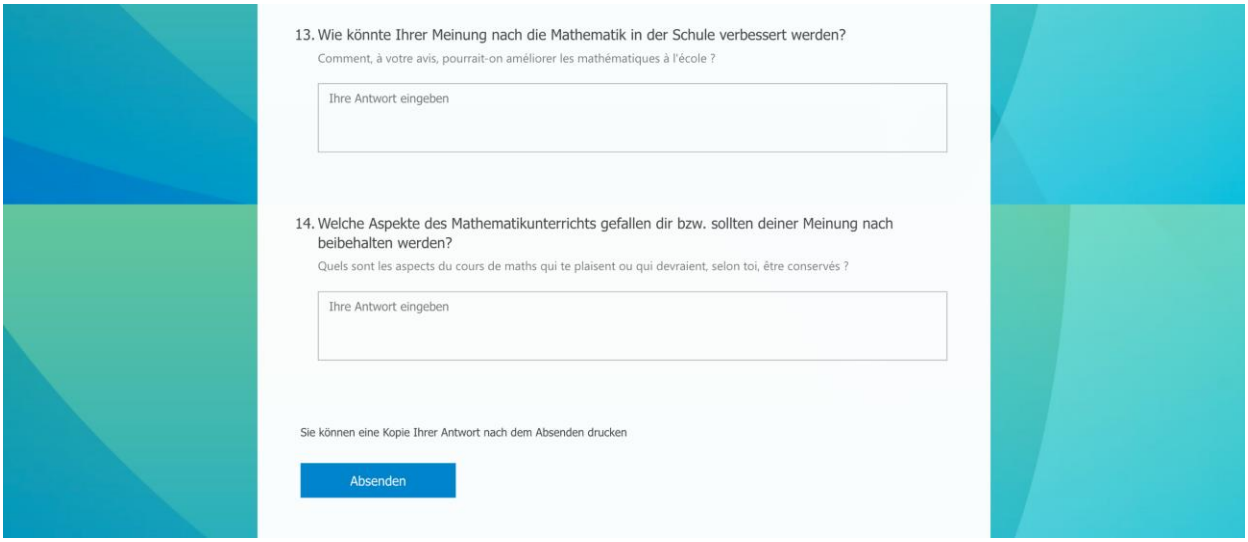
Mon cours de mathématiques pourrait être amélioré d'une manière ou d'une autre.

- ◯ Ich stimme zu
- ◯ Ich stimme einigermaßen zu
- ◯ Ich stimme eher nicht zu
- ◯ Ich stimme nicht zu

12. Der Stil des Mathematikunterrichts in der Schule sollte geändert werden, zum Beispiel weil er nicht ansprechend oder relevant genug ist.

Le style des mathématiques enseignées à l'école devrait être modifié, par exemple parce qu'il n'est pas suffisamment captivant ou pertinent).

- ◯ Ich stimme zu
- ◯ Ich stimme einigermaßen zu
- ◯ Ich stimme eher nicht zu
- ◯ Ich stimme nicht zu


13. Wie könnte Ihrer Meinung nach die Mathematik in der Schule verbessert werden?
Comment, à votre avis, pourrait-on améliorer les mathématiques à l'école ?
Ihre Antwort eingeben
14. Welche Aspekte des Mathematikunterrichts gefallen dir bzw. sollten deiner Meinung nach beibehalten werden?
Quels sont les aspects du cours de maths qui te plaisent ou qui devraient, selon toi, être conservés ?
Ihre Antwort eingeben
Sie können eine Kopie Ihrer Antwort nach dem Absenden drucken
Absenden

Selection criteria for the questions

Questions used for surveys must meet certain criteria in order to be used, this includes being legible, simple, and obvious. There is nothing worse than responding to a survey where the questions are asked in difficult to understand manner as this leads to fewer responses and less pertinent data. Therefore, eliminating bias, unnecessary complications ensure for qualitative data and a maximum number of respondents. These measures include posing closed questions with predefined answers, to simplify the evaluation of large amounts of data, furthermore closed questions mean the survey can be completed more efficiently without the respondent having to use words to communicate in a language they may not master. Throughout this next part each question will be presented, why it was chosen, and what the desired information is for each answer followed by my personal predictions.

Questions

1. *How old are you?*

Possible answers: 11-13, 14-16, 17+

As previously mentioned, all questions are optional meaning no one has to answer this question if they are not comfortable with providing it. I believe a simple first question encourages people to continue on with surveys. Additionally, this question allows for me to observe whether there is an age-related trend in the data. Are younger students more inclined to dislike and potentially fear their maths classes or do these feelings grow with the age of the students?

Providing merely three responses was purposely done as these are the three main categories of mental development in teenagers (pre-pubescent, young adults, and fully-grown adults). Moreover, providing an answer for each year of age was deemed excessive.

2. *How do you identify yourself?*

Possible answers: Male, Female, Other, prefer not to say.

At first glance this question appears to be as simple as the first one, however it is everything but. Gender based questions are always difficult to ask as offending someone or a group of people can easily happen even if inadvertently. Making sure everyone feels in included in this question was my first priority which is why I consulted with the following website to be as precise and inclusive as possible:

https://www.ruth-ng.co.uk/how-to-ask-about-gender-in-forms-respectfully

I was not able to implement the total amount of answers as suggested by the website as I had to take the immaturity of children and adolescents into consideration. Under perfect conditions I would have been able to list nonbinary, transgender as well as many other options, however, through personal experience and research adding these explicit options would lead to a loss of credibility in the results. A large number of students tend to wrongfully mark themselves as transgender as a misplaced ‘joke’ which is why it was necessary to remove these options. Similar to the first question, the data gathered from this question should allow me to determine whether there is any gender-based trends.

3. *What language is your maths lesson mostly taught in?*

Possible answers: German, French, Luxembourgish, Other

The first question which is explicitly about the respondent's mathematics class is the third one which asks a basic yet vital question. Mathematics is primarily taught in French and German in Luxembourg and the language the lesson is taught in makes a big difference in the comprehension of students. Further questions about language will follow and this first one serves as a global overview of what language maths is mostly taught in. This data will later be compared with which language students prefer to be taught in. In terms of the answers, no additional options were deemed necessary. I anticipate French to be the main answer, followed by German with a couple answers in Luxembourgish.

4. *Do you enjoy mathematics in general?*

Possible answers: 1-4

Mathematics appears in almost all aspects of daily life from time and money management to following baking recipes which can all bring a lot of joy to individuals. This question seeks to determine how much the respondent enjoys their maths class combined with the outside of school mathematics. Furthermore, this is the first question with a numbered answer scale from 1 – 4 (lowest to highest enjoyment). The reason the scale goes from 1 to 4 (rather than 5 or 10) is due to the fact that most respondents, when unsure, choose the middle option. However, with 4 possibilities the respondents are made to commit to one side without the presence of a middle option. Therefore, they either dislike maths more than they like it or the other way around. This also simplifies the analysis later on. I predict the average score to be rather low around the 2 mark, as maths is not the most fun subject at school for most students.

5. *How much do you enjoy your maths lessons at school?*

Possible answers: 1-4

This fifth question is directly linked to the previous one, as this inquiry focuses solely on the enjoyment of in class mathematics rather than incorporating all aspects of the field of mathematics. This question will help identify whether there is a fundamental issue with what is taught in class, because the average scores of questions 4 and 5 will provide a decent understanding in what how and where students prefer to learn. I predict the average score to be lower than the previous question as I personally also enjoy maths outside of the classroom.

6. *If you dislike maths at school, for what reason?*

Possible answers: Too difficult, boring, not relevant in life, not relevant for my career, prefer other subjects, other reason.

This question is specifically aimed and targeting students who dislike and/or fear their mathematics classes at school and is intended to be skipped by those who do not. Disliking mathematics can be caused by many different factors, therefore understanding which factors are most prominent aid in determining what causes the issue and what could possibly be done to combat it. I listed the most likely options as possible answers. I expect 'boring' and 'too difficult' to be the most selected options because students often complain about these factors, especially in my own class.

7. *Do you enjoy learning about mathematics outside of the classroom (managing money, statistics, baking recipes, …)*

Possible answers: 1-4

This question is related to both the 4th and 5th question, isolating solely the enjoyment of the respondents for maths associated tasks outside of the classroom. People often do not recognise the omnipresence of mathematics in day-to-day life which is why several examples (managing money, statistics, baking recipes) were listed. I predict the average answer to be significantly higher than both of the other questions (around the 3 mark) because mathematics can be fun contrary to popular belief.

8. *What language would you like mathematics to be taught in at school?*

Possible answers: Luxembourgish, German, French, English, other

French is the language that maths is most often taught in in Luxembourg which corresponds to third and penultimate language that most Luxembourgish students are educated in. Could this be a fundamental issue with the manner in which mathematics is taught? I predict a majority of answers will represent both Luxembourgish and German as most students feel more at ease when reading, writing, and speaking in these languages. I believe this to be a pivotal and key question which will help me propose solutions later on.

9. *The teacher influences my interest in the maths lesson.*

Possible answers: Agree, somewhat agree, somewhat disagree, disagree.

Every lesson has a teacher who influences both what is taught and how the lesson is taught, does this contribute to the overall quality of the lesson? I believe that the most commonly selected answer will be 'somewhat agree' as the role of a teacher is vital in motivating and educating adolescents. After having collected sufficient data from this response I plan on discussing it with the maths teachers at my school to see whether or not they agree and/or are aware of the student's opinion. Moreover, the answer scale was revised for this question in order to increase pertinency and clarity to the possible answers.

10. *I believe what we are learning during our maths class is important for later in life.*

Possible answers: Agree, somewhat agree, somewhat disagree, disagree.

This question challenges the necessity of mathematics at school. Education provides the tools needed to succeed further in life, if students fail to see that the maths class is unable to provide necessary or relevant skills for later in life, then it is clearly being taught in the wrong way. Does the content of the maths lesson need to be revised? My hypothesis states that students are aware of the value of mathematics although they may struggle to provide concrete examples.

11. *My maths lesson could be improved in some way.*

Possible answers: Agree, somewhat agree, somewhat disagree, disagree.

There is not much explanation needed for this question as it is posed in the most direct manner possible. I included these questions so that students could decide whether their lesson could be improved or not. If the majority responds with 'somewhat agree' or 'agree' then proposing solutions becomes a must because the lesson that is being provided is not attaining its full potential. I believe 'somewhat agree' will be the most selected answer due to the fact that their class is not perfect, however, improving it may not be evident.

12. *The style of mathematics taught at school should be changed, for example due to it not being engaging or relevant enough.*

Possible answers: Agree, somewhat agree, somewhat disagree, disagree.

As the survey comes to end, the last questions seek to get to the bottom of the issue with maths lessons. Is the teacher partially at fault or does the content of the lesson need to be changed? Here, the content of the lesson is challenged, letting the students share their opinion on the quality of the lesson. The most likely answer will again be 'somewhat agree' in my own personal opinion.

13. *How, in your opinion, could maths be improved at school?*

The two open-ended questions of the survey are the last two. Although it may often be skipped because it requires a slightly longer written answer, this is without a doubt the most crucial question. If it were up to the students, how would they change and improve their own lessons? What suggestions would they give their teachers if they had the possibility? I look forward to listening to other students and working with their improvements to propose changes to the way we teach our future's maths class.

14. *What aspects of maths lessons do you like or think should be maintained?*

The maths class is not inherently bad, many students enjoy and favour this lesson, which makes it important to know what is working well as well as the aspects that keep students engaged.

Results

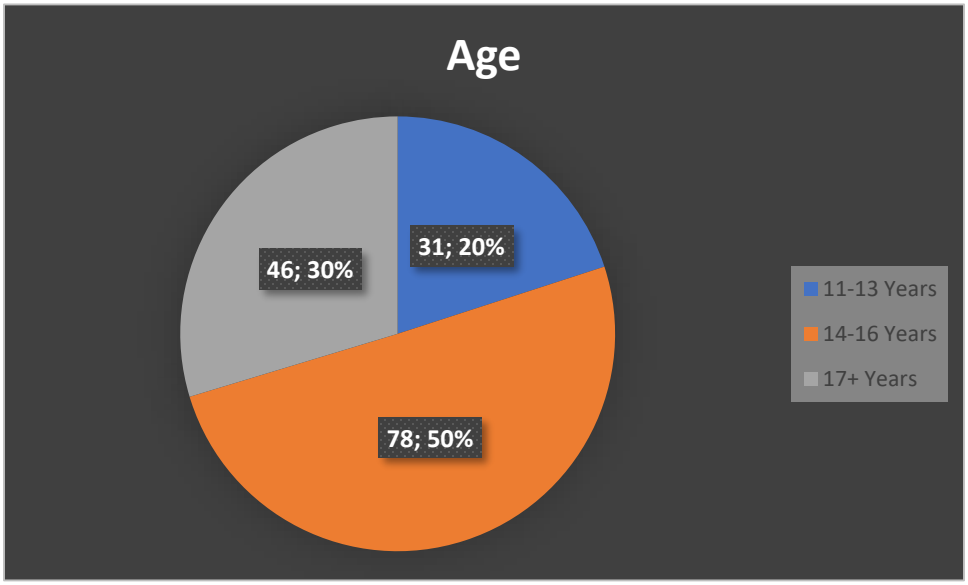
I initially promoted my survey by word of mouth to fellow students and entire classes and then after having received permission from the teachers at my school, I was able to share links to every online class group which dramatically helped me collect more responses. For a total of 2 months, students were able to follow an online link and complete the 14-question survey anonymously, in total 155 responses were submitted from a large variety of students attending the Lycée Ermesinde Mersch.

I am satisfied with the number of responses that I received, given that around 25% of all students saw and answered this survey, with select individuals eager to share their opinion and to find and propose solutions for a better maths lesson. Although the bulk of the operation went to plan, I did learn how to optimise certain questions and answer keys for future surveys in order to make them more accessible and comprehensible. Certain questions needed more context, I was also made aware of the fact that respondents rarely read the informative header and introduction. Finally, one or two questions provided no interpretable or logical data. I will use this experience to optimise my approach.

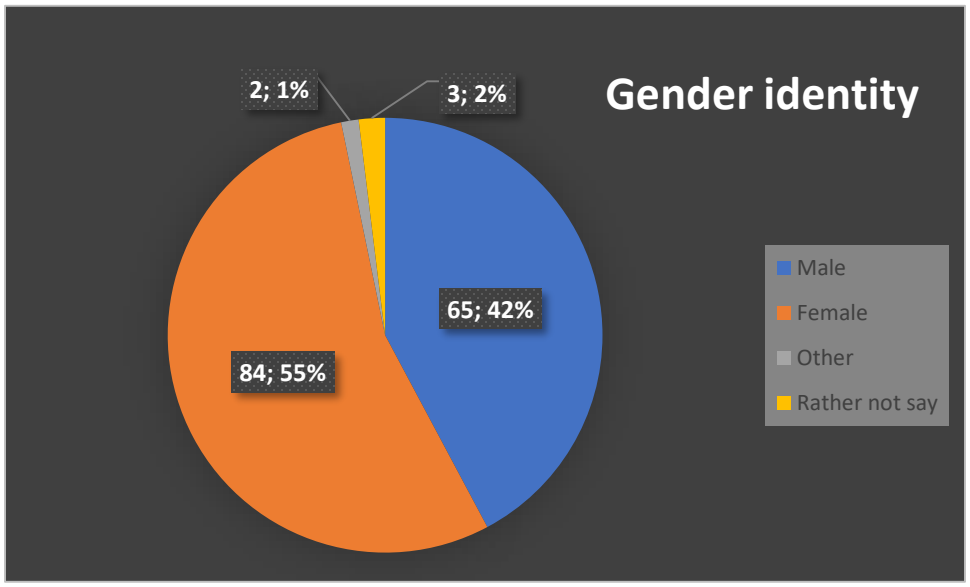
Given the large number of data collected, as well as the motivation of those who completed my survey, I can confirm that this practical experiment was a success and will provide a global outlook covering the opinions of students.

Raw Data

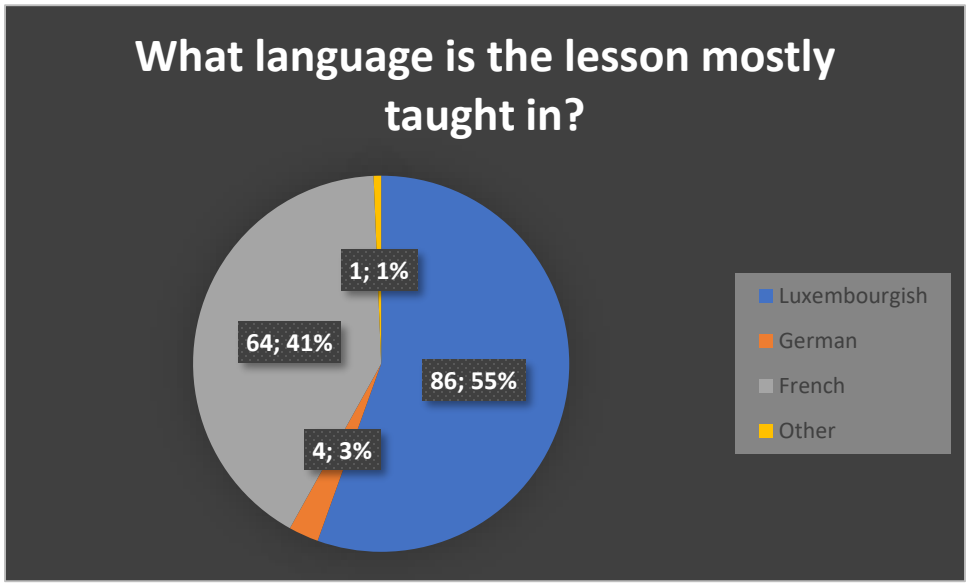
1. *How old are you?*



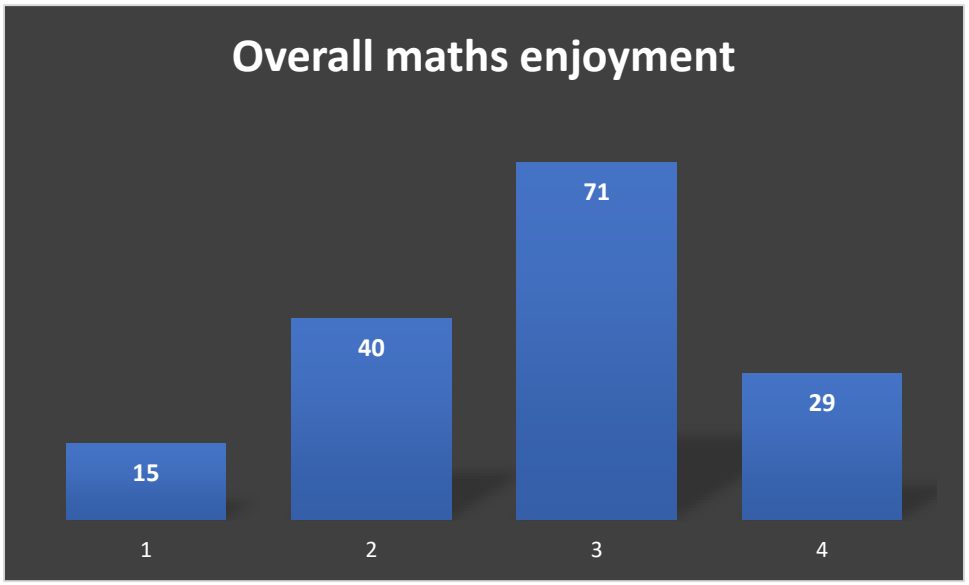
2. *How do you identify yourself?*



3. *What language is your maths lesson mostly taught in?*

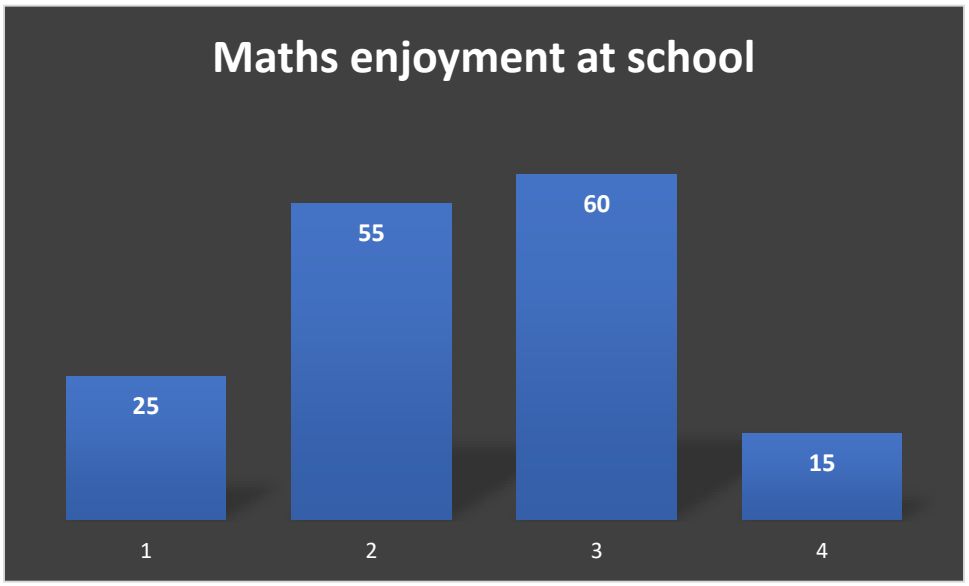


4. *Do you enjoy mathematics in general? (1 = the least, 4 = the most)*



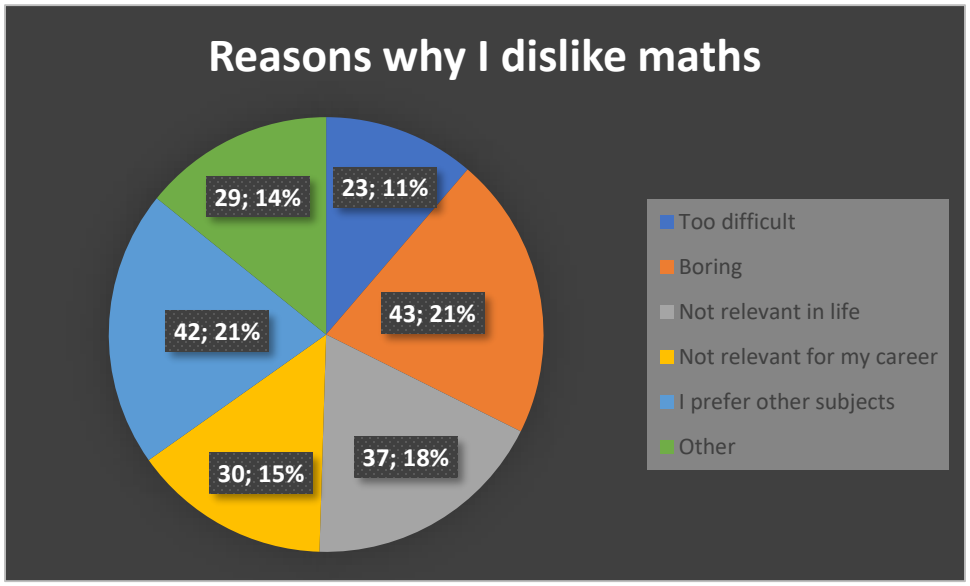
Average (2,74)

5. *How much do you enjoy your maths lessons at school?*

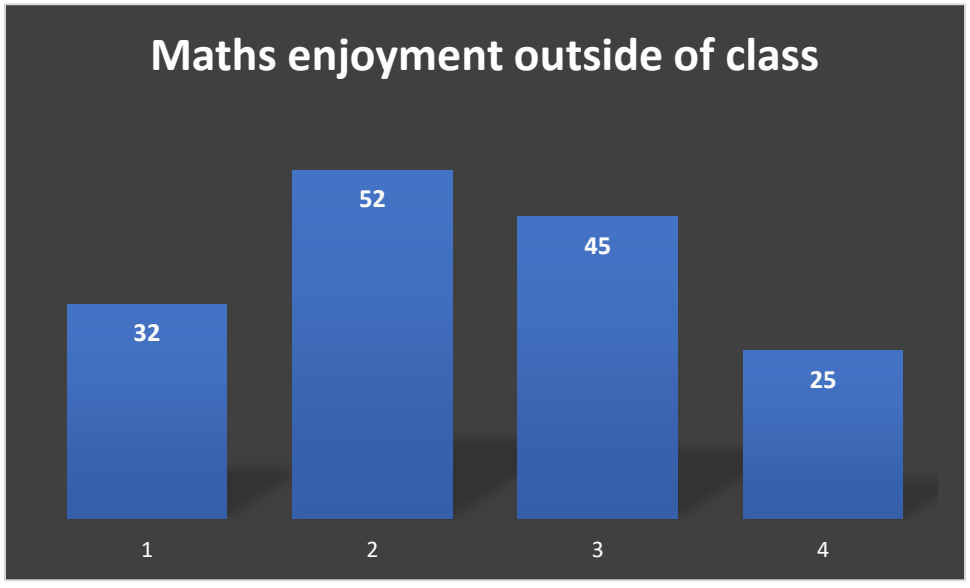


Average (2,42)

6. *If you dislike maths at school, for what reason?*

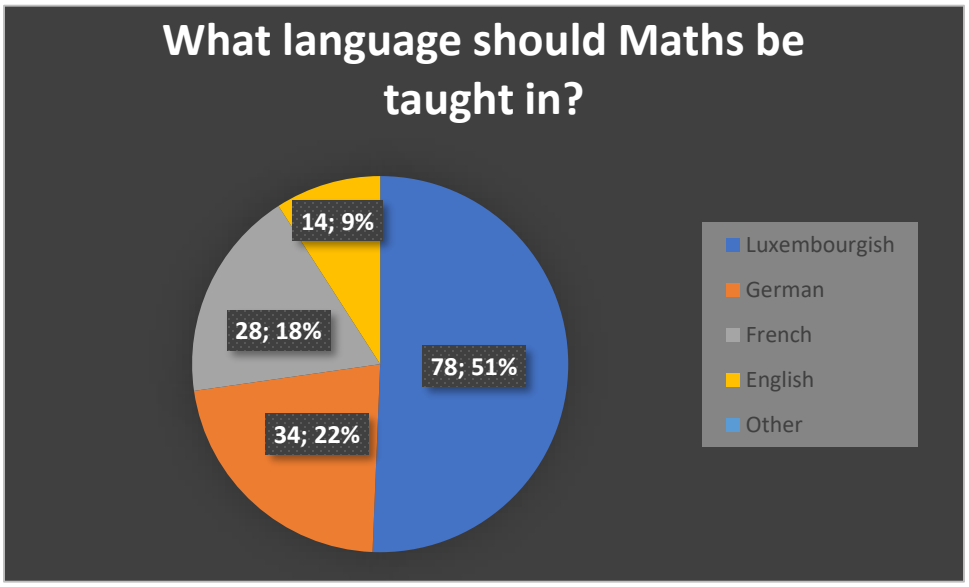


7. *Do you enjoy learning about mathematics outside of the classroom (managing money, statistics, baking recipes, …)*

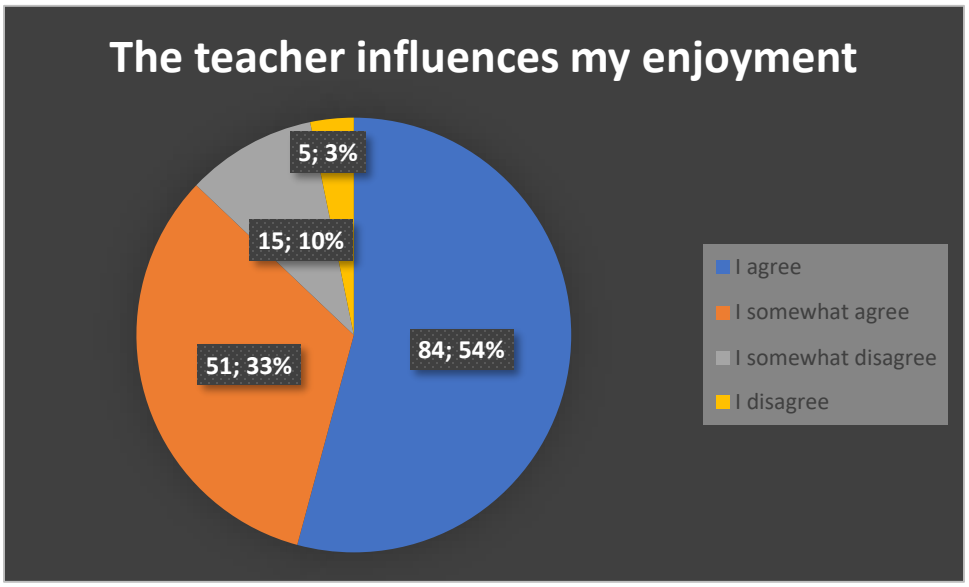


Average (2,41)

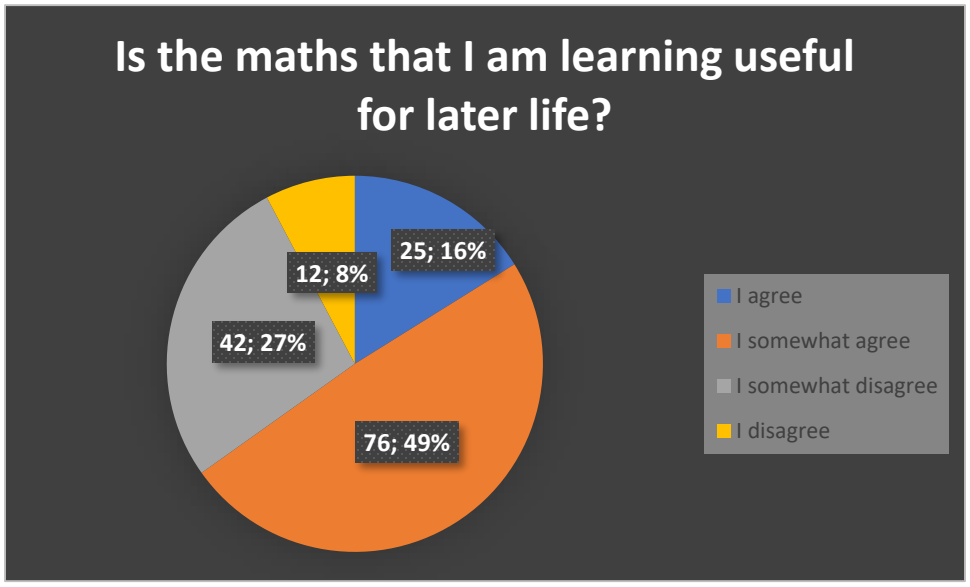
8. *What language would you like mathematics to be taught in at school?*



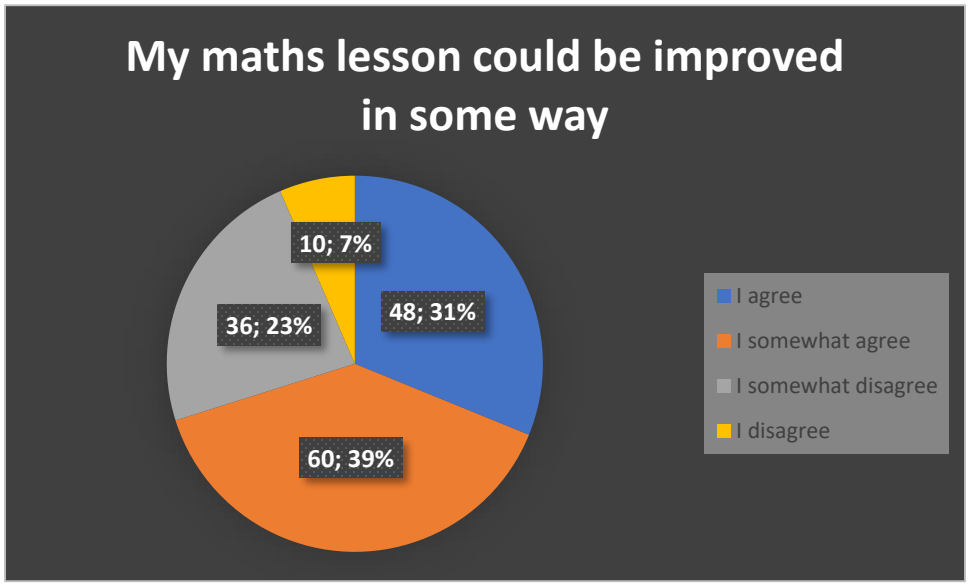
9. *The teacher influences my interest in the maths lesson.*



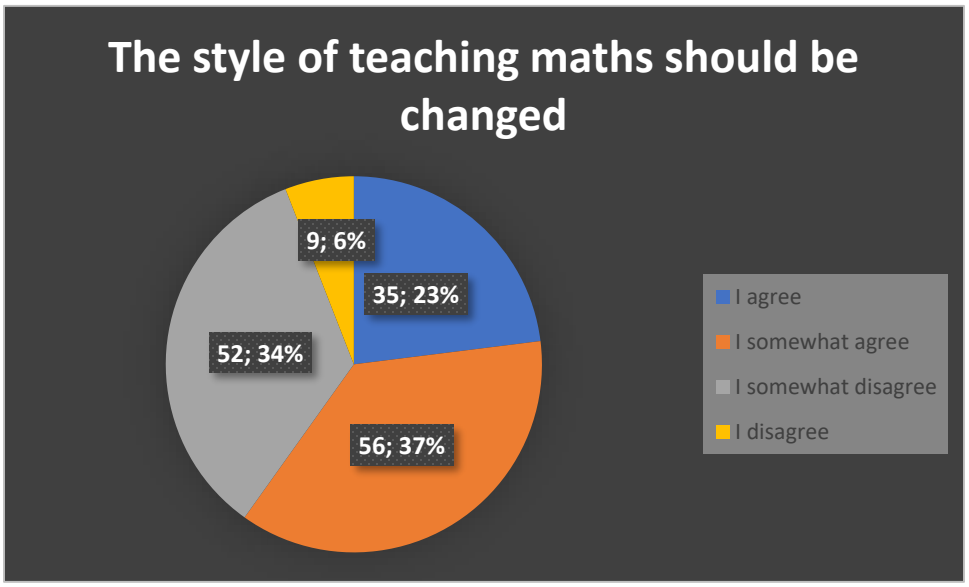
10. I believe what we are learning during our maths class is important for later in life.



11. My maths lesson could be improved in some way.



12. *The style of mathematics taught at school should be changed, for example due to it not being engaging or relevant enough.*



For the last two questions it would be unpractical to note down all responses, due to the large volume (65 for Q13 and 43 for Q14) and the fact that some are incomplete. Therefore, I have selected and translated the best answers that summarise the entirety of the responses.

13. How, in your opinion, could maths be improved at school?

- “Hire teachers who not only really know maths, but who can also teach it to you.”
- “More use could be made of tablets.”
- “I think everything is fine the way it is.”
- “In my opinion, mathematics should be adapted in terms of career choice. Everyone should have the same basic knowledge, of course. For example, medicine: someone who wants to study medicine in the future should "get to know" the mathematics in this field. Unfortunately, I don't have a solution for students who don't know what they want to be when they grow up.”
- “Less time should be spent writing down theory and more time should be spent learning to apply theory.”
- “It would be better if students were not forced to study mathematics if it does not coincide with their career path.”
- “Explain more how and where you will see and use what you learn in life.”
- “In my opinion, maths lessons can only be improved with a better teacher. The theory learned cannot be changed and the exercises are attached to the theory, so in itself the exercises also do not really change. So, it all depends on the teacher and how he or she holds the class. So, the question becomes: What is a good teacher?”
- “Improving the atmosphere in the maths lesson.”
- “Less theoretical, making maths tangible.”
- “In my opinion, I think it would be better to do more exercises in practice, instead of theory, exercises and then test. The teacher should be able to explain in a simpler form, instead of reading what is in the book and copying it 100%.”
- “Other language.”
- “Cover current topics like money, deal with topics that you can use in later life.”
- “More inclusive (pupils more involved).”
- “Allocate just a bit more time for doing exercises individually or in pairs/groups. Copying the teacher's solutions doesn't really stimulate your own ability to solve exercises/problems. The best way to learn math is to practice.”

14. What aspects of maths lessons do you like or think should be maintained?

- “Calculus, geometry, algebra.”
- “Independent task solving.”
- “Learning how to solve problems as well as the logical thinking that comes with it.”
- “Calculating without a calculator.”
- “In my opinion, a strict programme should continue to be presented. So that all classes have seen the same topics at the end of the year.”
- “Tasks like: How many litres of beer fit in our school: calculate how long all the people in Luxembourg could drink it until there is nothing left.”
- “The cooperation between teacher and pupil.”
- “Above all, the group work.”
- “Solving tasks together as a class.”
- “Not everyone does this, but my teacher takes a short break in the middle of the lesson.”
- “I like the fact that it is first written in French and then explained again in Luxembourgish and German respectively.”

Analysis

While evaluating data and graphs to create statistics, it is essential to determine whether the result is statistically valuable. If a data set is statistically valuable, it means there is a clear correlation or result which is not caused by mere chance. From statistically valuable data, conclusions can be drawn, and discussions can be led, although it is always important to remember that correlation does not automatically mean causation.

Notable trends

Commenting on every graph would be excessive as not every question provided statistically valuable, however certain questions provided intriguing results.

Question 3 and 8

At the Lycée Ermesinde Mersch secondary school the vast majority of maths lessons should officially be taught in French with select few in German (for some younger students). However, question three clearly outlines the fact that most teachers are favouring the Luxembourgish language when teaching mathematics (55%) contrary to 41% of lessons in French and just 3% in German.

If we add this information to the results of question 8 the results become much clearer, as just over half of students (51%) desire mathematics to be taught in Luxembourgish. Additionally, 22% of students prefer German and support for the French language is a mere 18 percent.

Students are clearly unhappy about the fact that their lesson is supposed to be taught in French and teachers are adapting their lessons accordingly in order for students to better understand what is being taught. Mathematics certainly is not an easy lesson and with French commonly being the third language learnt by students, this extra complication can influence motivation and comprehension. Especially in Luxembourg, the added difficulty of language could be one of the determining factors in trying to improve the maths lesson at school. Many students may simply not be looking forward to their mathematics lesson due to the difficult language that it is being taught in.

Question 4 and 5

The comparison and intent of these two questions is clear, where is the enjoyment of maths at its highest, at school or in general elsewhere? To begin with, respondents were not bewildered with maths in the first place with averages of 2,74 on a scale of 1 to 4 for question 4 and 2,42 for question 5.

If we were to transform these averages into percentages from 0-100%, the maths enjoyment in general would be 58% and 47% enjoyment at school. This means that maths is most probably not the most favoured subject at school, however, the 11-percentage point swing does clearly indicate that mathematics becomes less striking in the classroom.

Personally, I believe these differences can be attributed to the style of mathematics taught at school. Less engaging and more repetitive exercises don't provide enough stimulation as other methods of learning about mathematics. I agree with the majority of students in this scenario, as I too prefer learning about maths through puzzles and videos which I am only able to access outside of a classroom environment.

Question 6

The results displayed by the sixth question raise more questions than they answer, what is certain is the reasons for disliking maths are numerous and diverse. It therefore remains difficult to attribute the blame when it comes to determining what is wrong with the maths lesson. What is enthralling to note is that the least voted answer was too difficult, which takes that aspect out of the conversation.

The most voted answers all surround a similar issue which is relevance, the answers "not relevant in life", not relevant for my career" and "I prefer other subjects" all allude to the fact that there is not enough of connection between what is being learnt and why it is being learned.

Question 9

The results coming from this question could not be clearer. When asked whether the teacher influenced their enjoyment of the maths lesson, a tremendous 87% of students stated that they completely agree or somewhat agreed, with only a measly 3% disagreeing. It is undoubtedly clear that the teacher makes or breaks the quality of the maths lesson making it incredibly subjective. A ton of pressure is put on the teacher to provide a qualitative lesson, as the interest of almost 9 out of 10 students depends on how they teach the lesson rather than what they are teaching.

Furthermore, if a student comes across a teacher that they dislike, they are stuck disliking the maths lesson for an entire year where they will most probably not reach their full potential. I aim to share these results with the teachers from my school in order to make them aware of the gravity of their lesson plan.

Questions 10

Returning towards the question of relevance, do students believe that what they are learning is useful for later in life? Although the majority of students agree or somewhat agree, the number of students who completely agree is low with only 16% of students confirming they absolutely believe what they are learning is useful for their future. The majority of answers are from students that somewhat agree which may point to the fact that they believe it will be useful but are not sure why.

I concur with the majority as certain mathematics chapters, such as trigonometric equations and inequalities for example, bear no real use in any field of mathematics, especially not for students who do not wish to pursue a career of mathematics. However, the true value of mathematics occasionally does not lie in what is being taught but rather the cognitive processes that are used to determine an answer a more valuable. Almost all careers require logical thinking, quick thinking and adaptive learning which is mostly learned indirectly during the mathematics lesson. Formulas and algorithms used to solve equations and other diverse problems stimulate the brain to think logically which boosts a large number of valuable work skills such as those previously mentioned. The issue is that students are rarely made aware of this which can lead to frustration as they are unable to make sense of why they are learning some topics they will never need later in life.

Questions 11 & 12

When asked whether their maths lesson could be improved in some way, 70% of students either said that they completely agree or somewhat agreed with only 7% disagreeing. This shows a clear consensus that there exist areas of the lesson that could realistically be improved.

This data can be coupled with the next question which aimed to determine whether the style of teaching mathematics should (not could) be changed in order to improve the lesson and make it more engaging. In spite of the fact that the outcome was less unanimous than the previous question, 60% of students still agree or somewhat agree that the maths lesson could, should and needs to be adapted. It appears that students agree on the fact that their lesson could be improved, however, they remain a slight bit more hesitant in actually changing the maths lesson. This could possibly be due to the fear of change as well as the entirely reasonable fear that change could potentially worsen the overall experience of a mathematics lesson.

Question 13

The answers to the 13th question can be summarised by the following five points. This is how students believe their maths lesson could possibly be improved.

- Teachers should be competent and entirely capable of explaining the content of their lesson in a way that every student is able to understand.
- Less time should be spent writing down theory and formulas, more time should be dedicated to applying said theory. Essentially, students would like more time to be able to practice exercises (possibly in pairs) with less copying the teacher's responses.
- Teachers should explain why each is topic is being taught and how it could be potentially useful in real world situations. More contemporary chapters should be included with the potential addition of technology such as tablets to make maths more tangible.
- The atmosphere of the maths should be improved to make the lesson more engaging.
- The official language of the lesson should be revised for optimum comprehension.

Question 14

The aspects of the maths lesson that students like and think should be kept can be summarised by the following three statements.

- Basic maths skill such as calculating without a calculator.
- Independent and logical problem solving
- Occasional group work as well as exploring problems together as a class.

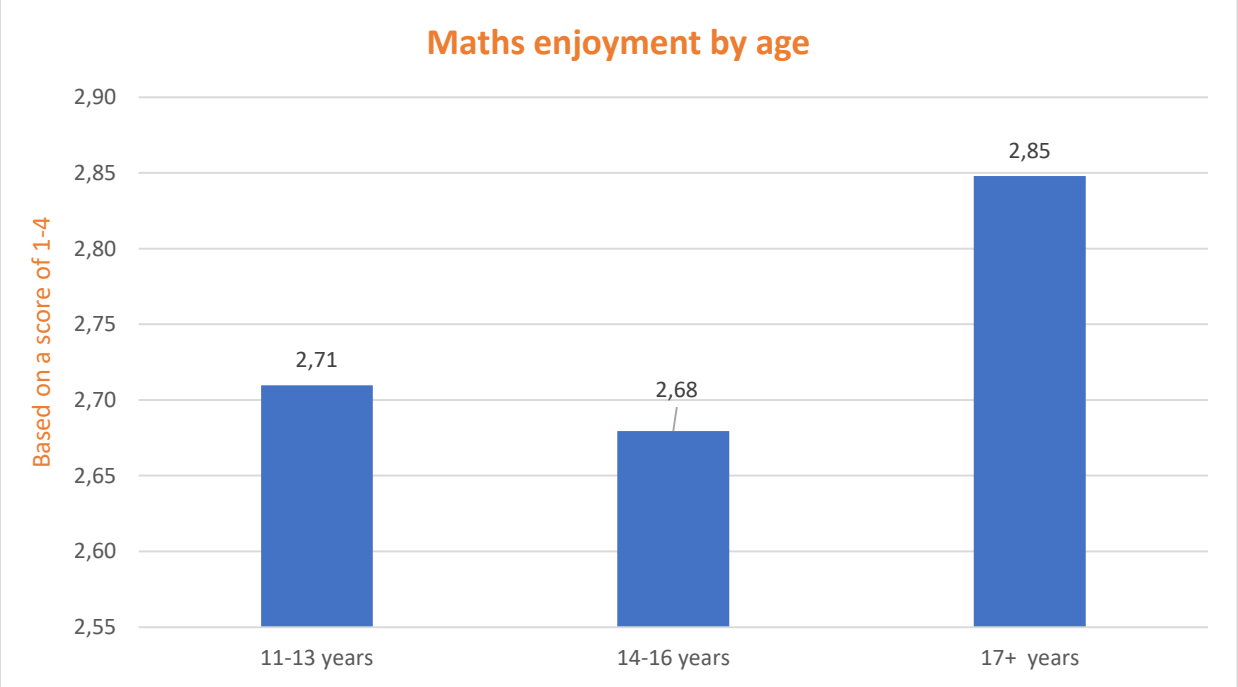
Deeper analysis

True data analysis is not limited to merely interpreting each question separately and attempting to draw conclusions. In order to dive into a deeper and more thorough level of data analysis, individual data sets and questions need to be intercompared with each other to be able to further discover and explore correlations. These intercomparisons can handily be reviewed while using pivot tables.

After intercomparing almost all data, the following graphs and tables encompass the most evident as well as striking correlations from my survey.

Maths enjoyment by age

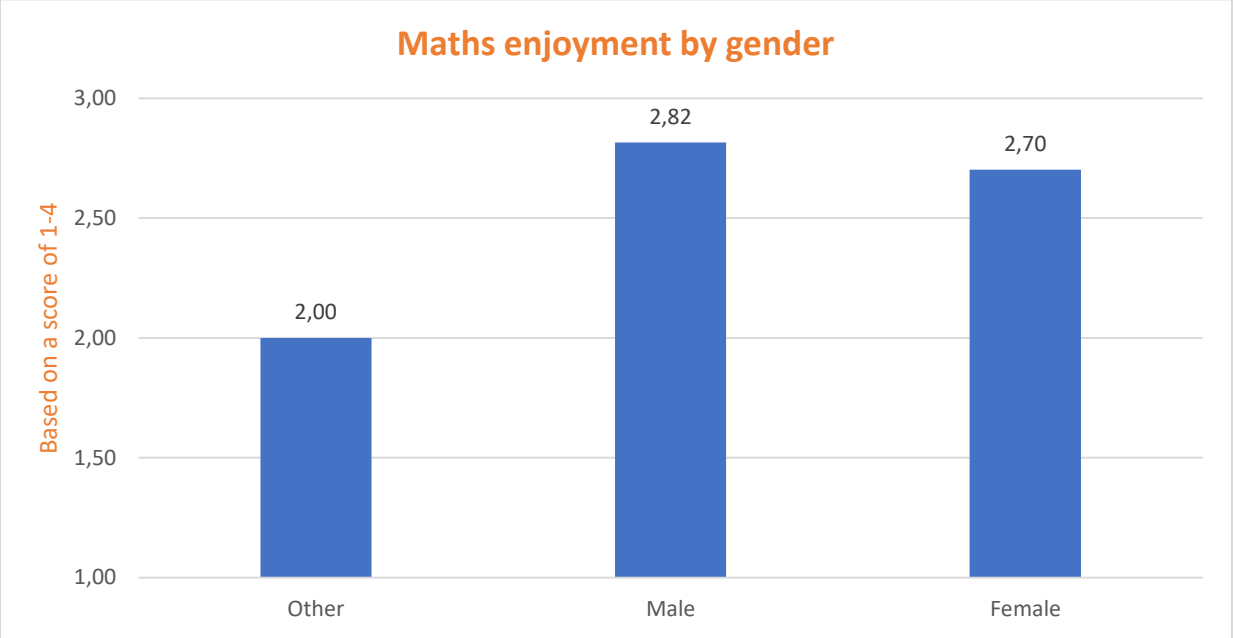
Row Labels	Average of Do you enjoy/interested in mathematics in general? (1=I agree least, 4=I agree most)
11-13 years	2,71
14-16 years	2,68
17+ years	2,85
Grand Total	**2,74**



The aim of this graph was to see how mathematics appeals to the different age groups, although the reasons behind these differences are unclear, a notable 10% increase can be seen between the second and third age group. This could potentially be due to the fact that the Lycée Ermesinde Mersch offers more maths related future career paths, with those preferring other careers changing schools.

Maths enjoyment by gender

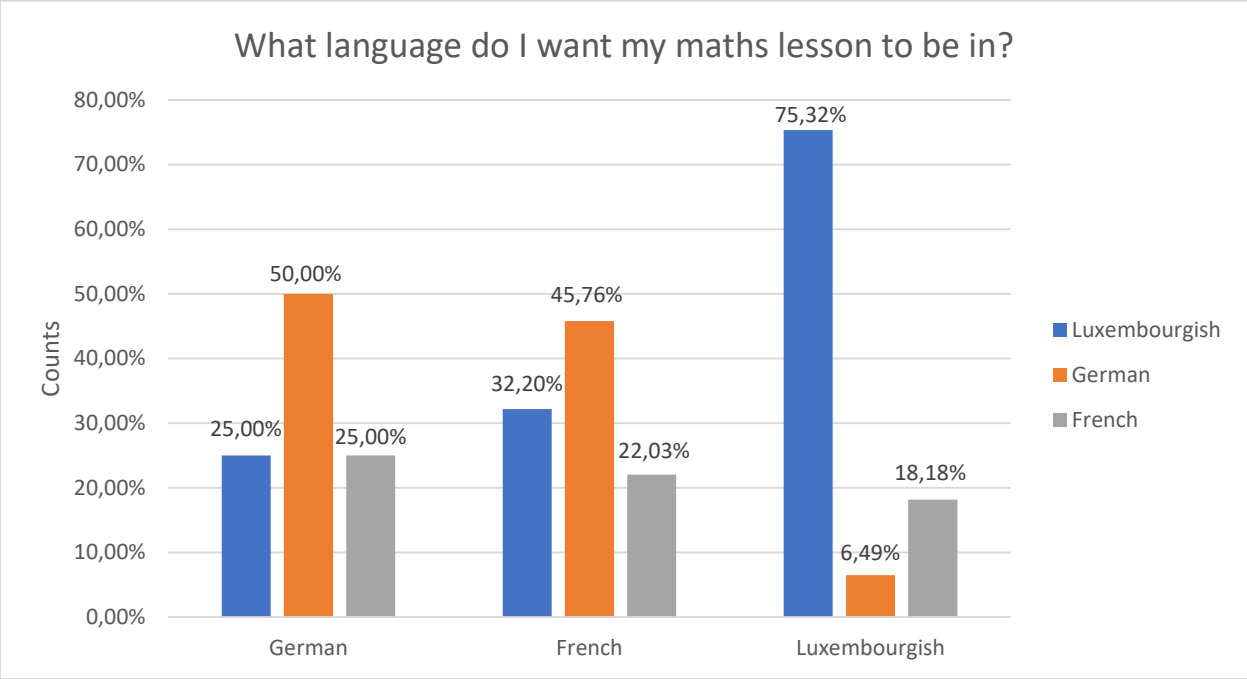
Row Labels	Average of Do you enjoy/interested in mathematics in general? (1=I agree least, 4=I agree most)
Other	2,00
Male	2,82
Female	2,70
Grand Total	**2,74**



The goal of this second table was to analyse how mathematics appeals to the different genders. Here we are able to determine that the difference between the male and female gender is almost statistically insignificant at around 6%, the other genders were not numerous enough to provide statistically valuable data. The common stereotype that girls, on average, dislike maths with less interest is disproven with this survey.

Language complications

Count of in which language would you like to have mathematics taught at school?	Column Labels			
Row Labels	**Luxembourgish**	**German**	**French**	**Grand Total**
German	1	2	1	4
French	19	27	13	59
Luxembourgish	58	5	14	77
Grand Total	**78**	**34**	**28**	**140**



This graph may be more challenging to decipher, however, it's value cannot be understated. This analysis serves as an extension to previous language questions. The previous questions had already determined that most students preferred that their lesson be taught in Luxembourgish with the support for the official language, French, being extremely low.

Along the horizontal axis, this graph shows the results from question 3 (what language your maths lesson is mostly taught in), then the counts represent the language the students would like their lesson to be held in. This means that, for example the students who said that their lesson is mostly held in Luxembourgish, 14 (18%) of those students said they would rather have it held in French.

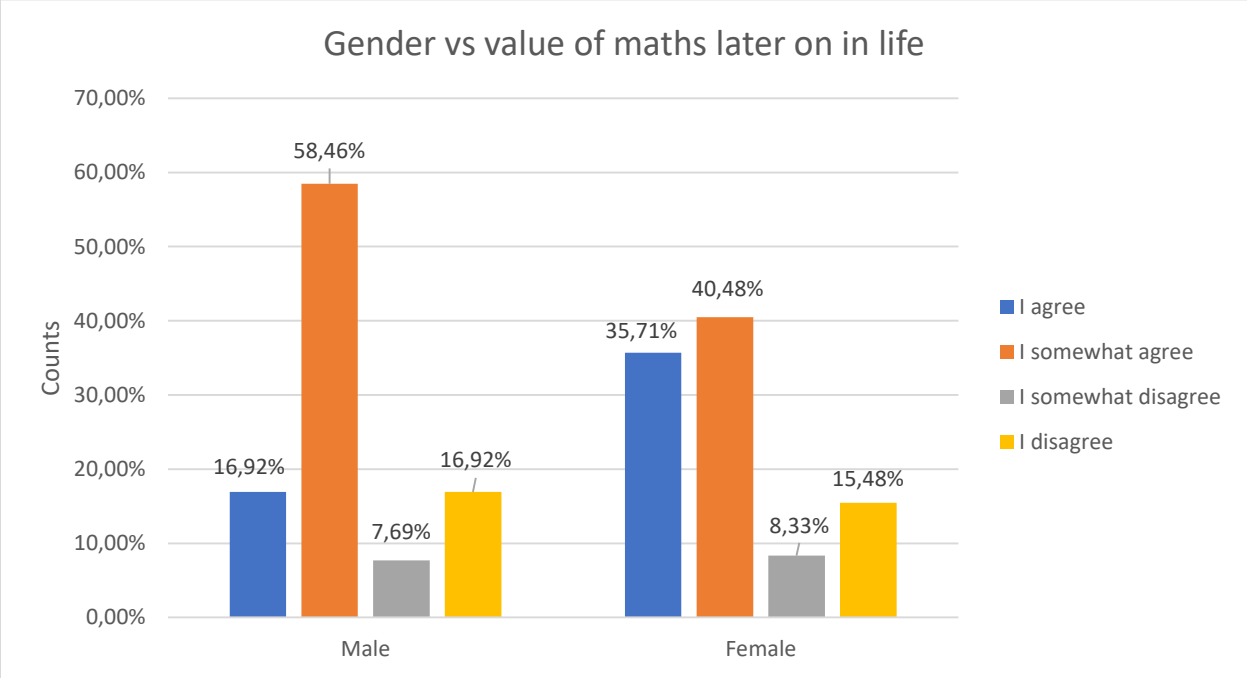
The results are dramatic, the students whose lesson is being held in French, only 22% of those students actually wanted it to be held in French, which is terrible as 78% of students would prefer it to be held in either of the two other languages of German (46%) and Luxembourgish (32%).

Even when the script is flipped the same results shine through. The students whose lesson is being held in Luxembourgish, a massive 75% of those students actually wanted it to be held in Luxembourgish. The percentage of students who would like it to be changed to French is extremely low at 18%.

This clearly shows that the official language of French should be replaced as students overwhelmingly prefer either Luxembourgish or German. A decent amount of student struggles could potentially be solely down to the language of the lesson which is a big shame.

Gender vs career perspectives

Count of I believe that what we learn in maths class is important for later life.	Column Labels				
Row Labels	**I agree**	**I somewhat agree**	**I somewhat disagree**	**I disagree**	**Grand Total**
Other		2			2
Male	11	38	5	11	65
Female	30	34	7	13	84
Grand Total	**41**	**74**	**12**	**24**	**151**



The aim of this graph was to determine if a specific gender valued maths for their career more than another. Sadly, not enough other genders submitted responses in order to provide statistically valuable data. It is immediately clear that the male and female answer counts are similar except for one response.

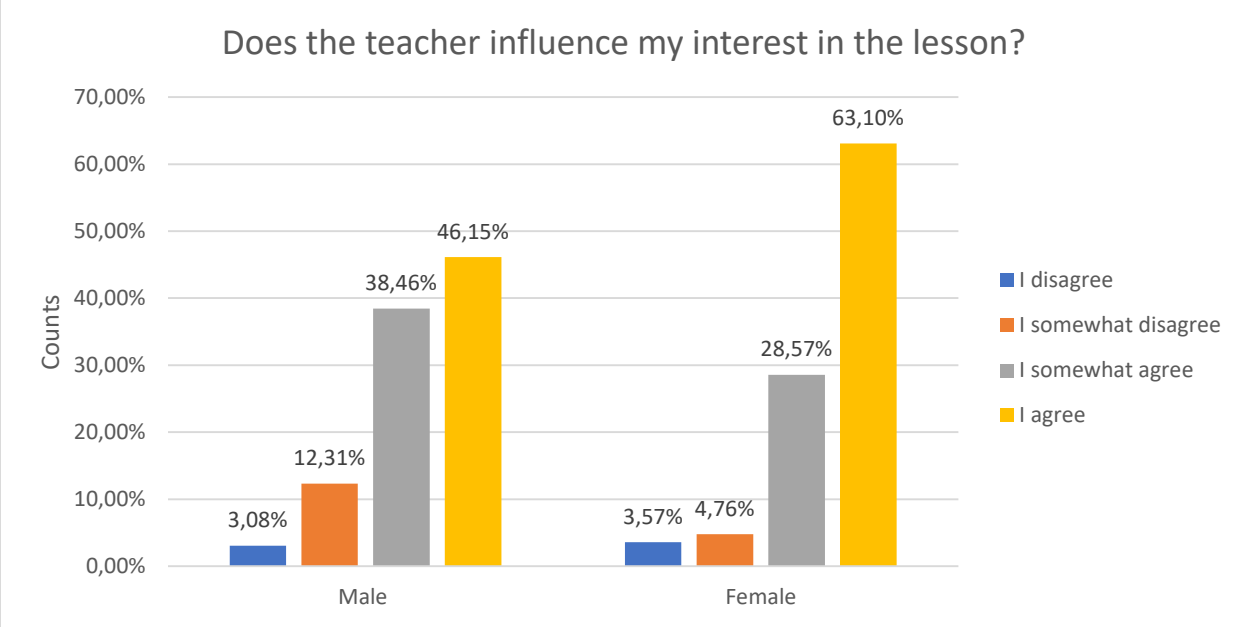
17% of boys fully agreed that the content of their maths lesson was vital for their careers later on, whereas 36% of women, more than double (even after weighting the individual counts) stated the same.

However, these percentages are solely based on the number of respondents who stated that they fully agreed. When taking both “I agree” and “I somewhat agree” into account, the percentages even out with 75% of boys agreeing or somewhat agreeing that maths is valuable for later in life and 76% of girls saying the same. What can still be said is the following:

Girls are far more likely to strongly believe that their maths lesson is valuable for their future careers.

Gender vs teacher influence

Count of the teacher influences my interest in maths lessons.	Column Labels				
Row Labels	I disagree	I somewhat disagree	I somewhat agree	I agree	Grand Total
Other		1	1		2
Male	2	8	25	30	65
Female	3	4	24	53	84
Grand Total	**5**	**13**	**50**	**83**	**151**



The final pivot table and graph surrounds the topic of student and teacher interactions. The aim was to determine if a specific gender believes the teacher notably influences their interest in a lesson more so than another gender. Yet again, not enough other genders submitted responses in order to provide statistically valuable data.

Here, it is clearly noticeable that female students are much more likely to say that their teacher largely influences their interest in the maths lesson. 63% of girls completely agree that the teacher plays an overwhelmingly crucial role in the classroom, whereas 46% of male students say the same.

These results further highlight the gender disparities within a maths classroom. At the beginning of this study, research proved that teachers treat each gender differently and this result is reflected in the following graph where female students are far more likely to be impacted by a teacher. In order to create a so-called perfect mathematics class, equality needs to be the first step which sadly has definitely not been achieved yet.

Summary of the data analysis

The data analysis and conclusions can be summarised and broken down by three main categories:

1. Language

The language of the maths lesson is a crystal-clear area of concern for students, especially in Luxembourg where so many languages are taught at school. In order to achieve optimum comprehension, the lesson needs to be taught in the language that students feel most comfortable in. Through carrying out my survey this language turned out to be Luxembourgish, the most common first language in the country, which may appear obvious. However, the lesson is officially supposed to be taught in French which has not accumulated much support by students. With this genuine data and research, it might be time to begin heading discussions concerning the language of mathematics in schools throughout Luxembourg.

2. Gender disparities

The most predominant genders in Luxembourg, male and female, appear to have slightly different experiences when it comes to school mathematics classes. A vital question that needs to be asked is whether maths teachers are aware of this issue and whether they are willing to accept a certain amount of responsibility for the classroom inequalities. Girls and boys should be treated equally, and the teacher should not influence a certain gender's learning experience more than another. Why is this happening and where does it stem from?

3. Relevance

The last but certainly not the least important issue deals with relevancy, a topic I myself have struggled with as well as many of my fellow classmates. Confusion can arise when learning, especially when a student is not made aware of the pertinence of the subject, furthermore, capitulating is far easier when you are able to say that maths is useless anyway. This is not an unsurmountable problem either, a motivated and passionate teacher should be more than capable of providing real world example of where trigonometry and calculus can be applied. Understanding why you are learning a skill is essential to wanting to learn a skill.

Tapping into the teacher's expertise

When analysing the current state of the maths lesson at school, as well as possible improvements the opinion of the students is valuable. This was collected and analysed through my survey; however, the student's opinion should not be put above all other information as students do not teach the lesson that could potentially be enhanced. When attempting to improve the maths lesson at school, it is essential to seek out the teachers' opinions and thoughts. Teachers have first-hand experience with students and the curriculum, making them well-suited to identify the strengths and weaknesses of the existing lesson plan and suggest ways to improve it.

In order to fully round out my collection of information and opinions, I tackled the specific results from my survey with the maths teachers employed at my school, as well as one teacher who does not teach mathematics and the psychological department of the school (SePAS). Throughout our conversations, I noted down their thoughts and was given permission to summarise them in this chapter. All responses are paraphrased and summarised with their approval.

1. Alain Flammang (maths teacher with 13 years of experience)

On the topic of the language of the lesson:

I believe that the language that the lesson is taught in does not directly influence how well my students understand the contents of my lesson. Whether the exercise is written in French or Luxembourgish students will know how to solve it. Language plays a much bigger role when it comes to the willingness of students to participate in class or ask questions, if they prefer Luxembourgish, they might be less inclined to formulate a question in French and so on. I don't believe the language of the lesson in Luxembourg needs to be changed, however, I do believe a certain amount of flexibility should be given to teachers and students when it comes to discussing mathematics.

On the topic of the gender disparity:

I think it is rather clear to see that the mathematics and physics section is usually dominated by male students. I agree that this could be due to the stereotypes and values of our society.

On the topic of the relevancy and student motivation:

Probably the most difficult part of my job is tailoring the lesson to the needs of each different class and student. It depends on the size of the class, because it's harder to create a more engaging lesson for a larger class, furthermore, the quality of the students and their interests also influence how easy it is to create a lesson plan. I believe it is important for a teacher to avoid teaching the same lesson year after year, a teacher needs to have the courage to completely change the plan if it's needed.

Additionally, it is challenging to provide relevant topics in maths because I already know what students need to be capable of for their final exams. Subjects like algebra are not fun, but it is necessary to cover them. Understanding the practical use of mathematics only begins later on in the last couple of years of secondary education. Here, students start to understand why maths is needed as well as how to use it which is truly exciting for students. Personally, I believe my lesson is of a favourable quality, it is vital for teachers to keep questioning themselves and some things just come with experience.

2. Jerry Kreins (maths teacher with 25 years of experience)

On the topic of the language of the lesson:

Yes, absolutely the language of the lesson poses a problem to how well students understand what is being taught in the lesson. It is a difficult problem and one quite unique to Luxembourg because of the high number of mother tongues of Luxembourgish students. I believe it is not good to teach the maths lesson in French over here and that is why I don't personally do it. Teaching the subject in the student's third or fourth language adds another dimension of difficulty as students have to decipher the language barrier before they can start understanding the actual maths behind the subject. I like to compare it to an old computer, where as soon as you start opening multiple applications, the computer's fans start to kick in because too many things are going on at once. I would prefer for teachers to have more freedom in choosing the language in which they teach their maths lesson, especially because my lessons are filled with a lot of Luxembourgish students. Although it would be difficult to completely change the language of the lesson to Luxembourgish, simply because the Luxembourgish language does not have the necessary vocabulary to be able to describe mathematic objects and operations. Either way a teacher would need to borrow word from French or German.

On the topic of the gender disparity:

It is undeniable that we still sometimes lose the battle against gender-based stereotypes - even though we keep trying to neutralize these. We are not able to completely shake off society's traditional values, which is reflected in today's classroom, for example when considering the gender ratio in the enrolment figures for various fields and disciplines.

On the topic of the relevancy:

There are a couple of concrete examples of maths being used for real world situations such as the physics lesson and optimisation problems where maths is used frequently. The issue is that it is sometimes unhelpful to create a maths problem for the sake creating a problem. Many examples may be real world uses but they are not realistic. For example: A hotel has 50 rooms and 75 beds, how many one-bed rooms are there and how many two-bed rooms are there? This problem could be solved by using equation systems with 2 variables. But in the real world no one would write equations down to answer this question. Maths is not just taught to be used in real world situations, because it also teaches important skills such as abstract and logical thinking, identifying patterns and structures.

3. Tom Goedert (maths teacher with 14 years of experience)

On the topic of the language of the lesson:

Well, French is the vehicular language of the lesson (a language used as a means of communication between people with different mother tongues) which has both advantages and disadvantages. French is advantageous because it has the precise vocabulary, particularly for algebra, which helps the lesson be more understandable because some things just work better in French. However, it is still clear that learning maths in French is difficult for students who have difficulties with the language. In general, Luxembourgish students tend to dislike the language as a few are even scared of it which may impact their participation in class.

It is difficult to say whether the language should be changed, although it may be difficult at the start, students do get to grips with French after a while. The language should be adapted to the needs of each specific class; however, it is important to maintain one (1) language throughout.

On the topic of the gender disparity:

It is a tough question, especially because university classes in maths appear to consist of almost 50% men and 50% women, but in applied maths courses like engineering, IT (...) and physics as well, this disparity is much, much greater. I don't know why we have this issue or what specifically caused it. I believe it is surely a social problem rather than a biological one. A possible cause could be children's toys and the way they are marketed to specific genders, even though we have been trying to solve this problem I think it might be getting worse. Another valuable point is that boys are more likely to be taught to react with courage and confidence in unknown situations, while girls are more likely to be "protected" in such situations. This has an effect on the "problem solving skills" that are more prevalent in mathematics classes than in other subjects. From an early age, the girls witness the boys reacting more "courageously" in such teaching situations and are thus influenced in their self-assessment.

On the topic of the relevancy and student motivation:

The toughest challenge for a maths teacher, is trying to teach maths to struggling students and classes, this includes students with much bigger problems at home for example. To make the lesson more engaging, a teacher should make sure there are rhythm changes throughout the lesson. Another useful tool is to incorporate students into the lesson and give them more control to work on the lesson and alongside the teacher. Finally, I believe authenticity is needed on the teacher's behalf; there is nothing worse than saying 'The result is like that because I studied maths'.

4. Service psycho-social et d'accompagnement scolaires (SePAS)

On the topic of the language of the lesson:

Personally, I think that the fact that for many pupils, education in Luxembourg does not take place in their mother tongue does have a negative impact on performance. An explanation in the mother tongue is of course more comprehensible than via a learned foreign language - for everyone and also in every subject.

At the same time, the Luxembourg school system and education are distinguished precisely because of their multilingualism.

On the topic of the gender disparity:

Stereotypes regarding school subjects certainly play a role. Generally, male students are said to be better at science. Research that has examined different types of schools (same-sex classes versus mixed classes) has found that girls perform better in science (maths) when they are taught in classes among themselves. Part of the explanation lies in the social construction that boys are better at science than girls.

Career choice and further education play a similar role: gender differences in career choice are also a social construct. Thus, women are more likely to take up a "social" profession and men a "technical" one, which certainly partly explains the distribution in the different sections.

5. Paule Kremer (English teacher with 10 years of experience)

On the topic of the language of the lesson:

I think it's most subjects are easier when they are taught in the student's mother tongue. With the official language of the maths lesson being in French, it then makes it difficult for students who have a better understanding of Luxembourgish. A possible reason for the education ministry to have chosen French as the main language of the maths lesson could be due to the fact that it is the official administration language of the nation; besides, several other subjects are taught in French. I would probably start maths education in Luxembourgish in the first couple of years to favour student comprehension, before switching to French later on.

On the topic of the gender disparity:

Several factors play an important role here. To begin with, the upbringing of children strongly influences their career decisions later on in life. With toys being so strongly gendered along with their perceived social roles, girls may find it difficult or unusual to prioritise maths topics. With the lack of idols doing similar things, girls are also much less exposed to these types of profession; the same goes for boys in literature orientated sections who represent a clear minority.

It shouldn’t be like that and it’s certainly more than just a school issue. With maths teachers being predominantly male and possibly treating the two main genders differently, an additional concern is that girls tend to want/need a positive relation to their teacher, certainly much more than boys in my opinion.

Similarities and differences of opinion

The three teachers, Alain Flammang, Jerry Kreins, and Tom Goedert share similar views on the relevance of mathematics education. They all agree that mathematics provides important skills such as abstract and logical thinking, pattern recognition, and problem-solving. They also recognize that creating engaging lessons for students is challenging and that teachers need to adapt to the needs of each class and student.

However, the teachers hold different opinions regarding the language of the lesson. While Alain Flammang believes that the language used does not significantly impact students' understanding, Jerry Kreins thinks that teaching in the students' third or fourth language adds an extra level of difficulty. Tom Goedert believes that French has advantages and disadvantages as the vehicular language of instruction in mathematics, and the language should be adapted to the needs of each specific class.

Regarding the gender disparity in mathematics, Alain Flammang acknowledges that the field is usually dominated by male students, and this might be due to societal stereotypes and values. Whereas Tom Goedert mentioned the vital aspect of the gender-based marketing of toys that starts at a very young age. Paule Kremer, the only female teacher, was able to provide many more concrete causes and examples of gender-based issues at school and outside of it, which shows the importance of talking to a wide variety of teachers when debating this issue.

The psychological department's thoughts on the language of the lesson align with Paule Kremer's opinion that education in a student's mother tongue is more comprehensible. However, they also acknowledge that multilingualism is an important aspect of the Luxembourg school system.

On the topic of gender disparity, the psychological department agrees with the idea that stereotypes play a role in the distribution of genders in different sections and career choices. They also bring up research on the benefits of same-sex classes for girls in science and math, which is a different perspective not previously mentioned.

Overall, this cooperative and data confrontational interview process has proven to be invaluable, as it has allowed for teacher specific thoughts to be uncovered and presented. It is clear that teachers are aware of the main issues (with them mostly agreeing) that students complain about, furthermore, they are willing to share their opinion on potential causes and reasons. The disappointing aspect has been the clear lack of solutions, which are ultimately unclear. The best course of action for the future is yet to be determined, although the first step to solving a problem, consists of acknowledging its existence.

Why are you not looking forward to your next maths lesson?

After extensive research, discussions with numerous students and teachers it is clear that there is no single solution that will revolutionise the mathematics lesson at school. The problem does not start at school, but well before that with certain values anchored in our society. The survey conducted with over 150 students from the same school allowed me to narrow down and determine several core issues with the maths lesson here in Luxembourg, as well as internationally. The students were motivated to share their point of view and offer their own possible solutions or wishes for the future. The teachers helped me see the lesson from a completely different point of view, as they gave me their thinking. Despite there not being a clearly outlined solution, several future paths could be and should be explored by teachers as well as the education ministry of Luxembourg.

Why are you not looking forward to your next maths lesson?

It could be due to the language barrier present in the lesson, as maths is usually taught in a language inconsistent with the mother tongue of most students. This French language is unwelcomed by the majority of students; teachers agree and believe it could be adding another unnecessary degree of difficulty to the lesson. The language barrier needs to be addressed; the language should be reconsidered. This could include giving teachers more freedom in offering the lesson in the most commonly spoken language of the class. At a bare minimum, students who struggle with the language of instruction should be given additional language support. A student should never be marked down purely because of language difficulties.

Why are you not looking forward to your next maths lesson?

Your disinterest might be caused by unfavourable treatment by your teachers. You could be treated differently because of your gender or simply due to an inferior teacher. Female students stated that the teacher influenced their lesson more than boys did at this school. “Hire teachers who not only really know maths, but who can also teach it to you.” Was often voiced by students. It is clear that schools need to promote a culture of inclusivity and respect to ensure that all students feel comfortable, as well as value teacher training and teacher competency to avoid preferential treatment of certain students.

Why are you not looking forward to your next maths lesson?

Further lack of interest may simply be due to the learning environment and relevance of the lesson. Why would you be interested in learning something that seems detached from reality and dull? True interest can be achieved when the material is interactive, when students participate and when students understand and believe in what they are learning.

It is essential to remember that the maths lesson is not fundamentally flawed and that many students really enjoy maths (myself included), however, I believe that the joy of maths can reach a larger audience of interested individuals. My aim with this study was to encourage rather than discourage students from studying maths. Mathematics is brilliant and enlightening subject which offers many dynamic career paths and life skills. I hope that minor changes could be introduced that have the ability to truly improve a standard class of mathematics here in Luxembourg.

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