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The relevance and application of mathematics in the equine industry

A study with the purpose to increase students' motivation for mathematics on equestrian upper secondary schools.

Master's thesis in learning and leading.

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Abstract

The study investigates how a selection of professionals in the equine industry perceive the subject of mathematics, conducted through conversational interviews. Additionally, the study examines students attending equestrian upper secondary schools' thoughts on the subject of mathematics through a survey. Both the professionals and the students hold very similar views on the subject.

The primary aim of the study is to increase understanding of how mathematics is relevant for functioning as an individual in society and in one's professional life, specifically within the equine industry. A secondary aim is to explore how mathematics is utilized in various actors' work within the equine industry and then compare this with the curriculum of mathematics 1a studied at equestrian upper secondary schools.

In conclusion, the findings highlight a shift in perception regarding the practical relevance of mathematics within the equine industry among both professionals and students. The integration of real-world examples and applications has demonstrated the utility of mathematics in various aspects of the industry, fostering a greater appreciation for the subject. However, there remain discrepancies between the perceived importance of certain mathematical concepts and their practical applications, suggesting a need for further education and clarification. Additionally, the study raises questions about the effectiveness of mathematics education in equestrian upper secondary schools and its alignment with industry needs. Addressing these gaps and challenges through targeted educational strategies could lead to a more mathematically competent and engaged workforce, better equipped to meet the demands of the equine industry.

Contents

1 Introduction

During my time as a mathematics teacher at an equestrian upper secondary school, I observed that many students perceived mathematics as unnecessary, particularly those intending to pursue careers exclusively within the equine industry. This sentiment reflected in their lack of engagement and prior knowledge in mathematics. To address this issue, I aspired to illustrate the practical applications of mathematics in my own experiences as a horse owner. While this approach seemed to help improve student motivation, I believe there's potential to deepen their understanding of the relevance of mathematics and further enhance their motivation to study the subject.

As a result, I intend to delve into the utilization of mathematics within the equine industry through a dual approach: conducting interviews with industry professionals and administering surveys to students at equestrian upper secondary schools. These interviews will provide invaluable insights from practitioners regarding the tangible applications of mathematics within horse-related professions. By gathering firsthand accounts and diverse perspectives, my study aims to illuminate specific instances where mathematical concepts are integral to various facets of equestrian careers. This qualitative data will enrich our comprehension of the significance of mathematics in the context of equestrian vocations, ultimately fostering greater student engagement with the subject.

Furthermore, insights gleaned from student responses will offer a deeper understanding of their perceptions and attitudes towards mathematics. This information will not only enrich my research findings but also provide valuable insights into strategies for motivating students to engage more actively with the subject.

In conclusion, this research endeavour holds promise for bridging the gap between mathematics education and the equestrian industry. By elucidating the practical relevance of mathematics in horse-related professions and exploring strategies to enhance student motivation, this study aims to contribute meaningfully to both fields.

1.1 Background

Mathematics teachers on vocational programs need to be familiar with the vocational program's orientation to adapt the mathematics teaching to the students' vocational orientation and thereby make it more meaningful and relevant for the students (Muhrman & Lundberg, Lärportalen Skolverket, 2015). By connecting mathematics to the professional subject, students can see how mathematics can be used in their future profession and thus increase the motivation to learn the subject (Skolverket, 2015). According to the Swedish National Agency for Education, mathematics teaching in vocational programs must function as a tool for students in their vocational education. This means that mathematics teachers on vocational programs need to have knowledge of how mathematics can be used in the students' future profession and how it can be connected to the vocational subject (Muhrman & Lundberg, 2015).

According to an inspection conducted by the School Inspectorate in 2017 (Lanteli, 2017), there was a lack of interaction between the vocational subjects and the general upper secondary school subjects in the vast majority of the schools they examined. The

students simply did not get an overall perspective of their education, which is crucial for fostering intrinsic motivation. It is beneficial for students to recognize the connection between professional life and school assignments (Skolverket, 2015).

During a conversation with a former student, during the search for interviewees, an observation was: according to her, only one student from her class currently works in the equine industry, while the rest have pursued further studies or changed careers entirely. This raises questions about the relevance of a vocational upper secondary school focused on equestrian studies. Do students end up in the careers they train for? Are they not employable after graduation, or are there other factors at play? Muhrman's thesis highlights a deficiency in mathematics skills among graduates of natural farming programs with a focus on agriculture when they enter the workforce (Muhrman, 2016). Could a similar gap exist in the equine industry? If students from equestrian vocational schools do not enter the equine industry, then who does? What educational background do they have, and what career paths led them there? It is questions like these that underscore the relevance and significance of this study to me.

1.2 Purpose

The main purpose of the study is to increase the understanding of how mathematics is relevant to function as a human being in one's professional life, then specified to the equine industry. A second purpose is to investigate how mathematics has been used in the work of different actors in the equine industry and then be able to compare this with the syllabi in Mathematics 1a course that are studied at the equestrian upper secondary school. The purpose of this knowledge is to be able to create relevant tasks for the students in my future professional role as a mathematics teacher at an equestrian upper secondary school.

1.3 Limitations

There are already some comprehensive studies on the relevance of mathematics in vocational programs, including a thesis focusing on agricultural orientation (Muhrman, 2016). Therefore, this study will exclusively focus on horse-related professions and the relevant mathematical knowledge for students in agricultural programs with specializations in horse management or riding, for their future careers.

Interviews will only be conducted with individuals who are fully employed in the equine industry and located in southwestern Sweden. The survey will only be distributed to students from three different equestrian upper secondary schools in southwestern Sweden.

This report will only address some of the most common professions in the industry: farrier, veterinarian, riding instructor, horse trainer, course designer, and equestrian facility manager.

2 Theory

The literature that is used for this report primarily consists of other reports, research papers, theses, student literature and articles shown in the reference list. The theory is divided into three main sections with the following headings: 'Equine Industry in Society', providing background information on its current state; 'The Importance of Studying Mathematics', presenting various arguments for the relevance of mathematics; and 'Motivation, Learning Theories and Teaching Methods', discussing ways to increase motivation, and exploring common teaching practices.

2.1 Equine Industry in Society

The equine industry is defined by the Swedish National Equestrian Foundation (HNS) as "*all activities based on the use of horses, including both hobbies and professional activities, as well as the turnover of horse-related goods and services*" (Heldt, Macuchova, Alnyme, & Andersson, 2018).

According to the Swedish Board of Agriculture, there were 355,500 horses registered in Sweden in 2016 (Jordbruksverket, 2017). The equine industry directly generates just over 31 billion SEK per year and creates approximately 17,000 full-time jobs (Heldt, Macuchova, Alnyme, & Andersson, 2018). This makes the equine industry relevant to Sweden's GDP and its residents' employment. There are various professions within the equine industry (Hästnäringens yrkesnämnd, 2024). Some of the most common professions in the industry are farrier, veterinarian, riding instructor, horse trainer, course designer, and equestrian facility manager. The significance of the equine industry extends beyond its economic contributions. Understanding the essential care and services involved is crucial for both the welfare of horses and the industry's sustainability.

The horse's hooves constitute a fundamental part of its physical health and performance, as emphasized by the well-known saying "No hoof, no horse" (Börs, 2020). As a responsible horse owner, it is paramount to ensure regular care of the horse's hooves by engaging a qualified farrier. The horse's hooves grow much like human nails, requiring regular maintenance to ensure optimal conditions for the horse's movement and health. A common practice is to shoe the hooves every 6 to 8 weeks to maintain their functional status and prevent injuries (Hovslagarföreningen, 2024). Farriers are therefore an extremely important profession for the equestrian industry to function properly.

A crucial aspect of horse management involves the process of breaking in and training horses to function as riding horses. Horse trainers specialize in working with breaking in and basic training of horses. According to the Swedish Equestrian Federation (Svenska ridsportförbundet, 2024), horse trainers oversee training across various disciplines, from basic to moderately challenging levels. They also handle recruitment, competition participation, marketing, and sales of horses, alongside ensuring their well-being and managing facilities and equipment. Being exemplary in both riding skills and horse management practices is central to their role, and certification requires passing a professional test.

An individual who instructs another individual in the art of riding is referred to as a riding instructor. In Sweden, there are specialized riding schools where riding

instructors work. These riding schools contribute to public health by offering approximately 5 million hours of riding annually (Svenska ridsportförbundet, 2024). In addition to riding instructors, there are specialized trainers for various disciplines such as show jumping, dressage, cross-country, and so forth, who coach private equipage. However, in this report, all these different types of instructors are referred to as riding instructors, except for Vertical Balanced Riding (VBR) trainers, as their approach differs slightly. VBR focuses on harmonizing the triad of rider, saddle, and horse to ensure symmetry and collaboration between these parts, enabling balanced riding with minimal effort and force (Jonsson, 2024). The principles behind VBR are based on the latest research in rider and horse biomechanics. At the country's 450 riding schools (Svenska ridsportförbundet, 2024), in addition to the riding instructors, there are also equestrian facility managers who handle the organizational aspects regarding finances, facilities, staff, and horses.

In Sweden, the primary discipline within equestrian sports is show jumping (Svenska ridsportförbundet, 2024). Show jumping requires trained course designers to construct suitable competition courses. While certified course designers also exist in other disciplines such as cross-country jumping, carriage driving, and Working Equitation (Svenska ridsportförbundet, 2024), this study specifically refers to course designers involved in horse show jumping.

2.2 The Importance of Studying Mathematics

Schools play a crucial role in shaping society's citizens and preparing them for future life in the community (Jarl & Rönnberg, 2015). By establishing goals and qualities for teaching in curricula and syllabi, political and social values and priorities are reflected. The overarching task of schools is to ensure that students acquire the knowledge and skills demanded by society and that they are equipped to become active and engaged citizens in society (ibid).

During the 19th century, the role and significance of mathematics underwent significant changes, especially with the emergence of industrialization. From being knowledge reserved for a small elite, mathematics became an indispensable part of industrial development and progress (Niss, 1996). It was emphasized that knowledge of mathematics was necessary for the functioning and survival of society in various industrial sectors. Today, mathematics is considered so essential that it is one of the three compulsory core subjects.

Historically, the arguments for studying mathematics have been numerous and multifaceted. It has been argued that mathematics is seen as a means to train and develop thinking skills and increase intellectual capacity. Additionally, that studying mathematics makes an individual a more socially useful and responsible citizen and prepares them for higher education and professional life (Niss, 1996). Traditionally, success in mathematics has required discipline, accuracy, and reflection, qualities considered equivalent to good study skills.

According to the Swedish National Agency for Education's curriculum for upper secondary school (Lgy-22), the purpose of mathematics education is to develop students' ability to work mathematically (Skolverket, 2022). This means understanding mathematical concepts and methods, developing strategies to solve mathematical problems, and applying mathematics in various societal and vocational situations. The

teaching also aims to challenge and deepen students' creativity and mathematical knowledge and demonstrate the relevance and importance of mathematics for the individual and society as a whole (Skolverket, 2022).

The universality of mathematics and its necessity for broad societal contexts is undeniable. The basic mastery of mathematics is not only crucial for individuals striving for careers in mathematics-intensive areas, but it also constitutes a cornerstone for society's democratic and economic welfare (Andersson, Lundh, & Jäntti, 2013). Although it is possible to function well in everyday life with a basic understanding of the four arithmetic operations, it is through a deeper mastery of mathematical concepts that individuals can actively participate in societal development and make well-founded decisions about their personal finances. Thus, it can be argued that a broad and deep understanding of mathematics is a prerequisite for a well-functioning democratic society (ibid).

The Swedish government also emphasizes the importance of the population learning mathematics for the socio-economic benefit with this quote (SOU 2004:97):

"A basic ability to use mathematics for personal finance reduces the risk of problems with credits, debt collection agencies, and social authorities."

Mathematical principles constitute a fundamental part of modern technology, present in everything from mobile phones and cars to oil tankers. The structure of the internet is built on mathematics, while statistical methods and mathematical models improve production processes in the food industry and enable more efficient manufacturing and distribution of goods within the industry. These mathematical tools are central to understanding and regulating economic and societal processes. Furthermore, new research in mathematics and statistics contributes to advancements in chemistry and physics and is crucial for a deeper understanding of modern biology and climate science (Björner, Engelmark Cederborg, Håstad, & Rootzén, 2010).

2.3 Motivation, Learning Theories and Teaching Methods

Creating a conducive learning environment where students are motivated to engage and achieve their goals is a central task for all educators. To understand how to best support students' learning and motivation, it is important to explore various motivational theories, learning theories, and memory strategies.

2.3.1 Motivation

When examining motivation and learning, Maslow's hierarchy of needs is often a central starting point, see *figure 1*. According to this theory, an individual needs to have their basic needs met in order to focus on learning and achieve motivation (Maslow, 1943). These basic needs include physiological needs such as food and sleep, as well as safety needs such as security and stability. Once these needs are fulfilled, a person can direct their attention towards more complex needs, such as belongingness and social relationships, which constitute the next step in the hierarchy. Only when these basic needs are satisfied can the individual aspire towards self-actualization, where they strive to realize their full potential and achieve personal growth and development. Understanding this hierarchy in *figure 1* is important for creating environments and situations that support learning and motivation in individuals. This theory highlights the importance of creating safety and support in the classroom environment to promote students' learning and motivation.

Figure 1 - Illustration of Maslow's hierarchy of needs

A fundamental distinction within motivation theories is the division between intrinsic and extrinsic motivation. Intrinsic motivation arises when individuals engage in activities for their own interest or satisfaction, while extrinsic motivation involves external rewards or incentives. Self-Determination Theory (SDT), a theory that has had significant influence in the field, emphasizes the importance of three main factors in promoting motivation and well-being: autonomy, competence, and relatedness (Deci & Ryan, 2000). By providing students with opportunities for autonomy and supporting their sense of competence and relatedness, educators can increase students' motivation and engagement in the learning process. According to Deci & Ryan (2000), individuals are more motivated and thrive better when their internal psychological needs for these three factors are satisfied, compared to a situation where only external influences and rewards are present.

Utility value is another concept often associated with motivation and learning. It refers to the perceived usefulness or relevance of an activity or knowledge for the individual. By communicating the practical value of learning goals and linking them to students' interests and future goals, educators can increase students' motivation and engagement in learning (Dahlkwist, 2019).

Motivation is closely associated with joy in learning and can be seen as the engine that drives the learning process forward, a force that ignites a desire to learn more. However, it is important to problematize both positive and negative emotions in relation to motivation, as both can have different effects on the student's active participation in learning (Cronqvist, 2021).

2.3.2 Learning Methods

When it comes to effective learning methods, various learning theories guide educators. Behaviourism focuses on shaping behaviours through different stimuli, while cognitivism emphasizes the importance of mental processes such as memory and creating intellectual connections. On the other hand, constructivism highlights that students actively construct their own understanding through interaction with their surrounding environment and past experiences (Phillips & Soltis, 2014).

To enhance memory and promote long-term learning, educators can apply principles from memory research, such as Bjork's Principle of Spacing (Bjork, 2024). By planning repetitions and reviews, students can improve their long-term memory and retain information more effectively.

2.3.3 Teaching Methods

By integrating insights from motivation theories, learning theories, and memory strategies, educators can create a dynamic and engaging learning environment where students feel motivated, involved, and ready to reach their full potential. Understanding students' backgrounds, prior knowledge, and life experiences is crucial for creating meaningful and engaging instruction. Pedagogical content knowledge involves adapting subject matter to make it interesting and relevant to students (Shulman, 1986).

Making learning relevant to students enhances their motivation and engagement. According to the curriculum (Lgy11), it is important for teachers to organize and conduct lessons in a way that makes the knowledge meaningful to students and provides opportunities for overview and coherence, as well as interdisciplinary work (Skolverket, 2024). Teachers are also encouraged to leverage students' experiences and knowledge from work and society in their teaching.

These guidelines underscore the importance of a varied teaching approach that combines different lesson formats to promote students' learning and understanding of mathematics. By integrating both traditional and interactive methods, teachers can create a stimulating learning environment that suits different students' needs and learning styles.

To create a dynamic and engaging learning environment, educators can integrate various learning strategies and methods. Differentiated instruction, where teaching is tailored to students' individual needs and interests, can enhance motivation and learning for all students. Active learning, such as problem-based learning and collaborative learning, encourages students' active participation and engagement in the learning process.

In today's school education, it is increasingly important to integrate real tasks and practical experiences to increase students' engagement and motivation (Boberg & Sterlinger Ahlring, 2023). By leaving the physical classroom and exploring the surrounding reality, students gain a holistic view of the subject, which increases their sense of coherence and meaningfulness in learning. To create a more meaningful and engaging learning environment, it is crucial to demonstrate the connection between what is taught and its relevance to students' current and future lives. By integrating practical experiences and real-world recipients into teaching, teachers can create a more meaningful and engaging learning environment for students (ibid).

A central insight from Hattie's research is that teachers have a significant impact on students' outcomes (Hattie, 2013). Hattie emphasizes the importance of having high expectations for students, providing constructive feedback, and using various teaching methods to engage them. He also introduced the concept of "effect size" to measure the effect of different teaching methods and interventions. According to Hattie's research, methods with high effect sizes, such as formative assessment and clear feedback, have a significantly positive impact on students' learning. In summary, Hattie's research highlights the importance of being aware of which teaching methods are most effective and continuously working to improve teaching to maximize students' learning and achievement (ibid).

Making learning meaningful, relevant, and engaging for students is of utmost importance. By creating a dynamic and supportive learning environment where motivation and interest in learning are encouraged and supported, teachers can contribute to promoting students' learning and development effectively.

3 Method

The study employs a mixed methods approach to gain a comprehensive understanding of the phenomenon within the equine industry. By combining qualitative and quantitative methods, a deeper understanding and complementary perspectives on the research questions are facilitated.

The following presents how the selection of interviewees and survey participants was made, along with the methods used for data collection and the procedure. Finally, the applied analytical method is presented.

3.1 Questionary

The questionnaire aims to gain insight into professionals' perceptions of the role of mathematics in their respective equine industry professions. By gathering insights from professionals, the study aims to guide the integration of Mathematics 1a course content with the practical mathematics used in the equine industry. The research questionnaire is divided into two questions clarified in the list below:

- How do professionals in the equine industry perceive the role of mathematics in their respective professions?
- How can the central parts of the Mathematics 1a course content be integrated with the mathematics used in the equine industry?

3.2 Selection

Informants have been chosen based on what kind of contact network I have as an interviewer of people in the equine industry. After that, additional informants will be selected according to a snowball selection, meaning that those who have already been interviewed direct me on to more interesting sources (Esaiasson, Gilljam, Oscarsson, Towns, & Wängnerud, 2017).

The selection of participants for the qualitative interviews was based on purposive sampling to include individuals with various roles within the equine industry. In total, eighteen individuals were interviewed. Only one man was interviewed as the men seem reluctant to participate in interviews, and there are also fewer men available to approach for interviews.

The study has interviewed two veterinarians, one female who works independently but collaborates to some extent with a school, and one male who owns his own veterinary clinic with about a dozen employees. While this clinic caters to all animals, the interviewed veterinarian primarily treats horses. Furthermore, three farriers have been interviewed, all of whom are female entrepreneurs. Interviews have also been conducted with two course designers, and since course designing is not a full-time profession, these two individuals also have other activities within the equine industry. One of them operates her own equestrian shop, is a C-level jumping coach, and breeds horses, while the other runs her own riding school and is a trained equestrian specialist. Three different stable managers from various riding schools have been interviewed, all of whom are essentially riding instructors and still conduct lessons. Two other riding instructors and a B-level eventing coach have also been interviewed; the riding

instructors and the coach are classified under the same category: riding instructors. Additionally, two VBR trainers have been interviewed, one of whom also operates her own boarding stable, and the other also works as an equine physiotherapist. Finally, three horse trainers have been interviewed; all of them breed and train young horses, offer training for horses, and compete with them. For more information about the interviewees, see *Appendix 4*.

The survey includes eleven questions about what the students think of mathematics and their future profession, see *Appendix 3*. It was distributed to students at three different equestrian upper secondary schools, chosen because of their proximity in southwest Sweden. The response rate was 87%. A total of 62 students received the survey, and 54 responded. Among the respondents, there were 26 third-year students, 12 second-year students, and 16 first-year students.

Since the selection of participants was limited to a specific number of individuals within the equine industry and students at equestrian upper secondary schools, the results should be interpreted with this limitation in mind. The lack of representativeness may affect the generalizability of the findings. The research was conducted in accordance with ethical principles, including ensuring anonymity for participants and obtaining consent to participate in the study.

3.3 Data collection methods

Data collection involved both conversational interviews and surveys to gain a broader understanding of the subject. Conversational interviews were conducted with open-ended questions to allow participants to reflect freely and express their thoughts and experiences in a complex manner, see *Appendix 2*. Short answer questions were also used to capture specific aspects of participants' views and preferences in a more quantifiable way.

Since the study aims to qualitatively explore how mathematics is utilized by various professionals, semi-structured interviews were used (Jacobsson & Skansholm, 2019). This approach provides flexibility in questioning, as interviewers can draw from a predetermined list of themes while also posing spontaneous questions based on the interviewee's responses. Semi-structured interviews provide the opportunity to delve deeper into interesting topics and elicit richer and more nuanced insights from the participants (Björkman, 2023).

Surveys were sent out to students to investigate their motivation for the subject of mathematics and their expectations for how it will be applied in their future careers within the equine industry. The survey had mostly short answer questions.

Data collection tools included recording equipment for interviews and web-based survey tools for the questionnaire. The results of both the interviews and surveys were analysed to gain a comprehensive understanding of how mathematics is perceived and used within the equine industry.

3.4 Procedure

Informants were briefed on the purpose of the interviews and that they would be recorded. The computer's recording function was used during the interviews. When the

transcription and the work were completed, the audio files were deleted to protect the personal integrity of the informants. The informants have been given aliases for their anonymity.

Initially, interviews were conducted at the workplace of each interviewee in a secluded setting. However, scheduling proved challenging, prompting a shift to conducting interviews over the phone. This approach facilitated greater flexibility for interviewees, allowing them to participate during mundane tasks such as mucking out or harrowing the riding arena.

Following the completion of all interviews, findings have been transcribed in writing. Transcriptions will aim to capture the entirety of each interview, with subsequent editing to ensure a coherent presentation of responses while preserving essential content. The text has then been refined into written language to enhance readability (Ahrne & Eriksson-Zetterquist, 2015).

The survey was conducted using Google Forms and distributed to three different mathematics teachers working at three different equestrian upper secondary schools. Subsequently, the teachers administered the survey to their students at appropriate times.

3.5 Analysis methods

Analysis of the data was conducted using both qualitative and quantitative methods to create a comprehensive understanding of the subject. The qualitative analysis involved thematic analysis of data from the interviews. The purpose of thematic analysis was to identify patterns and themes in participants' responses to capture the wide diversity of experiences and opinions.

The results of the thematic analysis revealed several overarching themes that permeated the participants' narratives. These themes included a range of mathematical concepts that can be linked to the central content of the Mathematics 1a course. By grouping participants' responses within these themes, a deep understanding of the subject's complexity and participants' perspectives was achieved.

While the qualitative analysis focused on exploring participants' narratives and experiences, quantitative methods were used to analyse data from the survey. Statistical methods were applied to generate quantitative results and statistical measures that quantified various aspects of participants' responses.

The results of the quantitative analysis of the survey complemented the in-depth understanding gained through the qualitative analysis of the interviews. By applying different statistical techniques, quantification, and comparison of various aspects of participants' responses were facilitated, providing additional insights and perspectives on the subject.

In summary, the combination of qualitative and quantitative methods for data analysis enabled a comprehensive and multifaceted understanding of the subject. By integrating different methods, the complexity of the subject from various perspectives could be illuminated, generating rich and nuanced results that contributed to answering the research questions and achieving the study's purpose.

4 Results

The following section presents the findings of the study, organized into two main components: the outcomes derived from interviews conducted with professionals within the equine industry, and the results obtained from surveys administered to students in equestrian upper secondary schools.

The results from the interviews with industry professionals provide valuable insights into the practical applications and perceptions of mathematics across diverse occupational roles within the equestrian sector. These findings elucidate the real-world utility of mathematical concepts and illuminate the perspectives of participants regarding the subject.

Conversely, the survey findings from students attending equestrian upper secondary schools offer insights into their attitudes towards mathematics and their expectations regarding its relevance to their future careers within the equine industry. These results provide valuable perspectives on students' motivations, experiences, and perceptions regarding the role of mathematics in their professional aspirations.

By combining the results from these two parts of the study, a more comprehensive picture of the role and significance of mathematics both within the equine industry as a profession and in the education of future professionals within the industry is provided.

4.1 Mathematics relevant for professionals in the equine industry

Here, the interview responses are presented based on the mathematical concepts selected from the Mathematics 1a course. These concepts include scale, vectors, symmetries, percentages, the four arithmetic operations, estimations and rounding rules, budget calculations, equation solving, linear and exponential functions, the Pythagorean theorem, index measures, unit conversions and changes, probability, and statistics.

To become an equestrian facility manager, it seems beneficial to at least have an appreciation for mathematics. As an equestrian facility manager, mathematics is extensively used on a daily basis, for example, in budgeting. Statistics on the previous year's budget, how many lessons the horses have given, and the cost of hay, among other things, are taken into account.

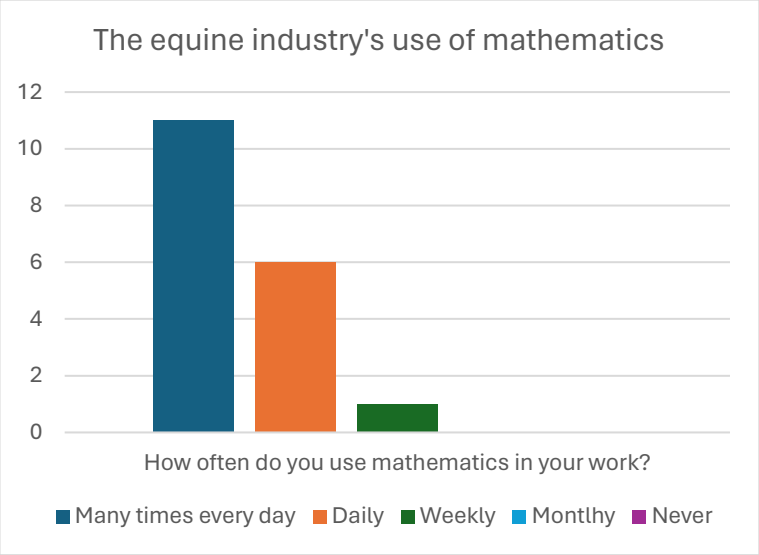

Figure 2 - Diagram illustrating how often the interviewees use mathematics in their profession.

According to the interviewees, mathematics is something they use daily and is an important tool in their professional lives, see *figure 2*.

"Mathematics is crucial in my profession as a veterinarian. I need to be able to handle company finances, calculate medicine doses, and make budgets. It is a cornerstone in all professions and life in general. Students should understand that it is indispensable and that lacking skills can negatively affect employability and professional performance." – VET2.

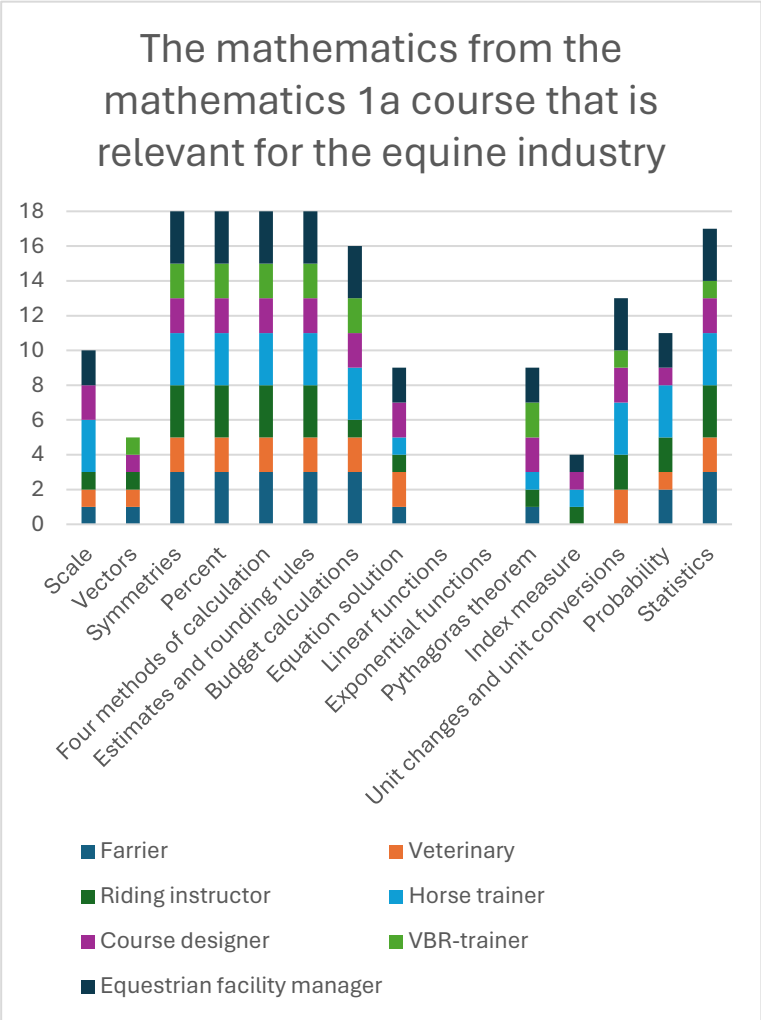

Figure 3 - Diagram illustrating the different profession groups' use of mathematics.

As pointed out by the veterinarian above, it is important to have mathematical skills to be employable at all. However, not all interviewees agree with this; three individuals believe that it is entirely unnecessary to have mathematical skills to be employed, see *figure 4*. On the other hand, they believe that it is important to know mathematics if you are a manager or a business owner because then you have a more significant economic role in your profession. However, there are those who believe that it is irrelevant even in such positions, as you can buy accounting services. F1 is one of those who agree with this.

Figure 4 - Diagram illustrating how important the interviewees think it is to know mathematics depending on if they are an employee or self-employed or a boss.

4.1.1 Scale

For course designers, scale is crucial for creating detailed track sketches that accurately reflect reality. By using scale, they can ensure that the dimensions and conditions of the tracks are correct, which is essential for the safety and fairness of competitions.

"*Drawing track sketches to scale by hand. Measuring the diameter of the arcs with a ruler to ensure they are reasonable. Using a wheel and measuring, the pace is indicated in the TR depending on the class. So, distance/pace x 60*." – CD1.

On the horse farm, scale is also important for renovation and new construction. When planning for new riding arenas, indoor riding arenas, or stables, precision is required to ensure that the buildings fit into the existing landscape and comply with regulations and requirements for building permits.

"By using scale, I can carefully draw and plan new paddocks on the farm, ensuring they are well-positioned and large enough for the number of horses that will be kept there." – VBR1.

For riding instructors, scale is a useful tool for planning and calculating riding trips. By using maps with scale, they can determine distances and estimate the time it takes to ride to different locations, such as summer pastures or how far they will get during an hour-long riding lesson, so that the lesson doesn't suddenly end when they are far out in the woods. By using scale, they can make realistic time estimates and plan their lessons or outings effectively.

4.1.2 Vectors

By applying principles of force vectors and moment forces, farriers and riding instructors can deepen their understanding of how force and load are distributed on the horse's legs and hooves, as well as during various riding exercises.

The farrier, F3, says that knowledge of force vectors is crucial to ensuring that the hoof is shoed with optimal angles. By considering the direction and magnitude of the force, the farrier can shoe the horse in a way that reduces the load on the horse's joints and soft tissue.

Similarly, riding instructors can benefit from vector analysis to understand how moment forces affect the horse's movements during various riding exercises. By identifying and analysing the forces acting on the horse's body, the riding instructor can adapt their instructions and exercises to maximize the horse's performance and well-being.

Despite the beneficial applications of vectors, only 28% believe they have a use for them, see *figure 3*.

4.1.3 Symmetries

Symmetries plays a crucial role in the equine industry, spanning across various areas with a common goal of promoting the horse's well-being and performance. For all farriers, symmetry is a central principle in shaping the horse's hooves, where the use of symmetry lines enables a balanced and natural form that reduces the risk of injuries and enhances the horse's mobility and comfort, see *figure 5*.

Figure 5 - A farrier shows how he uses symmetries in his work.

Riding instructors also strive for symmetry, both in the horse and the rider, to ensure even load distribution and optimal biomechanics. By addressing and correcting asymmetries between the right and left halves of both the horse and rider, the riding instructor can contribute to improving performance and reducing the risk of injuries. This is particularly emphasized in the approach of VBR trainers as it is integral to their way of thinking.

4.1.4 Percentages and the four arithmetic operations

Percentages and the four arithmetic operations constitute fundamental mathematical concepts that are highly relevant within the equine industry and everyday situations. Many interviewees emphasize the importance of having good mental arithmetic skills to handle tasks quickly and efficiently such as invoicing with VAT rates and calculating discounts in their daily work. At the same time, others note that they have transitioned to using digital tools for these tasks, which facilitates and streamlines their work processes.

"Imagine how fun it would be to go up to my old math teacher and say, 'I actually have a calculator in my pocket all the time,' apparently that wouldn't be possible." – Farrier, F2, who calculates invoices daily using the calculator on her phone.

Furthermore, mathematics is also crucial in the planning and construction of new paddocks. To ensure that the paddock is set up correctly and that enough materials are procured, various parameters need to be calculated, such as how far a roll of wire will reach, the number of insulators and posts needed, and sizing the power unit in relation to the length of the wire and desired current strength. By applying mathematical principles, functional and safe paddocks can be created that meet the needs of both horses and staff.

In invoicing and VAT calculations, percentages are used together with addition and subtraction to obtain a total sum. Additionally, the four basic arithmetic operations are applied to calculate travel reimbursements.

Riding instructors also use percentages to ensure appropriate weight distribution when assigning horses to riding students at riding schools. RI2 says that a generally accepted norm of approximately 15% of the horse's optimal weight is allowed for a rider, exemplified by a horse weighing 600 kg being able to carry a rider weighing 90 kg.

The equestrian facility manager, EFM2, needs to keep track of the employees' employment levels (odd percentages are common) in order to schedule shifts that suit everyone.

In feed ration calculations, percentage values are a central part, especially in handling roughage with specified dry matter, such as 83%. A horse should eat at least 1.5 kg of dry matter roughage per 100 kg of body weight, which means that a horse weighing 600 kg should eat at least 7.47 kg of the specified roughage.

$$\frac{83}{100} \cdot 1{,}5 \cdot \frac{600}{100} = 7{,}47$$

Then adjustments are required using proven experience to determine the appropriate feed quantity depending on the horse's workload and individual needs.

In summary, knowledge of percentages and the four arithmetic operations is crucial for managing various aspects of daily life and professional life within the equine industry, as evidenced by all interviewed individuals claiming to benefit from and use these daily. By applying these mathematical concepts, one can effectively solve problems and make informed decisions, contributing to smooth and successful operations.

4.1.5 Estimates and rounding rules

Observing the difference in attitudes towards accuracy and precision depending on the area within the equine industry one works in. In financial contexts, it is common to strive for accuracy and precision to ensure correct calculations and budgets. Estimates and rounding's may be seen as imprecise and can lead to incorrect results, which in turn can affect the company's finances and long-term sustainability.

On the other hand, in material usage, where values are often more variable and uncertain, rounding, and rough estimates are used extensively. This is because exact values are not always available, and it is more important to estimate and plan for material needs in a realistic manner than to strive for absolute precision. By using rounding and rough estimates, one can make rough approximations that are close enough to reality to be useful for planning and budgeting.

Estimations of time and costs are crucial for effectively managing operations within the equine industry and ensuring smooth and sustainable operations. Both farriers and equestrian facility managers rely on accurate estimations to plan and budget their workdays and the finances of the operation efficiently.

Farriers need to estimate the time required for various tasks, such as traveling between different stables and the time it takes to shoe a horse, to optimize their workday and maximize productivity. By carefully estimating the time required for each task, they can plan their schedules efficiently and avoid overloading or overlapping tasks. For veterinarians, the ability to accurately estimate both time and cost aspects of different procedures is of paramount importance. One veterinarian emphasizes the importance of estimating the difficulty of different tasks, such as performing a dental check-up on a horse; do only simpler measures such as rasping without the need for sedatives suffice, or do more advanced equipment that is impractical to transport to the field is required? This estimation also involves taking into account the distance to the patient and the associated costs of fuel and travel time, including the need to have two people on site, which entails additional expenses. At a fully equipped clinic, the presence of only the veterinarian may be sufficient, as other staff are already within a reasonable distance to be quickly called upon if needed.

Equestrian facility managers need to estimate the costs of various materials and equipment to maintain a balanced budget and avoid unexpected expenses. By being able to anticipate and plan for the lifespan and consumption levels of equipment, such as stirrups, blankets, fly spray, hay, and shavings, they can ensure that sufficient resources are available and avoid inadequate or unforeseen costs.

Having foresight and accurate estimation skills are therefore crucial for both farriers, veterinarians, and equestrian facility managers within the equine industry. By using these estimations, they can effectively plan and operate their businesses in a sustainable and successful manner.

4.1.6 Budget calculations

Budget calculations are important in the equine industry, but there are external services available to facilitate this work, which all farriers, among others, use. However, it can still be advantageous to have knowledge in these areas to be able to manage them independently and avoid being deceived. Many individuals in the equine industry lack knowledge of bookkeeping and handling financial matters, which is an important part of the operation. It is also common to desire more education in how to use tools like Excel to facilitate the management of financial data and budgets.

It is important to understand that even though external services can be used for budget calculations, a basic understanding of this area can be valuable for evaluating and understanding the results from such services. Being able to interpret and analyse financial information is crucial for making informed decisions in the equine industry.

4.1.7 Equation solving, linear- and exponential functions

Functions are not used by the interviewees in any way, see *figure 3*. Most of them don't even know what a function is. Equations are something that only a few within the equine industry claim to have any use for, mainly in problem-solving situations. A typical example is when you need to calculate how much feed a group of horses consumes during a certain period of time. For example, you might encounter the following problem: If a pallet of straw bales lasts for two weeks and there are 21 bales in each pallet, how much feed does each horse consume on average per week if there are 8 horses in the stable? To solve this, equations are used, where the variable "x" represents the number of bales a horse consumes per week.

The majority within the equine industry use this type of mathematics without necessarily referring to it as equations. Instead of expressing it as an equation, they often use a more practically oriented method. For example, they might say: "I usually put out at least one bale per horse per week, but rarely two. So, if I calculate with 1.5 bales per horse per week and I have 8 horses in the stable and they are there for 44 weeks, it should be enough with about 26 pallets. It's better to have a little extra than too little." This way of reasoning may be more intuitive for many within the equine industry than using formal equations like these:

$$21\ bales = 8\ horses \cdot 2\ weeks \cdot x \qquad \rightarrow \qquad x = \frac{21\ bales}{8\ horses\ \cdot 2\ weeks}$$

$$\frac{x \cdot 8\ horses\ \cdot 44\ weeks}{21\ bales/pallet} = number\ of\ pallets\ that\ are\ needed$$

4.1.8 Pythagoras theorem

It is clear that the Pythagorean theorem has practical applications in certain aspects of the equine industry, particularly in course design and the construction of stables and riding arenas. By understanding and applying the Pythagorean theorem, course designers and stable owners can ensure symmetry and correct dimensions in their structures, which are crucial for safety and functionality.

In course design, knowledge of the Pythagorean theorem can be used to cross-measure and position fences symmetrically, creating a comfortable course for horses and riders, see figure 6. For stable owners, the theorem can be useful in planning and constructing new structures such as paddocks, riding arenas, and stables, where correct dimensions and angles are of great importance for the horses' comfort and safety.

While the Pythagorean theorem may not be used in the daily operations of everyone in the equine industry, these examples demonstrate its relevance and utility in certain specialized areas. By integrating mathematical principles like the Pythagorean theorem into educational programs and professional practices, the industry can benefit from increased efficiency, accuracy, and safety in its activities and construction projects.

$$a^2 + b^2 = c^2$$
$$c = \sqrt{a^2 + b^2}$$

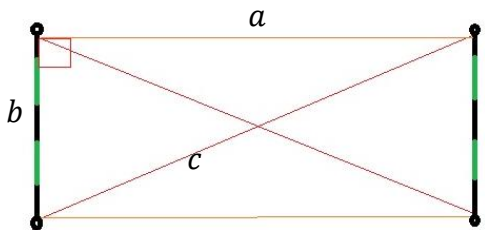

Figure 6 - Two show jumping fences that are 'b' wide and with the distance 'a' between them. Then the diagonal 'c' can be calculated with Pythagoras theorem.

4.1.9 Index measures

It's interesting to note that knowledge of indices seems to be lacking among those interviewed within the equine industry. Indices are an important part of many areas, including economics and horse breeding, and an understanding of their significance and usage can be crucial for the success of the business.

In economics, indices are used to measure and compare changes in prices, consumption, and other economic variables over time. By using index measures, companies can make informed decisions regarding pricing, budgeting, and planning for future growth.

In horse breeding, the BLUP index (Best Linear Unbiased Prediction) is a commonly used index to assess and compare horses' genetic characteristics and performances. The BLUP index provides breeders with valuable information about a horse's expected offspring's performance in various traits, such as temperament, health, and competitive ability. By using the BLUP index, breeders can make more informed breeding decisions and improve the quality of their horses over time.

4.1.10 Unit changes and unit conversions

When it comes to pace in cross-country riding, the cross-country trainer explains that it is important to be able to convert between units such as meters per minute (m/min) and kilometres per hour (km/h) to assess the speed during the ride. Knowing that a speed of 480 meters per minute corresponds to 28.8 km/h gives the rider a sense of the pace required for different cross-country stretches. It is also valuable to understand that a typical riding horse can approximately gallop at a speed ranging from 16 to 36 km/h, providing further perspective on the horse's capability and performance.

Equestrian facility managers, as well as anyone else responsible for horses, mention that when it comes to feeding horses, it is necessary to understand the difference between volume and weight to ensure the horse receives the correct amount of nutrition. Knowing that 1 Liter of concentrate feed does not weigh 1 kg but approximately 0.6 kg (depending on the type) is crucial to avoid over- or underfeeding the horse. If one needs to provide the horse with a specific weight amount of concentrate feed, it is important to either weigh it or convert the weight to volume to ensure correct feeding.

Both veterinarians also emphasize that it is of utmost importance for those working in veterinary medicine or animal care to understand the difference between different units and be able to perform unit conversions correctly. This is critical to ensure accurate medication dosing. They also emphasize the importance of having a sense of what seems right to spot and fix any wrong dosage calculations before giving them to an animal.

4.1.11 Probability and statistics

The interviewees' differing views on probability and the use of statistics in the equine industry provide insight into the practical and professional perspective, which often differs from the theoretical content covered in Mathematics 1a courses. One of the farriers exemplifies this by linking probability to factors such as hoof quality, previous injuries, and intervals between shoeing's. This perspective is based on professional experience and observations rather than strict mathematical calculations. This emphasizes the importance of professional knowledge and intuition in the equine industry, where each situation can be unique and require individual assessment. Even one of the riding instructors that instruct private riders use probability:

"The probability of winning is 1 in 4, for example, if there are 5 placed in a field of 20. In team selections, I can check previous results for the team and see which are most likely to score the highest points in the next competition" – RI1.

The interviews also show that statistics play a central role, especially in riding schools where it is important to effectively manage resources and assess the performance and profitability of the horses. It is clear that there is a lack of knowledge about tools like Excel and other statistical management software among those interviewed in the equine industry. This deficiency indicates a possible gap in education that needs to be addressed to improve professional competence in the industry. Excel and similar programs are powerful tools for managing and analysing data, which is of great importance in many areas of the equine industry, such as riding schools, farm management, and competition activities. By mastering these tools, professionals in the industry can effectively organize and interpret data to make informed decisions and optimize operations.

4.2 Survey answers from students at equestrian upper secondary school

The students here agree with those working in the equine industry that it is more important to have good knowledge of mathematics if you are going to run your own business or be a boss than if you are "just" employed, see *figure 7*.

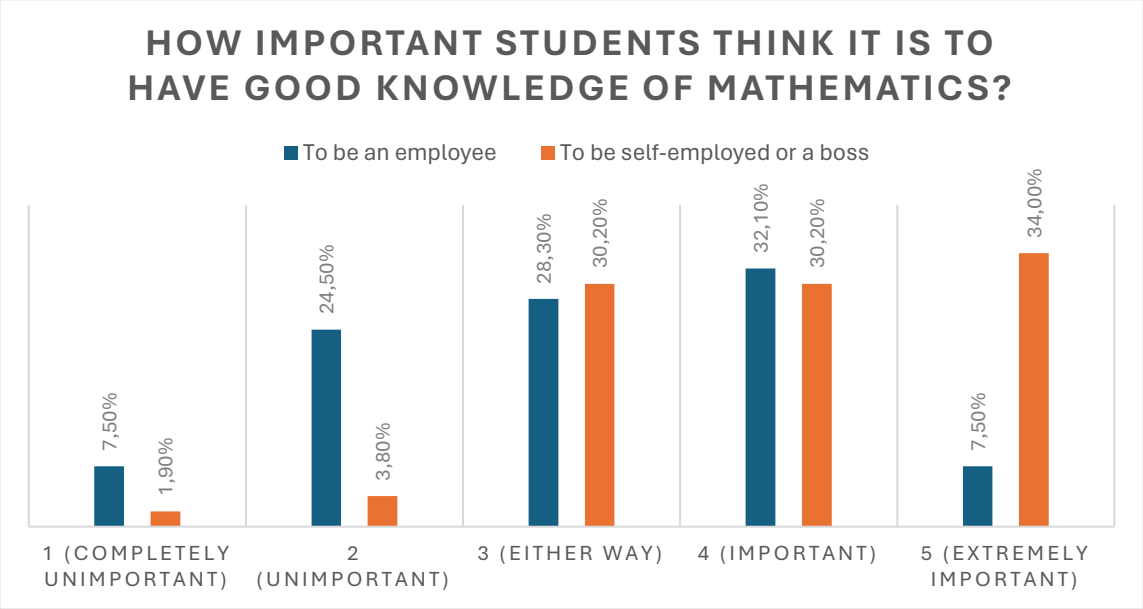

Figure 7 - Diagram illustrating how important the students think it is to know mathematics depending on if they will be an employee or self-employed or a boss.

The majority of students aspire to become some form of trainer, either training horses or riders, or working in stables, see *figure 8*. However, a considerable proportion aim to become veterinarians, which requires high grades and completion of Mathematics 4. For comparison, only Mathematics 1a is mandatory for most specializations at equestrian upper secondary schools.

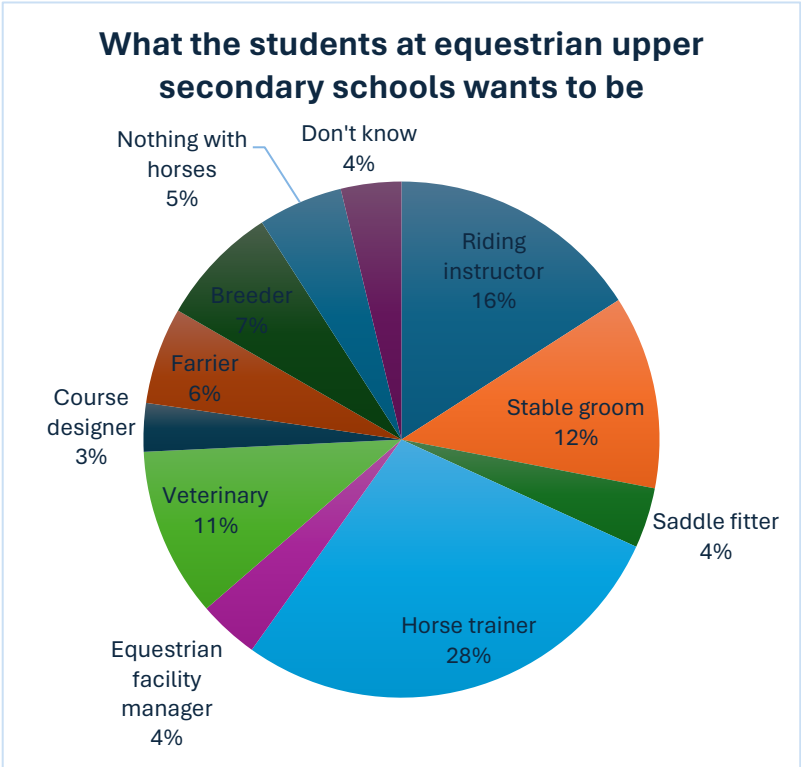

Figure 8 - Circle diagram that shows the distribution over which professionals the students want to work with after they graduate.

4.2.1 The Mathematics students at Equestrian upper secondary schools find relevant

The diagram in *figure 9* shows the students' responses to the question: "What mathematics do you think is relevant for your future career in the equestrian industry?

Students at the equestrian upper secondary school identify several areas where they believe mathematical skills will be useful in their future workplaces within the equine industry.

"For example, when you need to calculate feed rations or when you're buying feed or other supplies to stay within a budget or similar. Being able to calculate what something will cost on a percentage discount." - student.

It emerges that feed ration calculations, economics, and budgeting are central areas where mathematics is needed, including planning purchases of feed and equipment and staying within a budget.

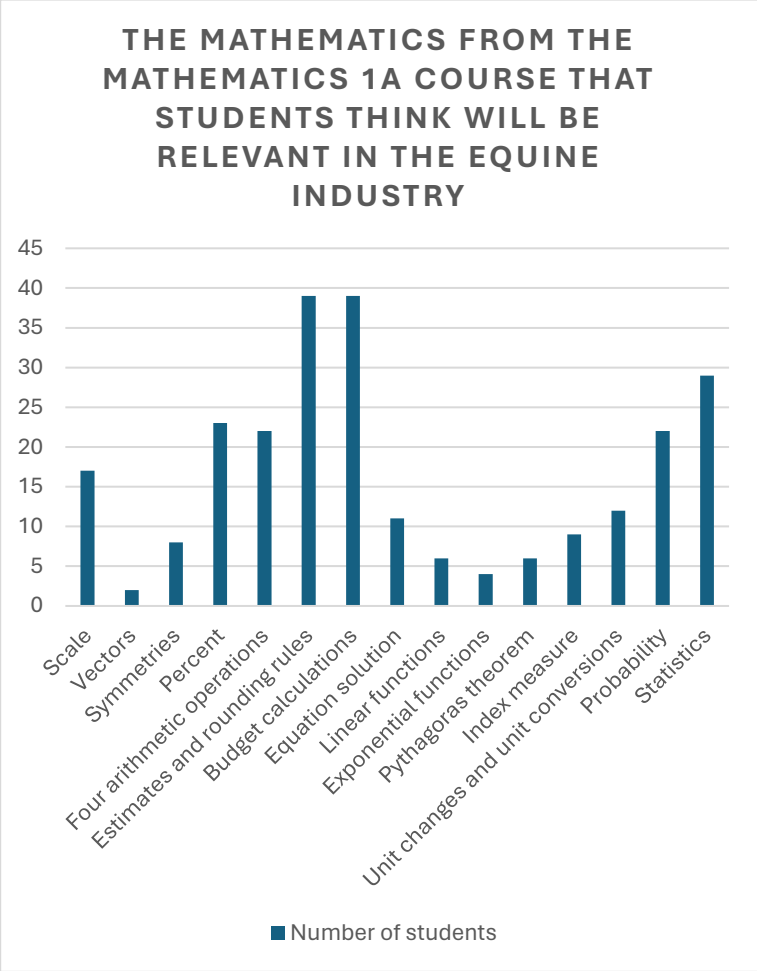

Figure 9 – Diagram over what students think is relevant mathematics to know when working in the equine industry.

"For instance, if you need to invoice, you need to be able to calculate how much the customer should pay, including travel expenses and the work you've done." - student.

Additionally, students point out the need for mathematics in accounting, pricing, and invoicing in self-employment. Other areas mentioned include calculations for paddocks, box sizes, and stable buildings, as well as medication and feed planning for the horses.

"Calculating how much feed you should give the horses based on weight and type of feed, box size, paddock/stable size and so on." - student.

Overall, students emphasize the importance of being able to apply mathematics in practical situations to effectively manage various tasks and financial aspects within the equine industry. The mathematics students find most relevant are estimations, rounding, and budget calculations, followed by the basic four arithmetic operations, percentages, statistics, and probability theory.

4.2.2 Motivation Towards Mathematics Education

Students are generally not very motivated to learn mathematics, with only 35% feeling motivated, se *figure 10*. The students' views on what can motivate them to learn more mathematics at equestrian upper secondary schools vary. 10 of the students emphasize the importance of an engaged and competent teacher and 16 students wish for more practically oriented and relevant tasks that can be linked to their education in the equine industry. Examples from the quotes is: *"Set a purpose in it: Why? And how can I work with it in my education?"* and another student: *"Good teachers, exercises that benefit you, such as learning feed rations, and feeling that it's useful. Practical exercises, for example."*.

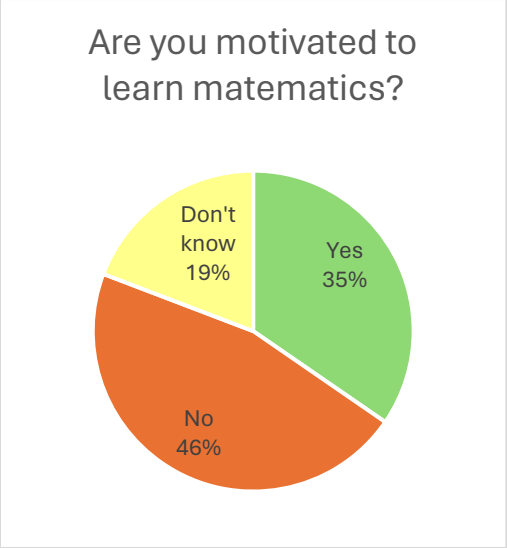

Figure 10 - Circle diagram that illustrates how motivated the students at equestrian upper secondary schools are to learn mathematics.

Additional factors that emerge include the need for clear connections to real-life situations, increased understanding of the subject's relevance, and the ability to apply mathematics in future careers. For some students, more difficult and challenging tasks would also make mathematics instruction more engaging and rewarding.

"Most things are a little too easy, more difficult tasks make counting more fun" – student.

In general, students request mathematics instruction that is more tailored to their individual needs and can provide them with tools and skills that are useful and meaningful for their future careers in the equestrian sport. Quotes from students include: *"If you know a little more about what it entails and what you need to know in your future career, then it probably motivates more if you know that you will use it in the future,"* and another student: *"See a connection in how it helps me in real life"*.

4.3 Courses in Mathematics: Incorporating Equine and Stable Calculations?

HT1 emphasized that if teachers had encouraged students to perform mathematical exercises in the stable, it would have felt artificial and not contributed to increasing her motivation to learn mathematics. She pointed out that she attended a social science program in upper secondary school and not an equestrian upper secondary school, which would not have allowed for such activities in her class. RI1 shared similar views and believed it would be artificial. It is noteworthy that she has the least use for mathematics among those interviewed, approximately once a week, and she does not really see its utility except in accounting and budgeting, where she has another person who takes care of it for her.

On the other hand, all the operational managers saw practical mathematics lessons in the stable as very rewarding and could provide many examples of various arithmetic tasks, such as feed plans, bedding volumes, mucking out time, and leading horses to paddocks. One of them, EFM1, pointed out that if they had used examples that she was familiar with and found enjoyable, perhaps she would also have had a more positive

attitude towards mathematics in upper secondary school. VBR1 mentioned that if her son, who has ADHD and dyslexia, had received similar mathematics lessons in school, he might have understood the subject better and received higher grades. She explained that it was evident that he actually understood when he was with her at work, but the complicated word problems in the mathematics book made him lose interest immediately.

Current students at the equestrian upper secondary school answered the following two questions as presented in *figure 11* and *figure 12*.

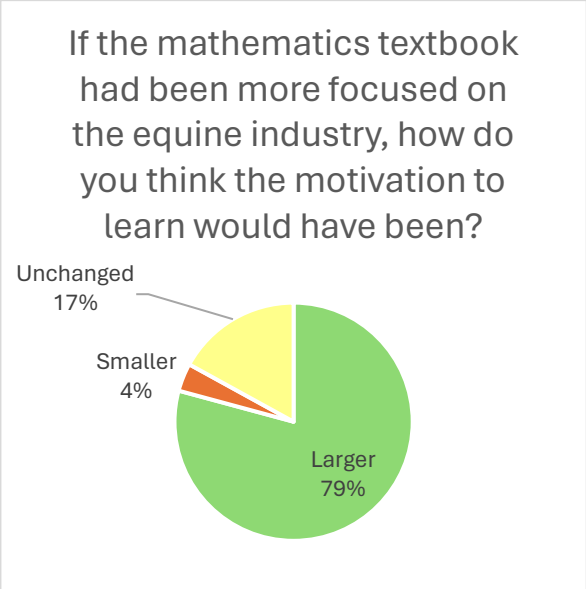

Figure 11 - A circular diagram representing students' opinions on revised mathematics textbooks

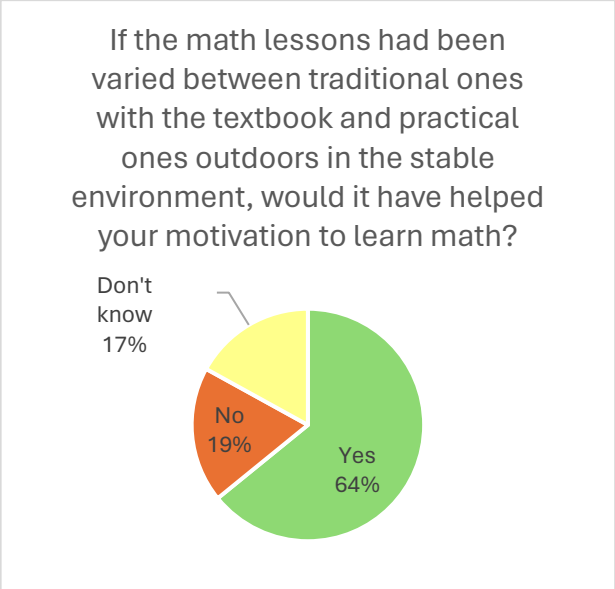

Figure 12 - A circular diagram illustrating students' opinions on whether more practical lessons in mathematics would enhance their motivation to learn.

These clearly illustrate that it would have been relevant and beneficial for their motivation and learning of mathematics to integrate their interest in both theoretical and practical exercises.

5 Discussion

It is interesting to observe the changed perception of mathematics among the interviewees after they have reflected on the various mathematical concepts and their applications within their professions. Many initially seemed to perceive mathematics solely as abstract and impractical concepts from their school days. However, by discussing concrete examples and applications from their daily work and linking them to the mathematics course they took, their perspective has changed. By demonstrating how mathematics is actually used in everyday situations within the equine industry, such as calculating costs, planning, and constructing paddocks, as well as estimating time and materials, the interviewees have recognized the practical relevance and utility of mathematics. It appears that they have gained curiosity and appreciation for the subject when they have seen its direct applications in their own work and daily lives.

Over half of the interviewees expressed a desire to have learned more relevant mathematics in school but found that school mathematics was too abstract and one-sided to be motivating. Similarly, the majority of students, as expected based on my experience as a mathematics teacher at an equestrian upper secondary school, lack motivation to learn mathematics. However, most students believe that their motivation could be increased if teachers integrated relevant examples from professional practice into their teaching, in line with the principle of utility value. This example underscores the importance of linking mathematics to real-life situations and applications to improve understanding and appreciation of the subject. By demonstrating the versatility and practical nature of mathematics, individuals can be convinced of its value and significance across various contexts, potentially leading to increased motivation and engagement in learning and using mathematics in daily life. Indeed, the majority of students believe that their motivation to learn mathematics could be increased if teachers were better at explaining how mathematics is relevant to them, preferably through examples from the equine industry.

It is interesting to note that both students and professionals share similar perceptions of which mathematical concepts are relevant in the equine industry. They also cite many common examples of mathematical applications. Recurring themes include feeding calculations, time estimates, material estimates, bookkeeping, VAT calculations, and invoicing. However, there are significant differences regarding symmetries, with only 14.8% of students finding them relevant compared to 100% of professionals. This difference may be due to the difficulty of the concept itself, where students may find it useful if they better understood its implications. This became evident during the interviews, as most initially dismissed symmetries but expressed their usefulness after receiving a brief explanation of what symmetries are.

The consensus between students and professionals on the relevance of mathematics in the equine industry on many areas, but deviation on others, is interesting. It appears that some concepts, such as symmetries, may not be immediately relevant to students until they receive a clear explanation of their applications. This underscores the importance of not only teaching mathematics but also demonstrating its practical applications in various contexts.

It is also striking that both students and professionals recognize the importance of mathematical skills for running a business in the equine industry. This suggests that a strong understanding of mathematics can be crucial for success in the sector, whether as

an employee or entrepreneur. Conveying this insight to students may be an important step in increasing their motivation and engagement with the subject. They also agree that it is more important to have good knowledge of mathematics if one is to run their own business or be a manager. This is emphasized by the professionals' desires to have learned more about business economics, budgeting, and bookkeeping, as many of them lack these skills and need to rely on purchased services in these areas.

Furthermore, it is important to note that the desire for more education in Excel and similar tools reflects the need to integrate practical skills into mathematics education to prepare students for the workforce and potential careers in various industries, including the equine industry. By improving knowledge and use of Excel and other statistical management tools, the equine industry can also benefit from increased efficiency, better decision-making, and more accurate analysis of operational data. This, in turn, would contribute to promoting the industry's growth and development in a sustainable manner.

While very few within the equine industry are familiar with the concept of vectors, examples from a farrier and a riding instructor demonstrate how science and mathematics can be applied to improve both horse welfare and performance. However, it does not seem to be done to a particularly large extent based on the interview responses.

It has emerged that equations are a significant tool in mathematics, provided that users are not deterred by the symbolic representation of variables, such as "x". Interviewees have expressed that when equations contain such variables, they tend to perceive mathematics as more complicated and less relevant to their everyday lives. It is possible that if they had not experienced obstacles in the form of these symbols, their ability to solve every day mathematical problems would have improved, which in turn would have resulted in a faster and easier problem-solving process.

It is regrettable that the concept and usage of functions are not more understood within the equine industry. Functions are a powerful mathematical tool that can be used to model and understand various phenomena and processes. To improve the understanding and use of functions within the equine industry, it may be valuable to integrate practical examples and applications of functions into educational programs and professional practice. By demonstrating how functions can be used as tools to solve real-world problems within the equine industry, their relevance and usage in the industry can be increased, promoting a more mathematically competent and efficient workforce. Perhaps if students get to repeat the concept of functions according to Bjork's principles several times, it will stick and enable them to benefit from it in their professional lives.

A parenthesis in the study is the original consideration of whether equestrian upper secondary schools are even worth existing, where if one looks at the interviewees' backgrounds, only 22% have attended equestrian upper secondary schools, with the rest having studied other, more theoretical programs (see the diagram in Appendix 4). However, if we instead look at the students' responses in *figure 8*, at least 91% express a desire to work in the equine industry. However, reality does not seem to match up exactly. The question then arises: why? Has the study interviewed too few people? Or is it, as veterinarian VET2 suggests, that there is a lack of mathematical skills among those who have studied at equestrian upper secondary schools, making them simply not employable?

In summary, these observations illustrate the complex and multifaceted nature of the equine industry, where both practical experience and theoretical knowledge are valuable. A more holistic education that integrates both professional experience and theoretical tools may be beneficial in addressing the needs and challenges facing the equine industry.

5.2 Feedback on purpose and research questions

The purpose of the study was to explore the perspectives of students and professionals on the use of mathematics in the equine industry and to identify any deficiencies and potential improvements in mathematics education at the equestrian upper secondary school. The research questions guiding the study were:

- How do professionals in the equine industry perceive the role of mathematics in their respective professions?
- How can the central parts of the mathematics 1a course content be integrated with the mathematics used in the equine industry?

The alignment with the purpose and research questions indicates that the findings from the study contribute to a deeper understanding of how mathematics is utilized and perceived within the equine industry and point to potential areas for enhancing mathematics education at the equestrian upper secondary school.

5.3 The reliability of the study

At times, the reliability of the investigation may be subject to scrutiny, particularly when interviewees have expressed fluctuating views on mathematics during the course of the interviews, possibly influenced by the interviewer's comments or questions. However, there are also instances of participants reconsidering their positions after reflecting on the inquiries.

It is also worth noting that the sample of eighteen interviews may not comprehensively represent the entire equine industry. Only two or three individuals from each occupational category were interviewed, and representatives from stable personnel were not reached. Furthermore, only one male participant was included in the interviews, partly due to the limited number of men in the industry and partly because several contacted individuals chose not to participate. It is also possible that women have been more inclined to assist other women, which may have influenced the selection of interviewees as a female researcher.

Conversely, a survey was completed by students from three different equestrian upper secondary schools, which hopefully contributed to broadening and diversifying the responses. Nevertheless, there is a desire to have received more responses that could have enhanced the statistical reliability. One potential challenge with the survey is that students may not have comprehended all mathematical concepts, such as symmetries, which may have influenced their responses regarding the relevance of these concepts.

The questions in the survey can be perceived as leading, especially questions 7 and 8, *see Appendix 3*. These questions offer three different answer options that are essentially just short yes/no questions. Question 7 may be redundant since question 6 already covers the same topic but in a more open-ended way. Question 8 could be more open, for

example: 'How do you think the teaching method can affect your motivation for mathematics and which method do you think would increase your motivation?'

The reason for the design of the questions was partly due to time constraints, as the survey needed to be sent out quickly, but also because interview responses indicated that mathematics taught in the stable would feel forced and awkward, and therefore not motivating at all. As a result, the outcomes of questions 7 and 8 were different from what was expected. But nevertheless, the closed questions may have affected the validity of the survey, and a more open-ended design could have provided more nuanced and insightful answers.

5.4 Ethical aspects of the study

To ensure the interviewees' privacy and protect their personal data, several measures have been taken in this study. The interviewees received a brief information sheet explaining the purpose of the study and the reasons for conducting the interviews, see *Appendix 1*. The interviews were recorded to allow for accurate transcription, with the promise that the recordings would be deleted immediately after transcription. In the transcriptions and the report, no names were mentioned; instead, their job titles and a number were used to identify them. This means that the interviewees were almost anonymous, except that someone might recognize the brief information summarized about each person in *Appendix 4*, which describes their profession, educational background, and initial thoughts on mathematics. To ensure the students' privacy and protect their personal data in the surveys for this study, no personal data was collected other than which class year they went. The students received a brief information sheet in the survey explaining the purpose of the study and why their responses were needed, see the beginning of *Appendix 3*. Through these measures, the study has aimed to protect the interviewees and the students' privacy and ensure that their personal data is handled ethically and responsibly.

The results of the study indicate that large parts of the core content in mathematics are relevant for students at equestrian upper secondary schools, but the teaching methods should be reviewed to ensure students can effectively absorb the knowledge. If the instruction is more aligned with the students' interests and career orientations, it is likely to increase their motivation. The parts of the core content that do not seem useful should be examined in a deeper study to either clarify their purpose or potentially remove them. This adjustment can help better tailor mathematics education to the needs within the equine industry. Additionally, the findings indicate that the study contributes to a deeper understanding of how mathematics is utilized and perceived within the equine industry.

5.5 Suggestions for further research

An interesting area for future research is to explore and develop teaching methods where students have the opportunity to apply mathematics in a more practical way directly in the stable environment. By integrating mathematical concepts into daily tasks and routines related to horse care and riding, a more meaningful and engaging learning environment could be created for students. It would be interesting to investigate how

this affects students' understanding and motivation for mathematics, and whether it leads to improved outcomes and increased interest in the subject.

Further research could also focus on developing and testing horse-related exercises that can be used in the classroom. By linking mathematics to concrete situations and problems within the equine industry, the subject can become more relevant and interesting for students. It would be interesting to see how students respond to such tasks and whether it enhances their engagement and motivation for mathematics.

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Attachment

Appendix 1 – Information Sheet Provided to Interviewees

Hello,

My name is Erica Henriksson, and I am in the final semester of the Master's program in Learning and Leadership at Chalmers University of Technology. The purpose of this interview is to investigate how mathematics is relevant to people working in the equine industry. I aim to explore the situations in which mathematics is useful and which mathematical concepts are most important for these professions. This is to find ways to motivate students at equestrian upper secondary schools to learn mathematics and also to map out which mathematics is relevant. I simply want to compare what is needed in reality with what the Swedish National Agency for Education considers one should learn.

The interview will be recorded so that I can transcribe and quote accurately. The audio files will be deleted once the thesis is completed. The interviews will be anonymous, and no names will be mentioned. I will share with you my compilation of our interview so that you can check if I have accurately represented you.

Best regards,

Erica Henriksson

Appendix 2 – Interview questions

Theme 1 - Background Information

1. How old are you?
2. What is your educational background?
3. What is your occupation? Can you provide an example of what a typical day looks like for you?
4. What were your feelings towards mathematics when you were studying?
5. Can you describe what mathematics means to you in a few words?

Theme 2 - Mathematics in the Profession

6. How do you believe your mathematical skills are beneficial in your current profession?
7. Which of these mathematical skills do you find useful? Please check all that apply:
    - Scale
    - Vectors
    - Symmetries
    - Percentages
    - The four arithmetic operations
    - Estimations and rounding principles
    - Budget calculations
    - Equation solving
    - Linear functions
    - Exponential functions
    - Pythagorean theorem
    - Index measurements
    - Unit conversions
    - Probability
    - Statistics
8. Which mathematical skills do you consider most important for your profession?
9. In what situations do you feel you could have performed better if you were stronger in mathematics?
10. How important do you consider it for individuals you hire or those who choose to start similar businesses to have good mathematics skills on a scale of 1–5? (1 - not important at all, 5 - extremely important)
11. How often do you use mathematics in your profession? (Please check:)
    - Several times a day
    - Every day
    - Every week
    - Every month
    - Never

Theme 3 - Mathematics from School

12. What do you think would have motivated you to learn more mathematics in school?
13. How do you think practical mathematics lessons in the stable would have benefited motivation for the subject of mathematics? Would it have improved knowledge acquisition?
14. Is there any mathematics you feel you missed learning in school that you could have found useful?

Appendix 3 – Survey questions

My name is Erica Henriksson and I am in my final year at Chalmers University of Technology. I am currently working on my master's thesis for the Learning and Leadership program, where I am investigating the relevance and application of mathematics within the equine industry with the aim of increasing students' interest in mathematics at equestrian upper secondary schools. The responses to this survey are anonymous and will be helpful for my research. I appreciate your willingness to take the time to respond.

1. What grade are you in?

2. What do you want to work with or study after graduation?
    - Riding instructor
    - Trainer
    - Stable personnel
    - Farrier
    - Veterinarian
    - Equestrian
    - Young horse trainer
    - Saddle fitter
    - Course designer
    - Breeder
    - Equestrian facility manager
    - Other:_____

3. What mathematics do you think is important to know for your future profession?
    - Scale
    - Vectors
    - Symmetries
    - Percentages
    - The four arithmetic operations
    - Estimations and rounding principles
    - Budget calculations
    - Equation solving
    - Linear functions
    - Exponential functions
    - Pythagorean theorem
    - Index measurements
    - Unit conversions
    - Probability
    - Statistics

4. What do you think about mathematics?
    - Important
    - Very easy
    - Easy
    - Fun
    - Don't know
    - Boring

- Difficult
- Terrible

5. Are you motivated to learn mathematics?
    - Yes
    - No
    - Don't know

6. What do you think could motivate you to learn more mathematics?

7. If the math curriculum had been more tailored to your education, how do you think your motivation to learn would have been?
    - Greater
    - Unchanged
    - Lower

8. If math lessons had varied between traditional classroom learning and practical lessons in stable environments, would it have helped your motivation to learn mathematics?
    - Yes
    - No
    - Don't know

9. On a scale, how important do you think it is to have good skills (at least a passing grade in Mathematics 1a) for a future job in the equine industry? Please answer on a scale of 1-5 where 1 is not important at all and 5 is extremely important.

10. On a scale, how important do you think it is to have good mathematical skills to start and run your own business in the equine industry? Please answer on a scale of 1-5 where 1 is not important at all and 5 is extremely important.

11. Please provide an example of when you think mathematics is relevant in your future profession.

Appendix 4 – Basic information about the interviewees

1 Farriers

F1
A 32-year-old woman who completed a 2-year program at the farrier school and later pursued a 1-year continuing education to obtain certification for medical procedures involving living tissue. During upper secondary school, she attended the aesthetics program with a focus on music. While she found mathematics to be manageable, she did not invest much effort into it and passed easily. However, she now acknowledges the importance of mathematics, considering it a significant aspect of her business.

F2
A 33-year-old woman who has completed three years of farrier training. Prior to that, she studied the aesthetics program in media in upper secondary school. She hates mathematics and avoids it as much as possible, considering it something she can rely on a calculator for.

F3
A 35-year-old woman who began her journey towards becoming a farrier back in upper secondary school, where she attended Åby Travskola (an equestrian upper secondary school specializing in trotting). There, she took a course in hoof care and became hooked. She has since completed both the basic and advanced training for farriers. Mathematics is not her thing, which is why she chose a practical upper secondary school and a practical job. She describes mathematics as 'a page in the math book with lots of numbers and stuff'.

2 Veterinarians

VET1
A 51-year-old woman that has studied five years at veterinary school. At upper secondary school she studied at the natural science program. She has always loved mathematics and had the best grade in upper secondary school. She perceives mathematics as akin to an art form, appreciating its abstract nature and its pervasive presence in our surroundings. To her, mathematics transcends mere calculations, revealing itself as a fundamental component woven into the fabric of our daily lives.

VET2
A 65-year-old man initially pursued veterinary studies in his native country before continuing his education in Sweden. During upper secondary school, he studied in the natural science program. Currently, he owns a veterinary clinic with about a dozen employees. While the clinic treats a variety of animals, the owner specializes in equine care and primarily works with horses. He passionately believes that mathematics is fundamental and essential knowledge for individuals to navigate both personal and professional aspects of society.

3 Equestrian facility managers

EFM1
A 51-year-old woman, she has completed all the available riding instructor programs in Sweden, achieving a level 3 instructor certification. Additionally, she has undergone a

two-year training program in stable management and has completed courses such as 'Ridsportens affärsskola' (Equestrian Business School) and several other leadership courses. During upper secondary school, she pursued the social science program with economic focus. While she had a positive experience with mathematics in middle school, her motivation and confidence were diminished by a negative experience with a teacher during upper secondary school. Nonetheless, she emphasizes the importance of mathematics in her profession, stating that it is indispensable.

EFM2
A 33-year-old woman with a Bachelor's degree in Hippology, having previously attended the natural science program in upper secondary school. She serves as the manager of a riding school, juggling between conducting lessons, overseeing staff, and managing horse care. She works two days from 8 am to 5 pm and three days from lunchtime until late. Despite finding mathematics enjoyable during earlier school years, she struggled with it in the latter part of upper secondary school. She believes that mathematics forms the foundation for many aspects of life and is something one should have basic knowledge of.

EFM3
A 46-year-old woman who has trained to become a riding instructor level 2 at Strömsholm. She currently works as an equestrian facility manager at a riding school where she also conducts some riding lessons. She considers mathematics to be the most enjoyable subject during her school years and still finds pleasure in solving various mathematical problems. According to her, mathematics is the only pure science, it is a universal language understood by everyone, regardless of ethnicity.

4 Riding instructors

RI1
A 51-year-old woman who has trained to become an elite coach at Bosön. In addition to this, she is self-taught and proficient in show jumping and cross country jumping. During upper secondary school, she pursued studies in the technology program. She runs her own company with her mother, where they own a stable with facilities for equestrian activities. They also have their own cross-country track where she conducts lessons. Additionally, she holds a 25% position at the Swedish Equestrian Federation, focusing on training young riders.

Her thoughts on mathematics are that it is filled with nightmares and anxiety, especially regarding school mathematics, which consumed a lot of her time due to its difficulty. She thinks mathematics represents more complex concepts than simple multiplication, which she doubts she could solve today, even if given a million attempts.

RI2
A 45-year-old woman who first studied the child and leisure program in upper secondary school, then spent 2 years training to become a riding instructor in England, and subsequently completed a 3.5-year program to become a pedagogue at a teacher training college in Sweden. She works as a riding instructor at a large riding school, teaching dozens of lessons per week. In addition to her teaching responsibilities, she is tasked with managing the stable, exercising horses on weekends and holidays, and maintaining the facility. When it comes to mathematics, she avoids the subject and describes it as very difficult. For her, mathematics is synonymous with school

mathematics, involving a lot of numbers, addition, subtraction, multiplication, division, and percentages.

RI3
A 56-year-old woman who studied the social science program in upper secondary school and then pursued further education in hippology to become a level 3 riding instructor. She works as a riding instructor at a large riding school and has been employed at the same facility for over 25 years. While she had more responsibilities in the past, she has since returned to being solely a riding instructor in the evenings, with fourteen lessons per week. Mathematics was her best subject in school, and she believes it is important and necessary in various aspects of life, including managing her own finances and calculating feed rations in her profession.

5 Horse trainers

HT1
A 40-year-old woman, she pursued the social science program during upper secondary school and has not pursued higher education since then. Despite this, she has acquired valuable skills through self-teaching and has established herself as a proficient rider with notable achievements in show jumping. Together with her sister, she runs a small company with one employee, focusing on horse breeding, training, and competition in show jumping. They also offer services for backing and further education of horses owned by others. While she does not harbour strong feelings towards mathematics, she views it as essential for basic calculation methods.

HT2
A 41-year-old woman who has studied equestrian upper secondary school. Then she finished the riding instructor Level 2 and completed the Swedish Equestrian Federation's training for C-trainers in cross country jumping. She works as a young horse trainer and runs a small stud farm, riding 3-6 horses a day, training private pairs up to medium-level dressage and up to 1.30m show jumping. She also rents out her own well-trained horses to private riders who want lessons with her. In her daily life, mathematics is something she needs to know to manage various tasks, such as calculating the amount of hay needed relative to dry matter, pricing items, planning renovations/construction, bookkeeping, etc.

HT3
A 35-year-old woman who holds a Riding Instructor Level 1 certification, is a young horse trainer, and an animal caretaker with advanced D9 competence. She studied the social science program in upper secondary school. Currently, she runs her own business offering horse boarding, riding lessons, riding camps, but mostly she does horse training. She finds mathematics difficult to grasp and feels stressed about making mistakes. The word "mathematics" brings to mind boring and challenging school textbooks for her.

6 VBR-trainers

VBR1

A 48-year-old woman who has pursued training as a VBR instructor and as a yoga instructor with a focus on riders. Prior to this, she attended an equestrian upper secondary school. She primarily works as a trainer, focusing on VBR, and also manages her own stable with a few boarders. She didn't enjoy mathematics in primary school but found it more interesting when she started upper secondary school, as it was more focused on agriculture and animals, making it relevant to her interests. For her, mathematics is about subtracting and adding things together.

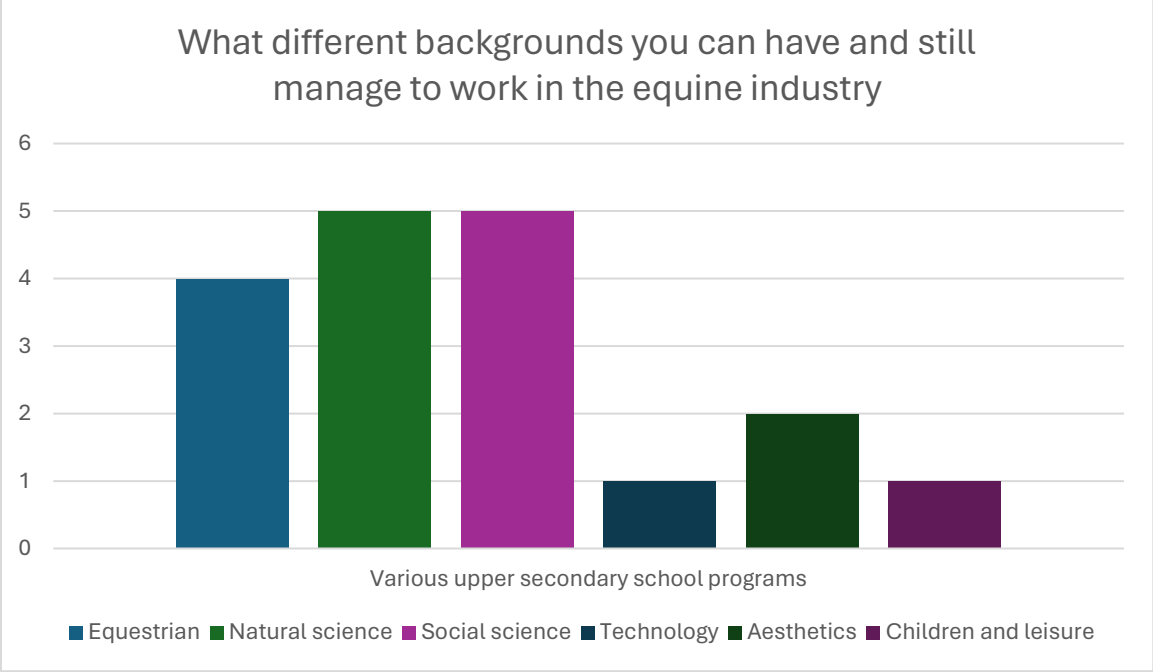
VBR2
A 47-year-old woman who attended an equestrian upper secondary school, followed by a 2-year distance education program in physiotherapy at UPH, then distance training in acupuncture, and finaly got a VBR certification. She works as a horse therapist, providing acupuncture and massage treatments to horses. Additionally, she assists her clients in correctly working their horses from the ground, including ground driving. She also coaches riders in VBR. She finds mathematics quite enjoyable, has always had a knack for it, and finds it relatively easy. For her, mathematics involves calculations, and as a business owner, understanding percentages is important.

7 Course designers

CD1
A 46-year-old woman who has completed training to become a Level 2 riding instructor, C-trainer, and C-level course designer in show jumping. She attended the natural science program at upper secondary school. She works as a self-employed individual primarily as a course designer, while also training riders in both jumping and dressage, as well as breeding horses. Previously, she ran her own small riding school, but she had to close it down due to profitability issues. Instead, she has now opened a riding sports shop. This woman has a passion for mathematics and would be willing to take extra courses at university just for fun, but unfortunately, she does not have the time. She believes that mathematics is highly significant; it can be found in almost everything and can greatly help in understanding the world around us.

CD2
A 40-year-old woman who has completed studies in hippology and is qualified as a B-level course designer in show jumping. She pursued the social science program with a focus on economics during her upper secondary school years. Besides working as a course designer, she runs her own small riding school where she also serves as a riding instructor. She has always had a fondness for mathematics and considers the four arithmetic operations as the essence of solving problems and performing calculations.

8 Diagram over the interviewees upper secondary school studies



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