



Improving Student Engagement and Academic Achievement Through Real-Life

Applications of Proportion

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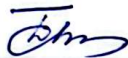
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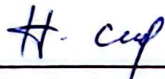
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ABSTRACT

This study investigates the impact of incorporating real-life tasks in the teaching of proportions on student engagement and academic performance. It is grounded in constructivist and situated learning theories and employs a quasi-experimental design. The intervention was carried out in a public school in Kazakhstan, involving 24 sixth-grade students in a single experimental group without a control group. The results demonstrated that real-life contextual problems enhance students' motivation, functional mathematical literacy, and critical thinking skills.

The research also includes a comparative analysis of Kazakhstani and Singaporean mathematics textbooks. Findings reveal that Kazakhstani materials emphasize formal procedures over real-world problem-solving, whereas Singaporean textbooks integrate contextual tasks more extensively. This highlights a need for curriculum modernization to better reflect practical applications and build essential competencies in mathematics education.

The experimental phase involved a proportion unit designed around real-life scenarios such as calculating discounts, adjusting recipes, working with scale models, and budgeting. Students worked individually and collaboratively, completed pre- and post-lesson questionnaires, and took a summative assessment. The comparison of results before and after the intervention showed a clear improvement in both academic outcomes and student engagement.

Key words: engagement, academic achievement, real-life problems, proportion, mathematics education.

АНДАТПА

Бұл зерттеу пропорция тақырыбын оқытуда шынайы өмірге негізделген тапсырмалардың оқушылардың белсенділігі мен оқу жетістіктеріне әсерін зерттейді. Зерттеу конструктивизм мен жағдайлық оқыту теорияларына сүйенеді және квазиисперименттік тәсілді қолданады. Эксперимент Қазақстандағы бір жалпы білім беретін мектепте өткізіліп, оған тек 24 алтыншы сынып оқушысы қатысты. Бақылау тобы болған жоқ. Нәтижелер өмірмен байланысты тапсырмалардың оқушылардың мотивациясына, функционалдық математикалық сауаттылығына және сыни ойлауына оң әсер ететінін көрсетті.

Сонымен қатар, зерттеу Қазақстан мен Сингапур оқулықтарының мазмұнын салыстырмалы түрде талдады. Қазақстандық оқулықтарда формальды есептер басым болса, Сингапур оқулықтарында өмірмен байланысты тапсырмалар кеңінен қолданылады. Бұл оқу бағдарламаларын тәжірибеге жақындатудың маңыздылығын көрсетеді.

Эксперименттік бөлім шынайы өмірге негізделген пропорция тақырыбындағы тапсырмалармен жүргізілді: жеңілдіктерді есептеу, рецепттерді қайта мөлшерлеу, масштабпен жұмыс және бюджет жасау. Оқушылар жеке және топпен жұмыс жасады, сабақ алдындағы және кейінгі сауалнамалар толтырды және қорытынды бақылау тапсырмасын орындады. Нәтижелерді салыстыру олардың оқу жетістігі мен мотивациясының айтарлықтай артқанын көрсетті.

Кілт сөздер: Оқушының белсенді қатысуы, Академиялық жетістік, Нақты өмірлік мәселелер, Пропорция / Пропорционалдық қатынас, Математика білім беру

АННОТАЦИЯ

Данное исследование направлено на изучение влияния использования задач, приближённых к реальной жизни, при обучении теме «пропорции» на вовлеченность учащихся и их академическую успеваемость. В основе исследования лежат конструктивистские подходы и теория ситуативного обучения. Эксперимент проводился в одной общеобразовательной школе Казахстана с участием 24 учащихся шестого класса. Использовался квазиэкспериментальный дизайн без контрольной группы. Результаты показали, что жизненные задачи положительно влияют на развитие функциональной математической грамотности, мотивации и критического мышления учащихся.

Кроме того, был проведен сравнительный анализ казахстанских и сингапурских учебников по математике, который выявил существенные различия в степени применения прикладных задач. Учебные материалы Казахстана преимущественно сосредоточены на формальных алгоритмах, в то время как сингапурские пособия активно используют контекстуальные задания. Это подчеркивает необходимость адаптации учебных программ к требованиям функциональной грамотности и жизненной применимости знаний.

Экспериментальная часть включала проведение учебного модуля по пропорциям, основанного на реальных жизненных задачах: расчет скидок, масштабирование, приготовление рецептов и планирование бюджета. Ученики работали индивидуально и в группах, заполняли анкеты до и после обучения, а также проходили итоговую диагностику. Сравнение результатов до и после модуля позволило выявить положительную динамику как в уровне учебной мотивации, так и в академической успеваемости.

Ключевые слова: Вовлечённость учащихся, Академическая успеваемость, Контексты реального мира, Пропорция, Математическое образование.

INTRODUCTION

Improving student engagement and academic performance in middle school mathematics remains as a persistent challenge, because educators often grapple with students who lack interest and have difficulty mastering foundational concepts (Jie, 2020). Engagement plus comprehension can greatly improve when connections linking math ideas and actual uses get support, studies show. The concept of proportion occupies a central place in the history of mathematics and has deep roots dating back to ancient science. Already in the works of Euclid (3rd century BC) in his *Elements*, proportions were considered in detail in the context of geometry and relationships between segments. Proportions played a key role in understanding harmony, symmetry and relationships in architecture and art (for example, the golden section). Later, in the era of Arabic mathematics and the European Renaissance, proportions became the basis for the transition from geometric to algebraic thinking, which is a crucial step towards the formalization of equations and concepts of variables. Researchers such as Al-Khwarizmi, Leonardo Fibonacci and René Descartes used proportional relationships to describe numerical patterns, movement and growth.

With the development of algebra in the 17th–18th centuries, proportions became the basis for understanding rational expressions, functions and equations. In modern mathematics, proportional thinking is considered a cornerstone of the transition from arithmetic to algebra (Lamon, 2007) It forms the basis for the concepts of linear equations, percentages, scales, rates, probability, and statistics. Due to its universality and applicability across various fields of knowledge, proportions remain one of the most essential and fundamental topics in school mathematics, forming students' mathematical literacy and functional skills (Karplus et al., 1983; Vergnaud, 1983). Specifically, the integration of real-life proportional problems into our curriculum has emerged as more of a promising strategy. This approach helps students to understand the practical relevance of mathematics also encourages critical thinking. Skills related to solving problem are fostered also since those skills are essential for academic success (Kazemi E. & Stipek, 2009). Contextualized teaching methods, which connect mathematical topics to students' daily experiences, have prove significant improvements in conceptual understanding and solving problem skills (Kazemi E. & Stipek, 2009).

Modern mathematical education is aimed at developing students' functional literacy and the ability to apply knowledge in vital contexts. The use of real-life problems is a method in which students learn to solve applied problems that simulate situations from everyday life: shopping, calculating time, budgeting, construction, etc. This context helps to connect the educational material with the personal experience of schoolchildren and makes mathematics socially significant (Kalinin & Pankratova, 2022).

The purpose of including these problems in the educational process is not just to test computational skills, but to develop the ability to make decisions, evaluate,

compare alternatives and argue for the choice of method. This reflects a competency-based approach, in which not only the correctness of the answer is meaningful, but also the validity of the actions (Aniskin & Rakhmatullina, 2023).

In addition, real-life problems are often interdisciplinary in nature, such as elements of economics, geography, ecology and other disciplines. This makes mathematics a tool for developing interdisciplinary connections and critical thinking (Basharina & Litvinova, 2023).

Research confirms that the use of practice-oriented tasks contributes to:

- A deeper understanding of mathematical concepts (Bushmeleva et al., 2018)
- The development of meta-subject skills such as analysis, synthesis and forecasting (Минакова & Клещёва, 2023)
- The formation of functional mathematical literacy (Семёнова et al., n.d.).

Based on this approach, studies show that when students work on problems rooted in relatable contexts —such as shopping discounts, cooking measurements, or scaling up recipes—they develop a deeper understanding of ratios and proportions (Matney et al., 2013). These challenges help students to see mathematical ideas in action, that's why enabling them to understand and less fear abstract ideas. Furthermore, group solving problem exercises based on real-life situations have been connected to improved peer interactions and class participation, as a result fostering a more dynamic and inclusive learning environment.

Studies also indicate that offering courses based on real-life proportional circumstances is a successful way to boost middle school math both in terms of participation and performance. When mathematical ideas are set in clear and meaningful settings pertinent to students' lives, they help students to understand the value of their education and create closer ties (Yezbick, 2020). Such practices have been linked to a better knowledge of fundamental mathematical ideas and enhanced solving problem skills. Contextualized lectures on measurement, for instance, have been shown to increase involvement with procedural processes, that's why improving general subject performance (Buan et al., 2021).

A quasi-experimental design was chosen to investigate the impact of contextualized, real-life mathematical tasks on student engagement and academic performance. This methodological approach is well-suited to the realities of educational research, as it accommodates the practical constraints of natural classroom environments while still enabling structured, evidence-based analysis of instructional effectiveness. Although traditional experimental designs offer greater control, the quasi-experimental format allows researchers to draw meaningful conclusions by comparing student outcomes before and after the intervention, particularly when full randomization or control groups are not feasible.

This research design aligns with practices commonly employed in educational studies, offering a balance between rigor and real-world applicability. It enables a systematic evaluation of how solving problem assignments rooted in real-life contexts affect students' mathematical understanding and interest, especially in genuine classroom settings.

A successful mathematics learning experience at the middle school level depends not only on instructional quality but also on fostering both academic achievement and student engagement. These two components are especially critical during the formative middle school years, when students begin transitioning from basic arithmetic to more abstract mathematical thinking.

The role of mathematics within fostering critical thinking, solving problem skills, and overall cognitive development is undeniable since its a foundation of modern education systems (Lein A. E., 2015). Kazakhstan is undergoing rapid economic and social transformation, a nation during transition. It is essential for one to ensure the high levels of mathematics achievement and engagement for the purpose of developing a competitive and skilled workforce. This study examines the unique challenges as well as opportunities within Kazakhstan's evolving educational landscape. It tackles the complex matter of student involvement and academic standing in math nationally. According to PISA results in 2018 (Тайболатов et al., 2024), Kazakhstan's math education achievement were somewhat less than in 2015. These changes are associated with various factors such as the academic motivation of students (Тайболатов et al., 2024). educational reforms for modernizing secondary education have been implemented in Kazakhstan (Hermans, 2018). These reforms do include such as the “Updated Content of Education” initiative and a transition to criteria-based assessment (Rakhymbayeva, 2020). In the educational system of Kazakhstan is characterized by a number of unique features in particular. The country has been actively implementing an “Updated Content of Education” program which seeks to shift the focus away from rote memorization so as to develop higher-order thinking skills (Turganalina & Malone, 2023a). Another meaningful change includes the shift toward assessment using criteria. This shift fosters student learning assessment that Kenzhetaeva et al. (2020) state is fairer and clearer. Formal additive, there is an increasing emphasis on functional literacy; this emphasis equips students with the practical skills along with knowledge necessary for success in real-world contexts (Ali et al., 2020).

Despite these efforts, problems facing mathematics learning still affect teachers and students in Kazakhstan. Gaps for students' foundational knowledge also insufficient teacher training with a lack of adequate resources may be included. Access which is unequal to quality mathematics education can stem from differences that are regional and disparities that are socio-economic. We must address the persistent issue about low academic performance. This requires that we intertwine both metacognitive and motivational and behavioral strategies within the classroom's microcosm.

Student motivation is a possible solution to mathematics achievement problem (Herges et al., 2017) Multiple studies have established a direct relationship between motivation and general academic achievement (Herges et al., 2017). Engagement in mathematics has been identified as a significant predictor of academic success (Lein et al., 2016). Engaged students are more likely to be motivated, persistent, and actively involved in their learning, leading to improved understanding and higher achievement. Understanding the factors that influence student engagement in

mathematics is so crucial for developing efficient interventions and strategies to enhance academic outcomes. This study seeks to provide a comprehensive analysis of academic performance and engagement in mathematics among students in Kazakhstan. By examining the interplay of various factors, including curriculum reforms, assessment practices, teacher quality, and student motivation, this research aims to inform policy and practice and contribute to the ongoing efforts to strengthen mathematics education in Kazakhstan.

As Wriston (2015) emphasizes, the development of strong mathematical foundations at this stage is essential for success in higher-level mathematics and STEM disciplines. Proportional reasoning, in particular, plays a pivotal role during this period, serving as a conceptual bridge between arithmetic and algebra and equipping students with tools for tackling more complex problems.

Academic performance depends much on student involvement, which comprises cognitive, emotional, and behavioral aspects. Engaged students are more likely to put effort into their education, apply good solving problem techniques, and persist under difficulty (Lein et al., 2016). Cognitive engagement is a student's commitment to learning and application of techniques to grasp ideas; emotional engagement is their attitudes, interests, and values connected to the subject. A student's active involvement in learning activities reflects behavioural engagement. Sadly, middle school years see a drop in student involvement in mathematics (Martin et al., 2015).

Thus, by giving both academic performance and student involvement top priority, teachers can create a more encouraging and efficient learning space that promotes mathematical success. Students of all achievement levels must address math involvement (Skilling et al., 2021).

Integrating creative teaching strategies is absolutely vital in Kazakhstan, where the education system is changing to fit world standards, so improving student results. The updated content of education in Kazakhstan aims to develop functional literacy and a wide range of skills, setting more complex intellectual tasks in mathematics (Turganalina & Malone, 2023b). This shift necessitates pedagogical approaches that can effectively bridge theoretical knowledge and practical application. Bringing in aspects of ethno-pedagogy can link the subject to national traditions, helping students feel more connected to their culture and possibly boosting their motivation. Formal additive, research suggests that engagement uniquely predicts mathematics problem-solving performance (Lein A. E., 2015), which emphasizes the value of creating learning environments that actively involve students. By using real-world applications, educators will make mathematics more relevant and engaging toward students, and this fosters a deeper comprehension of mathematical concepts and their practical implications (Sujatha & Vinayakan, 2023). This approach aligns well with all global educational trends and also it addresses itself to the specific needs that Kazakhstani students have so that they are each prepared well for tackling complex problems and also can succeed in an increasingly competitive world.

One of the main principles of this study is the use of carefully observed phenomena in everyday life - such as budgeting, recalculating family recipes,

navigating a map, and calculating distances - to develop balanced thinking. This choice allows students not only to mechanically master mathematical procedures, but also to understand and apply them in contexts that are close and understandable to them in everyday practices. Realistic tasks are set to increase students' motivation and engagement, stimulating the development of critical thinking and cognitive activity (Boaler, 1998a; Broza & Kolikant, 2020b). In contrast to the abstract problems traditionally prevailing in textbooks, the proposed approach promotes a deeper understanding of mathematical concepts and their practical application in explaining life (Sujatha & Vinayakan, 2023).

The scientific novelty of the study also lies in its approximation to the Kazakhstani educational context, such as elements of ethnopedagogy and a competency-based course. Connection with the cultural realities of students - through the use of tasks, boundaries with national traditions, everyday life and life experience - focuses motivation for learning and promotes the formation of a positive attitude towards mathematics (Turganalina & Malone, 2023b). The inclusion of such culturally significant components makes learning more meaningful and meets the objectives of the updated educational content in Kazakhstan, aimed at developing functional literacy and encouraging knowledge with life situations (Casler-Failing, 2018a; الهدور & Aldbyani, 2023). Thus, the study represents a multidisciplinary approach combining mathematics, ethnopedagogy and modern educational practice, which is especially relevant in the context of accepting challenges and moving towards education focused on the practical applicability of knowledge.

Educational engagement goes further than just taking part it involves using good learning methods. Measurable outcomes result from involvement both inside outside the classroom (Kong, 2021). A well-rounded educational experience is helped via these practices as community involvement and extracurricular activities with academic endeavors. Engagement operates at emotional, behavioral, and cognitive levels, and cognitive engagement focuses on people actively participate and people desire to learn beyond academic requirements (Syarifuddin, 2013). With this educational approach, students gain academic skill with social and emotional adjustment. It prepares the students, so that they will succeed in various aspects of their life.

Background of the Study: The development of proportional reasoning is a critical aspect of mathematical education since it acts as a gateway to more advanced mathematical concepts plus it plays a vital role in navigating real-world scenarios (Ayan-Civak H. & Işıksal-Bostan, 2018). Lamon describes proportional reasoning as involving the detection, expression, analysis, as well as provision of evidence for claims about proportional relationships (Tunç, 2020). However, many students do battle with proportional reasoning, which can obstruct their overall comprehension of mathematics. This basic idea supports science as well as other fields (Wriston, 2015). Heinz and Sterba-Boatwright stated, "Proportional reasoning is at the core of so many crucial concepts in mathematics and science, including similarity, relative growth and size, dilations, scaling, pi, constant rate of change, slope, rates, fractions, and probability." Its of importance for the creation of improved teaching strategies if

educators recognise all of the obstacles that students may face in their grasping of proportional concepts (Bintara & Suhendra, 2021). This challenge shows how its valuable to explore teaching methods for innovation that can help students comprehend and apply proportional reasoning (Ojose, 2015). Targeted instruction can promote development of proportional reasoning skills alongside research, as research has shown students often battle with proportional reasoning and its foundational concepts (Hilton et al., 2016).

With customary methods that are teaching proportional reasoning, people often have to memorize some formulas and various procedures by rote, which truly may not help people deeply understand or then apply these concepts in novel situations. Students may see mathematics as disconnected and abstract since they cannot appreciate its daily relevance using this approach (Sujatha & Vinayakan, 2023). Proportional reasoning is crucial outside the classroom, for it lets people decide wisely in daily contexts as they calculate discounts, adjust recipes, or understand financial ratios. People are able to comprehend quantitative data and tackle issues in many aspects of life via proportional reasoning. As a result, its essential for students to be academically successful as well as function effectively within a mathematically rich world. Thus, we have to find some ways to make that proportional reasoning be more accessible and also engaging for them. Understanding proportion concepts is a requirement for the transformation concept (Mardika & Mahmudi, 2021). Proportion concepts are meaningful hence. Karagöz Akar listed students' misconceptions in the ratio concept as misconceptions about additive and multiplicative association, misconceptions about covariation and transformation, and misconceptions about constancy (Çalışıcı, 2018).

The need for well-executed teaching strategies point out even further the Common Core State Standards for School Mathematics cause proportional reasoning is one of the four key areas in the sixth and seventh-grade curricula (Ayan-Civak H. & Işıksal-Bostan, 2018). This emphasis reflects the recognition that proportional reasoning is acting as a foundational concept. Proportional reasoning ensures success within higher-level mathematics courses as algebra and calculus. This study seeks to find how useful using real-life applications is for better student engagement plus student academic achievement in mathematics since students have difficulties with important proportional reasoning. This research seeks to provide some recommendations for transforming mathematics education so as to better meet learners' needs and to prepare them for 21st-century success by relating proportional reasoning with relevant contexts. Though proportional reasoning is central, many students battle so one must examine the issue's source.

Statement of the Problem: Despite the recognized importance of proportional reasoning within mathematics education and its common presence within real-world scenarios, students still greatly battle to grasp this concept (Ojose, 2015). Specifically, students often exhibit difficulties when they transfer their comprehension of proportional relationships from abstract mathematical problems to concrete real-world applications as well as generating errors in solving problem plus exhibiting a lack of confidence in their mathematical abilities. The effectiveness with

customary teaching methods is questioned since of this disconnect. Worries are expressed about nurturing understanding coupled with retention of proportional reasoning skills.

Mathematics is viewed by many of the students as rather abstract and not relevant, in addition to which it can truly impact their motivation in the learning process (Jupri, 2017). Student disengagement worsens their struggles to master proportional reasoning cause they might not invest effort to grasp the concept fully. The issue can be compounded cause proportional reasoning reasons at a higher order since it comprehends multiple relations among some relations (Ayan-Civak H. & Işıksal-Bostan, 2018).

Therefore, this study seeks to address how best to enhance student engagement and academic achievement in proportional reasoning. This study examines how real applications may be used as tools to teach this. Ultimately, this research is designed for offering actionable perceptions for educators, curriculum designers, and policymakers since it fosters the integration of genuine, real-world contexts into mathematics curricula to cultivate deeper student learning, heightened engagement, and improved solving problem capabilities within the domain of proportional reasoning.

Importance of the Study: This study holds significant importance for several reasons, particularly within the context of Kazakhstan's evolving education system. First, it addresses a critical need to boost mathematics education in middle schools by focusing on proportion, a foundational concept essential for success in STEM fields. As Kazakhstan strives to meet international education standards (Meterbayeva et al., 2015), enhancing students' understanding and engagement in mathematics becomes paramount. The President has emphasized the need for education to meet international standards (Meterbayeva et al., 2015). However, some critics argue that emphasizing real-life applications may detract from developing a solid grasp of abstract mathematical theory. It is essential to acknowledge this viewpoint, recognizing that a well-balanced approach, integrating both theoretical foundations and practical applications, is necessary for nurturing deep, transferable mathematical understanding (Boaler, 1998b).

Second, this research is particularly relevant given Kazakhstan's commitment to modernizing its education system and cultivating a skilled workforce capable of driving economic and social progress (Meterbayeva et al., 2015). By rigorously examining how real-life applications impact student engagement and academic achievement, this study offers actionable insights into helpful teaching methods that can be readily adopted in Kazakhstani schools. This approach not only deepens students' comprehension of mathematical concepts but also sparks their interest in the subject, fostering a more positive attitude towards learning (Arthur et al., n.d.). In addition, it equips them with the practical skills necessary to apply mathematical knowledge in real-world contexts, thereby enhancing their solving problem abilities and preparing them for future success.

Third, this study is a valuable addition to the expanding collection of research focused on student engagement, specifically within the realm of mathematics

education. A deeper understanding of effective student engagement strategies in mathematics is essential for boosting academic performance and equipping students for success in the future (Hollingsworth, 2012). With increasing emphasis placed on cultivating 21st-century skills and ensuring global competitiveness, this research provides educators with tangible strategies to foster more engaging and meaningful learning experiences for students. Another point is that, the study's emphasis on real-world applications is in line with the larger goal of encouraging a more useful and relevant education that adequately prepares students for the challenges and opportunities presented by the modern world (Arthur et al., n.d.).

Purpose of the Study: The primary purpose of this study is to rigorously investigate student engagement in addition to academic achievement in mathematics impacted by incorporating real-life applications of proportion. This research seeks to determine with definitiveness whether calculated use of real-life contexts within the teaching of proportional reasoning leads in demonstrable ways to increased student interest and motivation. It also tries to see if such use causes stronger, deeper comprehension of what is taught. This study seeks to have an evaluation of the effectiveness of this approach through the use of a comparative analysis, as this study measures the learning outcomes for students that receive instruction improved with real-life applications against all those students that receive customary instruction, and thereby this study provides research data of the added value from contextualized learning. In addition, the study seeks to uncover specific reproducible strategies for integrating real-life applications within mathematics instruction, and it offers actionable perceptions for educators who are looking to strengthen their pedagogical approaches and boosts student outcomes in proportional reasoning.

Furthermore, the study seeks to pinpoint efficient strategies and techniques in order to integrate real-life applications into the teaching of proportional reasoning for maximized student learning outcomes. Exploring the most engaging as well as relevant real-life scenarios for students is involved, through the optimal methods for presenting the scenarios cultivating critical thinking and advanced solving problem skills (Sujatha & Vinayakan, 2023). Project-based learning has the potential to foster meaningful engagement, so this study will examine its relationship with achievement. We will evaluate how effectively PBL teaches and helps students learn for a strategy (Coffman, 2022). Educators should explore active learning pedagogies like PBL cause PBL seeks to make learning opportunities engaging plus meaningful incorporating content for achievement (Coffman, 2022).

Ultimately, the overarching goal of this study is to furnish evidence-based recommendations for enhancing mathematics education by making it more relevant, engaging, and useful for all students, thereby fostering a deeper appreciation for the practical applications of mathematical concepts in everyday life.

This research is exceptionally helpful to participants within education. This research grants teachers useful perceptions into strong tactics for teaching proportional reasoning via evidence-based methods for integrating real-world applications into lesson plans. From this study's findings, curriculum developers are able to learn. Mathematics curricula for students can be more relevant, charming, and

efficacious if developers use the findings. textbook writers will also be notified by the study to bridge content as well as context, formal additive more real-life oriented mathematical problems will increase the mathematics textbook's effectiveness and quality (Jalali, 2021).

In addition, policymakers can use the results of this study to make informed decisions about mathematics education, such as encouraging the use of real-life applications in classrooms and providing resources for teacher training in this area. By identifying practices that students prefer their mathematics teachers engage in, the study can help enhance students' interest in mathematics (Arthur J., 2018). Additionally, the study contributes to the broader field of mathematics education by providing research data on the effectiveness of real-life applications as a pedagogical tool.

In essence, this research has the potential to transform mathematics education by making it more relevant, engaging, and helpful for all students, and also by helping students develop the skills and knowledge they need to succeed in the 21st century.

As educators realize that skills such as problem solving, investigation, critical thinking cannot be gained easily when knowledge is separated from application in the real world, this study is designed to integrate mathematics and science curriculum in a framework that enables teachers to show how beneficial and efficient scientific knowledge is in real-world application (Al-Mutawah et al., 2022) . Formal additive, this study addresses the call for educational programs to create students who are thinkers and doers, capable of applying their knowledge while working in collaborative environments (Casler-Failing, 2018).

Scope and Limitations:This study focuses specifically on the impact of integrating real-life applications into the teaching of proportional reasoning among middle school students. The scope is deliberately centered on exploring how the contextualization of mathematical content through original, real-world tasks affects both student engagement and academic achievement.

The choice of sixth-grade students (approximately 11–12 years old) as the target group for the study were determined by substantive requirements in mathematical education plus psychological characteristics of their development. J. Piaget's theory for cognitive development suggest children at this age transition from the concrete-operational to the formal-operational stage of thinking. They then begin to master abstract concepts in addition to logical structures (Piaget, 1972). Proportional thinking is one of the first truly abstract components in the mathematics course, requiring the transition from addition to multiplication and an understanding of the relationships between quantities (Lamon, 2007). Several studies emphasize that insufficient mastery of proportional relationships at the secondary level of education leads to serious difficulties in further education, especially when studying algebra, geometry, and data analysis (Karplus et al., 1983; Vergnaud, 1983). Thus, sixth grade represents a critical period during which targeted pedagogical interventions can significantly influence the development of stable mathematical concepts and ensure students' success in subsequent stages of education.

Proportional reasoning has been identified as a foundational skill necessary for success in higher-level mathematics and a wide range of real-life contexts, including science, economics, and technology (Lamon, 2007). Given its cross-disciplinary importance, improving students' understanding of this concept is a key goal of mathematics education, particularly in middle school, when such abstract reasoning begins to develop more fully (Vergnaud, 1983).

The study is confined to the use of real-life applications as a specific pedagogical tool, excluding the exploration of other instructional strategies such as digital simulations, flipped classrooms, inquiry-based learning, or traditional drill-based approaches. While a variety of teaching methods have been shown to influence mathematics achievement (Medina Herrera et al., 2024), the focus within this study narrows to isolate the effects on student outcomes in proportional reasoning of contextualized, real-world learning scenarios. The research design deliberately limits the content area so as to maintain focus plus coherence. Thus, algebra, geometry, or statistics, other mathematical domains, will not be deeply examined.

Formal additive, the study will involve a restricted sample, comprising students from a limited number of middle school classrooms. While efforts will be made to select participants from diverse educational settings, the findings may not be generalizable to the broader population of middle school students across regions or school types. This limitation is mainly due to practical constraints, such as time, staffing, and logistical considerations, which may affect the sample size, diversity, and duration of the intervention. Similar limitations have been acknowledged in other classroom-based educational interventions, where external validity is often traded off for tighter internal control (Cohen et al., 2017a).

Moreover, the duration of the instructional intervention is expected to span a few weeks, which, while sufficient for measuring short-term changes in engagement and achievement, may not capture long-term retention or conceptual transfer. As such, the findings should be interpreted within the context of a short-term experimental study, rather than a longitudinal analysis.

Objectives:

- Examine practical challenges employed in mathematics instruction.
- Pedagogical attributes of instructing dimensions using practical examples
- Methodology for instructing proportions in mathematics education
- Assess academic performance and determine appropriate methodologies for instructing proportions throughout experimental activity.

Scientific Innovations in Understanding Proportional Reasoning: Students comprehend proportional relationships more deeply since of some research data indicating embedding mathematical instruction within these real-world contexts actually helps (Arthur J., 2018; Ayan-Civak H. & İşıksal-Bostan, 2018). This pedagogical approach moves away from rote memorizing cause it fosters that people strongly and practically comprehend proportionality and can readily transfer proportionality to novel situations. Educators work to cultivate critical thinking skills by grounding abstract mathematical concepts within concrete everyday scenarios. They use math knowledge also in real situations. This fits well with ideas on

educating. These philosophies stress relevance along with applicability within mathematics education, according to Arthur et al. (2018). Also, students may change mathematical ideas that are abstract into actual strategies for solving problems, which helps mathematical literacy (Ayan-Civak H. & Işıksal-Bostan, 2018).

Didactic Strategies for Teaching Proportions Using Real-Life Examples: Research emphasize the didactic benefits of integrating real-life examples into the instruction of proportional reasoning (Arthur J., 2018). This approach not only elevates student motivation but also cultivates a deeper emotional and cognitive investment in the learning process. The incorporation of relatable examples eases students' retaining and students' understanding the subject matter in greater depth. Didactic key features include a contextual relevance focus, task complexity's progressive increase, with independent problem-solving's encouragement (Arthur J., 2018). These components integrally promote student cultivation of deep, important academic aptitudes as they confront mathematical obstacles exhibiting assurance and creativity.

Instructive approaches that cultivate mathematical reasoning have been discerned via scrutiny of research data (Arthur et al., 2018). These instructional techniques boosts scholastic consequences with regard to quantitative logic. Effecient strategies include for example the utilization of project-based learning along with collaborative solving problem activities. Reflection opportunities that are regular coupled with classroom dialogue promotion are also useful strategies. These strategies implemented all together create an environment which is conducive for mastering proportional relationships comprehensively. Because the recommendations resulted, they provide a methodological framework that designs curricula, improves teacher training programs, also eases adoption of revolutionary approaches to mathematics education. Some students have difficulties when dealing with different contexts (Arhin, 2018).

In summary, integrating real-life problems into proportion instruction yields positive effects on student engagement and deep learning. The engagement with mathematical problems refines students' ability to tackle challenges, enhancing their capacity to address problems in diverse contexts (Medina Herrera et al., 2024).

Aim:

- The aim of this research is to investigate how integrating real-life proportion problems into middle school mathematics curricula enhances student engagement, improves academic achievement.

Research question:

- How does the implementation of a real-life problem learning proportion unit impact the mathematics engagement and academic achievement of sixth grade students?

Subject of the research: The use of real-life related problems in teaching the topic of proportions.

Object of the research: The process of teaching mathematics to 6th-grade students.

1. LITERATURE REVIEW

The literature review is a critical component of this research, serving several important purposes. Primarily, it systematically examines the existing knowledge on the impact of real-life applications of proportional reasoning on student engagement and academic achievement. As previously mentioned, the integration of knowledge with real-world applications enable the acquisition of skills such as problem-solving, investigation, and critical thinking.

A thorough literature review is essential for several reasons. First, it establishes a knowledge foundation by identifying what is known about the relationship between real-life applications, student engagement, and academic achievement in mathematics (Lein A. E., 2015). This procedure includes exploring theoretical perspectives, empirical findings, and methodological approaches used in prior studies. Second, through a discerning analysis of remaining scholarly works, the review delineates subjects requiring additional investigation, like unexamined demographics or settings, or domains probing revolutionary treatments plus evaluative techniques. The analysis additionally seeks to pinpoint predicaments that students confront. Grasping as well as implementing proportional reasoning is explored within (Jupri, 2017). Assessing and integrating remaining scholarship is important to shape the present investigation's direction and structure and yield a complete comprehension of knowledge.

The literature review also informs the research design by giving information about useful interventions, appropriate outcome measures, and potential confounding variables to consider. Additionally, the review situates the current research inside of the broader field of mathematics education, and this also shows its relevance and importance. As mentioned, this study seeks to integrate mathematics into science curriculum, which enables teachers to show the benefits of scientific knowledge in real-world applications. In the literature review, project-based learning's potential as a teaching pedagogy is prove. This pedagogy does engage students and incorporates 21st-century skills, while it maintains academic achievement (Coffman, 2022). The literature review examines existing research regarding real-life applications plus project-based learning within mathematics education so it guides the current study's design as well as ensures building upon prior successes while addressing field gaps. This comprehension of the theoretical as well as empirical foundations will strengthen the study's methodology, which will increase the results' likelihood.

Overall, the review enhances the credibility and rigor of the study by demonstrating that the research is grounded in existing knowledge and contributes to the ongoing conversation in the field (Sujatha & Vinayakan, 2023).

Finally, the literature review explains all of the study's research questions since it point out both their importance and field contribution. Basically, the literature review ensures this research builds on knowledge, addresses gaps, and meaningfully contributes to understanding how real-life applications can strengthen student engagement and academic achievement in proportional reasoning. The review needs

to summarize as well as synthesize findings in order to analyze importance of the research question. Also, it should give a complete comprehension of current knowledge instead of just reporting research. This process of critical analysis as well as synthesis is meaningful to inform the design and focus of the current study cause it ensures it builds upon previous successes and addresses identified gaps (O'Brien, 2023). The literature review additionally strengthens the credibility as well as rigor of the research by showing the study is relevant and meaningful within the broader context of mathematics education.

Proportional reasoning improved abilities of students in science and mathematics. Ayan-Civak & İşıksal-Bostan (2018) say that this very understanding is quite solid. Instruction through highlighting the relevance and utility of mathematics can foster deeper understanding and engagement in solving real-world problems, connecting mathematical concepts to genuine, practical contexts.

1.1 Defining Key Concepts

Student engagement shapes and constructs a rich complex concept that helps shape students' experiences with learning. Cognitive, emotional, and behavioral engagement represent its three interrelated dimensions each uniquely contributing to students' academic motivation, performance, and persistence (Fredricks et al., 2004). It is quite necessary that educators fully understand and then support each of these dimensions, for educators must seek to cultivate more meaningful educational settings that actively promote academic achievement and long-term personal growth.

For learning, students invest intellectually in order to engage cognitively. It reflects that they willingly exert effort as they apply cognitive strategies in order to deeply engage with content. Cognitively engaged students show critical thinking and persistence. They also do show a metacognitive regulation as they strive for a comprehension of complex concepts (Mahmudi, 2021). They actively work to construct a meaning, synthesize some new information, and seek to find connections that exist within and also across subject areas instead of relying upon rote memorization. Challenges seem like chances for growth to learners and mastery is their motivation not performance.

Emotional engagement refers to students' affective responses to learning, plus these responses include their interest, enjoyment, sense of belonging, and overall attitude toward school. Students share emotional bonds with instructors, peers, plus educational settings (Syarifuddin, 2013). Positive emotional engagement fosters curiosity, intrinsic motivation, together with enthusiasm to explore academic content. On the other hand, negative emotions are able to greatly inhibit the willingness of students to participate. Students' feelings of competence or worth in learning lessen due to anxiety, boredom, or alienation.

Behavioral engagement is focused on the observable actions of students. This engagement happens inside the academic environment. This includes their attendance, punctuality, participation within classroom activities, and completion regarding assignments. Help-seeking behaviors are included as well (Sujatha & Vinayakan, 2023). Behaviorally engaged students consistently show initiative and

responsibility since they collaborate with peers, contribute to discussions, and actively own their learning process. These behaviors signal commitment toward academic success. They also do show that someone has internalized goals and expectations related to school.

Collectively, these dimensions interact to create a holistic portrait of a student's engagement profile. When nurtured together, they promote not only academic achievement but also self-efficacy, resilience, and lifelong learning habits.

Importantly, real-world applications of some academic content can potentially boost all of the three engagement domains. Students achieve greater learning when instruction incorporates real problems reflecting their lives and goals cause it motivates them and gains personal meaning (Boaler, 1998b). Educators help students see what they learn as useful through closing the divide between classroom theory and its practical application, which processes deeper cognition, invests emotionally, and participates actively.

For instance, using actual situations alters students' views about the topic in math learning. Budgeting, architecture-based measurement, or environmental data analysis are scenarios. New relevance for abstract or for disconnected concepts does gain. These concepts then become tools toward making decisions for solving challenges. According to research (Broza & Kolikant, 2020a), contextualized learning fosters conceptual understanding and greater perseverance, also motivation increases.

Ultimately, for when we foster student engagement, a thorough approach addressing the cognitive, emotional, and behavioral dimensions of learning is required. Instructional experiences challenging students intellectually as well as connecting with emotions and inviting them to take an active role must be created by educators for them. Teachers are able to learn through embedding genuine contexts, relate meaningfully inside the classroom, and cultivate an environment in which students engage and reach for their full potential.

1.2 The Importance of Proportional Reasoning

Proportional reasoning is generally recognized as a vital aspect of quantitative literacy as well as a bedrock of mathematical expertise. Fundamentally, proportional reasoning includes identification, depiction, contrasting, and utilization of multiplicative associations. This deduction is executed amid magnitudes (Lamon, 2007). This capability transcends simple arithmetic; it lets one understand more advanced mathematical concepts as well as helps one progress toward advanced topics such as algebra, geometry, probability, and calculus.

The importance of proportional reasoning extends far beyond its utility in solving textbook problems. Research consistently emphasize its crucial function since it cultivates students' conceptual comprehension throughout the middle school years, acting as a cognitive nexus toward more abstract mathematical thought (Karplus et al., 1983). Students readily comprehend proportional associations also boldly tackle detailed problem-solving situations. This comprehension empowers them to decipher and use quantitative arrangements and contemplate correspondence and proportion.

These abilities are especially crucial when students begin working with rates of change, linear functions, and other algebraic representations.

Formal additive, proportional reasoning exists deeply within everyday living practical numeracy required, beyond academic settings. People must frequently employ proportional reasoning to assess alternatives also attain well-informed selections in situations like budgeting, cooking, and contrasting discounts. People additionally require that for deciphering well-being metrics or affecting determinations contingent on hazard evaluations (National Council of Teachers of Mathematics, 2000; Suwarsono, 2019) In this regard, fiscal erudition, consumer cognizance, and civic accountability are advanced by proportional reasoning.

Proportional reasoning also occurs within the rapidly evolving, data-abundant global economy cause STEM (Science, Technology, Engineering, and Mathematics) fields remain vital. In scrutinizing scientific information, or grasping engineering stipulations, or construing statistical associations, experts depend on their skill to comprehend proportional correlations within inquiry. Specific endeavors stress dimensional conversion, measurement precision, also scale modeling. These assignments necessitate interpreting graphs or charts. All these tasks represent fundamental aptitudes within science and technology.

Since it remains broadly applicable and quite rudimentary, mathematics pedagogy should consider a proportional logic's deep, supple, and versatile comprehension an essential objective. Educational tactics must go beyond simple routines as well as fully grasp deep, meaningful situations that link academic study to genuine uses. This includes inspiring varied depictions joined with employing genuine problematic circumstances. People should foster metacognitive reflection since it relates to multiplicative reasoning processes as well.

Indeed, strengthening pupils' proportional reasoning capabilities is not simply an academic matter; its an crucial stride for readying learners to participate considerately and adeptly within mathematical fields and wider social predicaments. Instructors, curriculum architects, and policymakers should stress fostering proportional reasoning. They can cultivate mathematically literate as well as critically thinking citizens equipped to navigate modern complexities via revolutionary plus context-sensitive pedagogical approaches.

1.3 Impact on Student Engagement

Student engagement is a dynamic, multifaceted construct that plays a foundational role in shaping the quality and depth of students' learning experiences. It encompasses three interrelated dimensions: cognitive, emotional, and behavioral engagement, each of which contributes uniquely to students' academic motivation, performance, and persistence (Fredricks J. A. & Paris, 2004). Understanding and supporting these dimensions are essential for educators seeking to cultivate meaningful learning environments that promote both academic achievement and long-term personal growth.

Cognitive engagement involves the intellectual investment students make in learning. It reflects their willingness to exert effort, apply cognitive strategies, and

engage deeply with content. Students who are cognitively engaged demonstrate persistence, critical thinking, and metacognitive regulation as they strive to understand complex concepts (Syarifuddin, 2013). Rather than relying on superficial or rote memorization, they actively construct meaning, synthesize new information, and seek out connections within and across subject areas. These learners view challenges as opportunities for growth and are motivated to achieve mastery rather than mere performance.

Emotional engagement refers to students' affective responses to learning, including their interest, enjoyment, sense of belonging, and overall attitude toward school. It encompasses the emotional bond students form with their learning environments, peers, and instructors (Hollingsworth, 2012). Positive emotional engagement fosters curiosity, intrinsic motivation, and a desire to explore academic content with enthusiasm. Conversely, negative emotions such as anxiety, boredom, or alienation can significantly inhibit students' willingness to participate and diminish their sense of competence or value in learning.

Behavioral engagement, meanwhile, fixates upon conspicuous pupil conduct within scholastic settings. This includes help-seeking behaviors (Syarifuddin, 2013), completion of assignments, participation within classroom activities, punctuality, and their attendance. Behaviorally engaged students consistently show initiative as well as responsibility they collaborate with peers, contribute within discussions, plus actively own their very learning process. These behaviors evince a dedication toward scholastic attainment. In addition, they assimilate objectives and anticipations tied to scholastic pursuits.

Collectively, these dimensions interact to create a holistic portrait of a student's engagement profile. When nurtured together, they promote not only academic achievement but also self-efficacy, resilience, and lifelong learning habits.

Importantly, real-world applications of academic content have the potential to enhance all three engagement domains. When instruction integrates original context-rich problems then these problems mirror students' experiences plus future ambitions, students learn via methods that feel applicable, inspiring, and quite meaningful (Boaler, 1998b). Instructors may aid pupils to perceive the value of their education via closing the divide involving academic concepts and hands-on usage. This cultivates improved intellectual engagement, affective commitment, and dynamic involvement.

In mathematics education, as an instance, in the event that you incorporate genuine circumstances such as financial planning, ecological data assessment, or architecture-centered mensuration, this can alter learners' standpoints on the topic. Theoretical or unrelated ideas accrue salience as a strong instrument. They aid in resolving concrete predicaments, also to attain informed resolutions. Investigations reveal that a movement toward situated education not only increases impetus but also emboldens people to persist further and comprehend concepts more completely (Broza & Kolikant, 2020c).

Ultimately, in that moment we cultivate pupil involvement, we require an exhaustive tactic that confronts how students gain knowledge, experience emotion,

and conduct themselves. Instructive encounters that test students intellectually as well as connecting with their emotions, in addition inviting them to assume an active part within their scholastic expedition must be fashioned by educators. Educators may foster an instructional milieu via incorporating learning within genuine scenarios. Inside that classroom, educators can cultivate important relationships, thus enabling students to realize their complete capabilities as involvement flourishes.

1.4 Impact on Academic Achievement

Research strongly supports the idea that student engagement, academic achievement, and the use of real-life applications in mathematics education are tightly interconnected. When students are given opportunities to apply mathematical concepts—particularly proportional reasoning—in real-world contexts, their understanding deepens, and their motivation to learn increases significantly. This integration helps bridge the gap between abstract mathematical theory and meaningful practice, promoting long-term retention and the development of transferable problem-solving skills (Boaler, 1998b; Fielding-Wells et al., 2014).

Proportional reasoning—the ability to understand and manipulate ratios, rates, and relationships between quantities—is a critical skill that supports broader mathematical thinking. However, its effectiveness is significantly enhanced when embedded in actual contexts. For instance, students asked to solve realistic financial or measurement problems demonstrate higher cognitive engagement and a better grasp of the underlying mathematics (Ayan & Isiksal-Bostan, 2019; Sawatzki et al., 2019).

Studies have shown that students who are able to relate mathematics to everyday scenarios—such as adjusting recipes, budgeting, or scaling drawings—develop a more positive disposition toward the subject and report increased confidence in their abilities (Banerjee & Bhat, 2025; Prayekti, 2025). This is partly since real-life tasks make learning more relevant and reduce the perception of mathematics as abstract or irrelevant (Domondon et al., 2024; Risdiyanti et al., 2024).

Project-based learning (PBL) and inquiry-based approaches have also proven useful. PBL allows students to investigate real-world problems over extended periods, encouraging collaboration, reflection, and deeper learning. Research demonstrates that such approaches significantly strengthen proportional reasoning skills and support student engagement across cognitive, emotional, and behavioral dimensions (Coffman, 2022; Ergene & Karaboğaz, 2024).

However, while the benefits of real-life applications are well-documented, some researchers advise caution against over-relying on contextualized examples. Boaler (1998) and Yezbick (2020) warn that real-world contexts, if not well-aligned with mathematical learning goals, may distract from the abstract principles students need to generalize. For instance, some learners may focus too heavily on surface features of a scenario rather than identifying the core mathematical structure. This can impede transfer to unfamiliar or decontextualized problems.

Another concern is cultural relevance. When contextual examples are not sensitive to students' backgrounds or interests, they may be perceived as artificial or

irrelevant, leading to disengagement rather than motivation (Beswick, 2012; Calder, 2011). For this reason, designing inclusive and culturally responsive tasks is essential to ensuring that all students feel represented and empowered in their learning.

In support of this, research by Tjoe and de la Torre (de la Torre & Minchen, 2014) emphasized the need for diagnostic frameworks that assess not only procedural fluency in proportional reasoning but also students' conceptual understanding and ability to transfer knowledge. Similarly, Norton (2005) highlighted how genuine investigative tasks helped pre-service teachers enhance both content mastery and pedagogical awareness, suggesting long-term benefits for both learners and educators.

Despite challenges, most scholars agree that the thoughtful integration of real-life applications—supported by diverse instructional strategies and aligned assessments—can transform mathematics learning. As Fielding-Wells (2014) noted, inquiry-based models that value engagement, reflection, and authenticity create conditions where students see mathematics not just as a subject, but as a powerful tool for understanding and navigating the world.

Impact of Academic Achievement and Student Engagement in Mathematics on PISA Results: The Programme for International Student Assessment (PISA), overseen through the Organisation for Economic Co-operation and Development (OECD), devises an evaluation which efficiently gauges how 15-year-old students use their understanding and capabilities for quandaries within literacy, science, and mathematics in legitimate, actual existence. Mathematical skill constitutes specific importance inside the PISA model. It includes requisite proficiencies for example data interpretation, proportional reasoning, also mathematical modeling.

Academic Achievement and PISA Performance: Academic achievement in mathematics, typically evaluated through school grades and standardized assessments, has been shown to correlate positively with students' performance on PISA (OECD, 2019). Students who demonstrate strong academic outcomes in traditional settings generally perform better in international benchmarking, especially in domains related to algebra, percentages, and proportional relationships. However, existing research reveal that high achievement in classroom-based assessments does not always translate into high performance on PISA. This is particularly the case when instruction is overly procedural, emphasizing rote learning over conceptual understanding and real-world applicability (Boaler, 1998b).

In the context of Kazakhstan, although students often attain satisfactory academic results in mathematics at the national level, the PISA 2018 results revealed a decline in mathematical literacy compared to PISA 2015. This disparity show schools considerably mismatch pedagogical approaches with the aptitudes PISA evaluates (Pons et al., n.d.). Pupils might be capable to execute computations coupled with resolving formulated equations. Nevertheless, many people battle when they are tasked with employing such capabilities to analyze original data or surmount dilemmas demanding proportional logic within novel situations.

Student Engagement as a Predictor of PISA Success: Student engagement influences mathematics outcomes in PISA since it emerged as a critical factor like

academic performance does. Engagement is typically understood as being a multidimensional construct that includes cognitive, emotional, and also behavioral components (Fredricks et al., 2004). Research has shown that students succeeding in complex PISA tasks demanding reasoning, reflection, as well as adaptability are more likely to be cognitively engaged (Fielding-Wells et al., 2014).

In Kazakhstan, the decline in PISA mathematics scores has also been linked to low levels of student motivation and engagement. Contributing factors do include test-related unease, dearth of captivation regarding the subject, and exposure to contextualized real-world mathematical tasks that were insufficient (Kazima, 2013). These predicaments stress why educators must address pedagogy in a specific manner. They should not only focus upon acquiring knowledge but cultivate students' intrinsic motivation as well as sustained involvement in mathematical thinking.

Combined Effects of Achievement and Engagement

Current empirical research underscores that students flourish academically and engage regarding forecasting performance throughout international assessments such as PISA. Eminently successful learners exhibiting apathy might battle when faced with revolutionary quandaries. Even extremely dedicated pupils who possess inadequate primary capabilities can perceive undertaking advanced deductive activities as challenging. Accordingly, instructional efficacy and student involvement strategies both must be addressed to boosts upon national PISA outcomes (Fredricks et al., 2004; Sujatha & Vinayakan, 2023)

This mandates a twofold strategy: we elevate the caliber of mathematics education when we assimilate information theoretically and empirically, and we concurrently cultivate pupil enthusiasm and action should instruction link mathematics to original circumstances. These endeavors correspond with the global movement toward competence-based education as well as furnish a bedrock that improves academic success plus functional mathematical literacy, as PISA and similar assessments require.

1.5 Functional Mathematical Literacy, Engagement, and Academic Achievement

Research also suggests that while genuine contexts can support motivation and application, they do not always result in deep conceptual understanding or successful knowledge transfer (Coffman, 2022; Sujatha & Vinayakan, 2023). In some cases, students may rely too heavily on surface-level cues in real-life problems, thereby undermining their procedural fluency and abstraction skills (Beswick, 2011; Boaler, 1993).

As a result, a balanced pedagogical approach is essential—one that integrates real-life contexts with explicit instruction in core mathematical concepts and procedures. Such a hybrid model not only fosters engagement but also ensures that students build a strong conceptual foundation, which is critical for long-term mathematical proficiency (Stein et al., 2000).

Current research point out the important relationship between functional mathematical literacy, student engagement, and academic achievement. Functional

mathematical literacy is defined as the ability to apply mathematical knowledge and skills in meaningful life contexts, from making decisions in everyday life to critically understanding numerical information (Sujatha & Vinayakan, 2023;).

Coughlin (2003) examined the dynamics of brain activity in schoolchildren and found that functional neural networks activated when solving mathematical problems are predictors of successful academic performance. This confirms the link between deep cognitive engagement and functional literacy in mathematics.

In addition, research shows that the use of tasks related to real-life situations (e.g., budgeting, scaling, price comparison) increases engagement at both cognitive and emotional and behavioral levels (Boaler, 1998; Broza & Kolikant, 2020; Caratozzolo et al., 2025). Such tasks develop critical thinking and motivation, especially in middle school students, whose engagement often declines (Martin et al., 2014).

Also significant are the results of Zapata-Rivera (2024) who prove that the integration of generative AI and personalized feedback enhances functional literacy through adaptive student engagement.

In educational practice, the use of real-life tasks in proportional reasoning contributes to:

- Formation of a strong conceptual base;
- Increasing self-efficacy;
- Increasing interest in the subject and internal motivation (Fredricks et al., 2004; Lein et al., 2015).

It is engagement, as a complex psychological and pedagogical phenomenon, that becomes a mediator between functional literacy and academic achievement (Fredricks et al., 2004; Skinner & Belmont, 1993).

1.6 Comparative Analysis of Proportional Reasoning in Mathematics Textbooks: Kazakhstan and Singapore

As part of this study, a substantive analysis of mathematics textbooks recommended by the Ministry of Education of the Republic of Kazakhstan for the 6th grade were conducted. The purpose of this analysis were to identify the degree of presentation of tasks aimed at developing students' skills in applying proportionality concepts in real-life contexts.

The results of the analysis showed that the overwhelming majority of tasks in the textbooks are formal in nature. The main focus is on mastering algorithms for finding an unknown proportion term, solving problems on “diagonal multiplication” and transforming relations. However, tasks that model life and socio-economic situations - such as determining discounts, scaling, calculating the proportional distribution of resources, etc. - are presented in a limited way and, as a rule, are not integrated into the systemic educational strategy. This limits the development of applied skills in schoolchildren, reduces motivation for learning and hinders the formation of functional mathematical literacy (Kazima, 2013; Nissa, 2019).

A comparative analysis of the definitions of real-life tasks presented in the methodological developments of the Center for Pedagogical Measurement of the

Nazarbayev Intellectual Schools AEO (2023), in the works of Temerbekova, Chugunova and Baygonakova (2013), as well as in the international PISA framework (Pons et al., n.d.), made it possible to identify the key characteristics of such tasks:

- contextuality and proximity to reality;
- the presence of a choice of solution strategy;
- the need to apply mathematical knowledge for analysis and decision-making;
- development of critical and logical thinking.

Thus, the author of this study proposed the following definition, taking into account the specifics of teaching proportions in the 6th grade:

Real-life problems on the topic of proportions (in the 6th grade mathematics course) are learning tasks that are close to the everyday, social or economic reality of students (e.g. planning pocket money, calculating the cost of products, cooking according to recipes, changing the scale of drawings or maps), requiring the use of the concepts of ratio, share and proportion to solve practically significant problems, analyze information and justify decisions made.

Integrating such problems into the educational process contributes not only to a more meaningful and profound assimilation of concepts related to proportionality, but also to the activation of students' cognitive activity. This, in turn, has a positive effect on academic performance and the development of mathematical literacy, such as in the context of international comparative studies such as PISA (Pons et al., n.d.; Stillman et al., 2010).

As part of the empirical part of the study, a systematic quantitative and qualitative analysis of the content of proportion problems in mathematics textbooks for grade 6 used in the educational practice of the Republic of Kazakhstan and Singapore were conducted. The purpose of the analysis were to identify the degree of representation of problems close to real-life situations as an essential means of developing students' functional mathematical literacy.

1.6.1 Kazakhstani textbooks

The sample for content analysis encompassed two prominent sets of mathematics textbooks, each structured into two sequential parts and officially approved for use in Kazakhstani schools. These are:

1. The textbook series edited by E.A. Abylkasymova, T.P. Kucher, and Z.A. Zhumagulova.
2. The textbook series edited by T.A. Aldamuratova, K.S. Baysholanova, and E.S. Baysholanova.

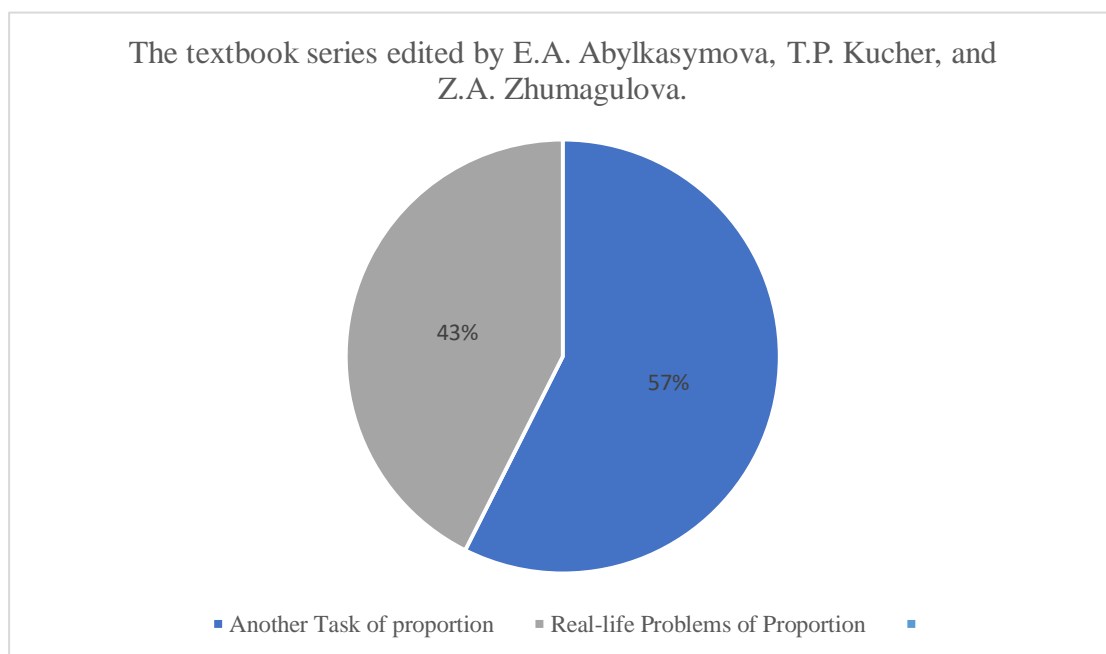
Each of these textbook sets is widely implemented in the national curriculum for sixth-grade mathematics and forms the core instructional resource for the topic of ratios and proportions. The selection of these materials for analysis were guided by their national relevance and widespread classroom adoption, thereby ensuring the findings are generalizable to mainstream educational practices in Kazakhstan.

The results of the analysis reveal that the total number of problems related to the topic of proportions ranges from 12 to 16 tasks per textbook part. These problems are generally found in dedicated chapters on ratios, proportions, and related concepts

such as percentages and rates. However, when considering only those problems that are embedded in real-life contexts, the numbers decrease significantly, ranging from 5 to 8 problems per part. These real-life problems include tasks that simulate practical scenarios such as price comparisons, recipe adjustments, or simple budgeting examples.

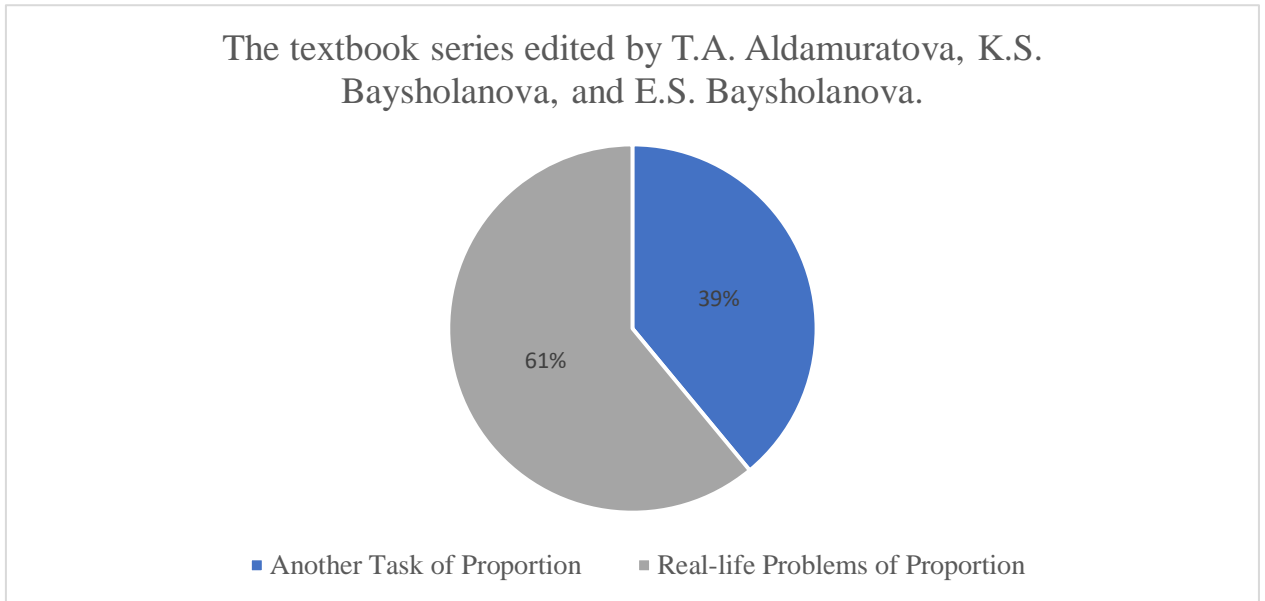
In quantitative terms, the proportion of contextually grounded, real-life problems across the analyzed textbooks averages approximately 43% of the total tasks dealing with proportions. This figure reflects a moderate level of integration of applied mathematical tasks within the curriculum. It suggests that while real-life context is not absent, it remains secondary to formal, procedural exercises. This may limit students' opportunities to engage in problem-solving activities that mirror the kind of quantitative reasoning required in everyday situations.

Figure 1.6.1.1 Problems on proportions in the textbook (E.A. Abylkasymova)



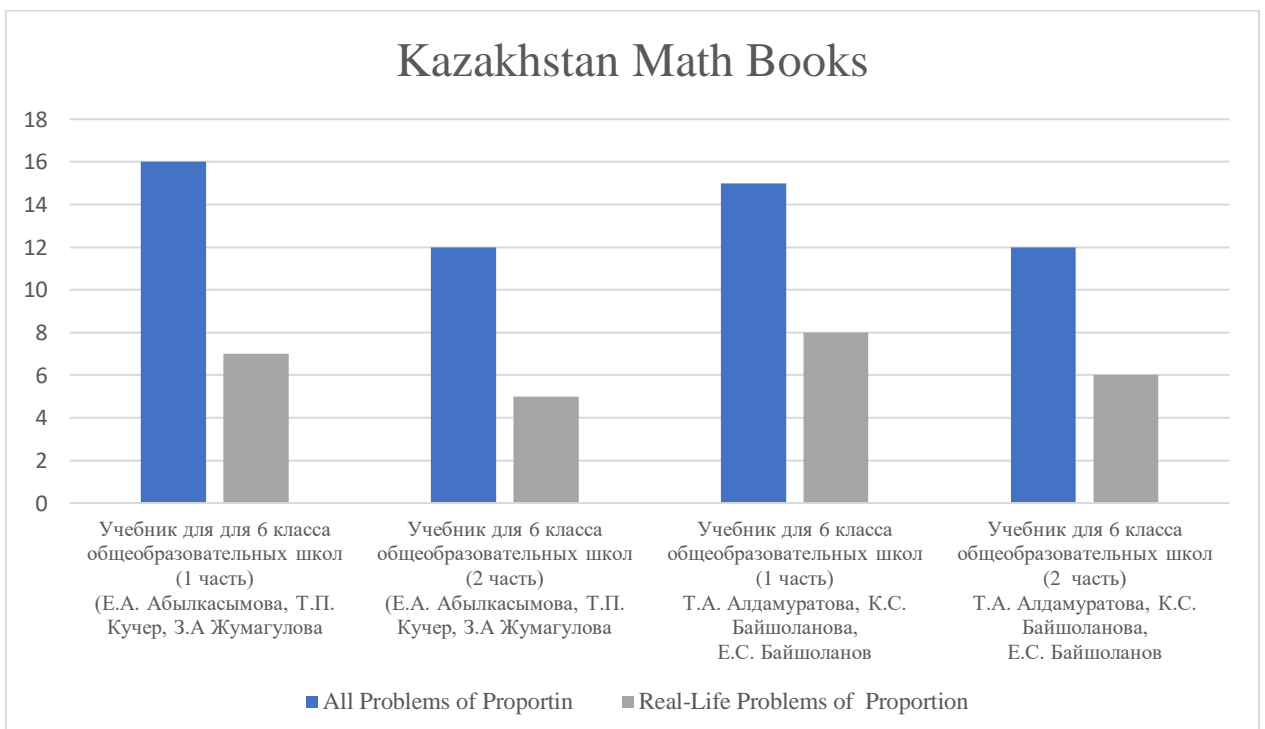
Notably, a slightly more favorable picture emerges in specific cases. For example, in the first part of the textbook edited by Aldamuratova et al., the number of proportion problems situated in actual, real-world contexts reaches 8 out of 15, which corresponds to approximately 53%. This shows a vague comparison stronger emphasis on applied mathematics in this particular textbook volume, aligning more closely with the principles of functional mathematical literacy and contextualized instruction.

Figure 1.6.1.2 Problems on proportions in the textbook (T.A. Aldamuratova)



Despite this relative progress, the overall data underscore a persistent pedagogical imbalance: the majority of textbook problems continue to be abstract and procedural, focusing mostly on algorithmic competence rather than conceptual understanding and real-life applicability. Given the goals of the updated educational content (ОЖСБ) in Kazakhstan—which emphasize the development of functional literacy and critical thinking—these findings point to a need for revising and enriching task design in textbook content to ensure more consistent and meaningful exposure to real-world mathematical applications.

Figure 1.6.1.3 Kazakhstan Math Books

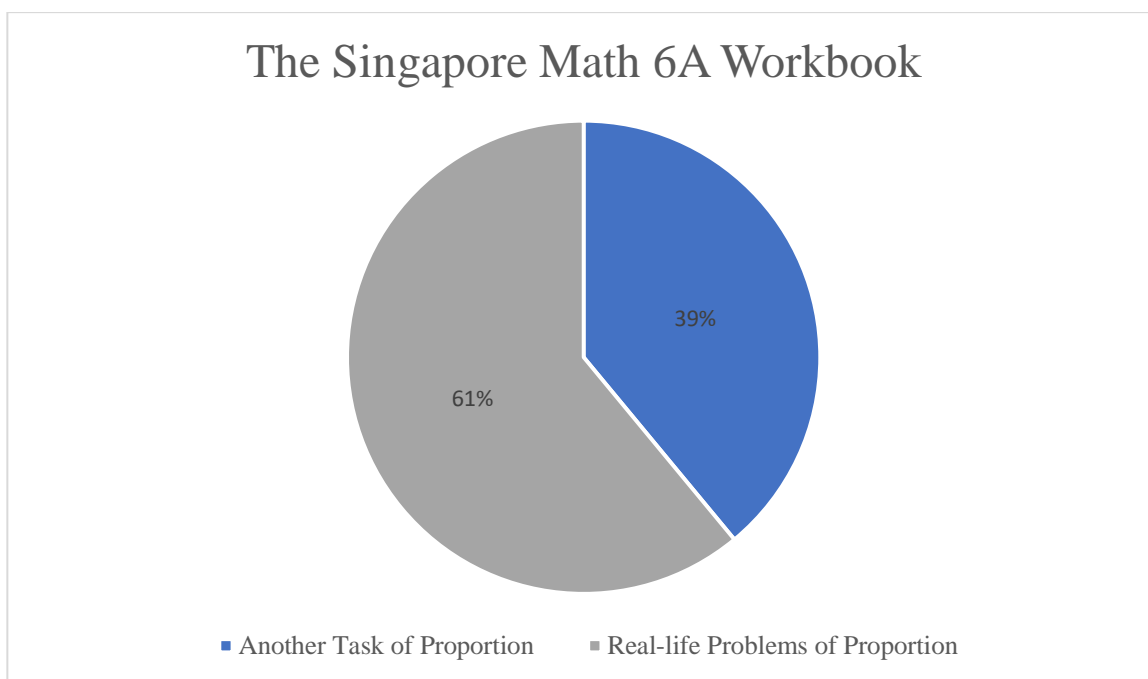


1.6.2 Singapore Math Textbooks

For comparative purposes, a detailed content analysis were conducted on four core components of the internationally acclaimed Singapore Math curriculum, specifically the 6A and 6B Textbooks and Workbooks. These educational materials have garnered global recognition for their emphasis on conceptual understanding, problem-solving, and the application of mathematical reasoning to real-world contexts. As such, they provide a valuable benchmark against which the Kazakhstani textbooks can be evaluated.

The analysis revealed a notably higher density of proportional reasoning problems in the Singaporean resources compared to their Kazakhstani counterparts. In each textbook or workbook component, the number of tasks explicitly focused on proportions ranged from 14 to 18 problems, demonstrating a substantial commitment to reinforcing this foundational mathematical concept.

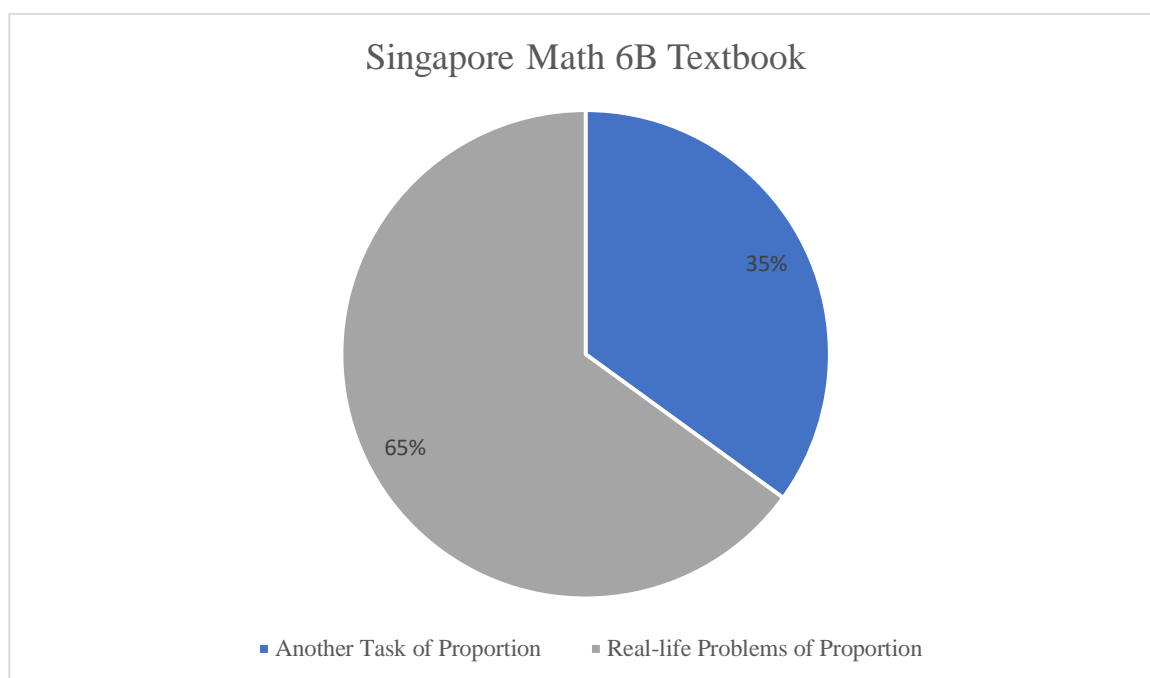
Figure 1.6.2.1 Problems on proportions in the textbook (The Singapore Math 6A Workbook)



Significantly, a large proportion of these problems—between 7 and 11 per component—were found to be explicitly grounded in real-life situations, yielding an average of approximately 61% of all proportion-related tasks. This high incidence of context-rich problem sets reflects a deliberate pedagogical strategy to foster functional mathematical literacy by embedding mathematical principles within familiar, meaningful, and practical scenarios.

The Singapore Math 6A Workbook and the Singapore Math 6B Textbook were identified as the most saturated with real-life applications of proportional reasoning. In these volumes, up to 11 problems are structured around genuine, everyday contexts. This represents over 60% of the proportional reasoning tasks in each book—an exceptionally high ratio by international standards.

Figure 1.6.2.2 Problems on proportions in the textbook (*The Singapore Math 6B Textbook*)



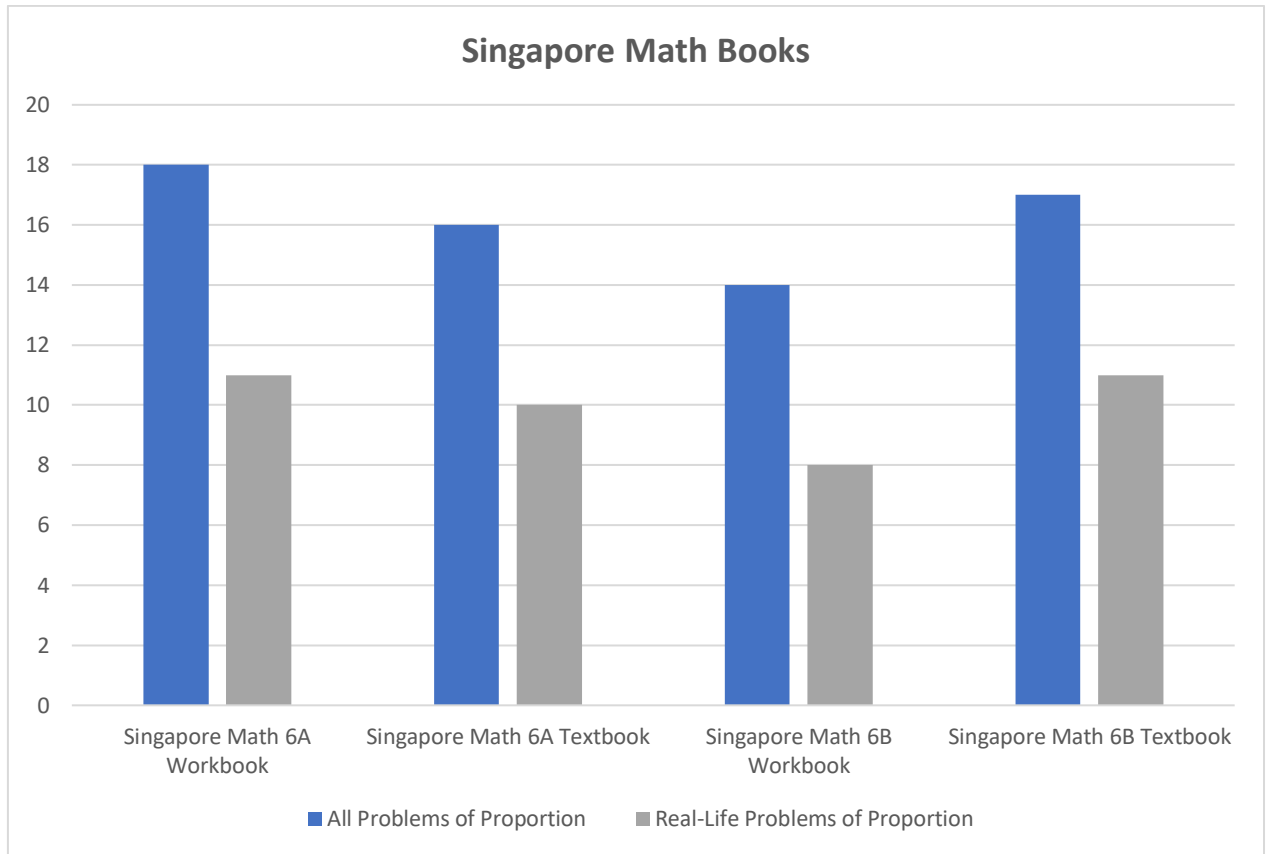
The nature of these contextual problems spans a wide variety of practical domains, including:

- Currency exchange calculations, allowing students to apply proportions in financial literacy contexts;
- Product price comparisons, which involve unit rate reasoning and decision-making;
- Time and resource allocation scenarios, which foster planning, critical thinking, and strategic problem-solving.

These tasks go beyond basic mathematics. Students have to interpret such information plus select strategies that are appropriate. Justifying reasoning as well as making informed decisions often are other requirements based on multiple variables. Learning experiences deeply embedded in real-world applications to enhance engagement coupled with conceptual transfer are advocated for by situated learning besides constructivist theories.

In summary, the Singapore Math series is one which best integrates applied mathematics at a primary education level. Connecting of mathematical theory with practical experience through its structured inclusion in proportion problems within life-relevant contexts shows an effort reinforcing both deep conceptual understanding and long-term retention in a systematic way. These findings stand in marked contrast with the Kazakhstani materials. Those contexts that are applied are less common and often are peripheral in those materials. Thus, the comparison emphasize potential areas within Kazakhstan's educational system for textbook development and curricular reform

Figure 1.6.2.3 Singapore Math Books



1.6.3 Comparative conclusion

The comparative analysis between Singaporean and Kazakhstani mathematics textbooks yields several meaningful as well as instructive conclusions within the field of teaching the topic of proportions. These conceptualizations offer perception into each country's mathematics curriculum's educational approach. Furthermore, these perceptions bear wider consequences upon curriculum construction notably when advancing practical mathematical expertise and judicious reasoning.

Integration of Real-Life Applications: One of the signal discoveries of this contrastive study is Singaporean textbooks assimilate realistic and circumstance-abundant quandaries to a markedly greater extent. The Singapore Math curriculum consistently situates mathematical assignments amid commonplace life circumstances including budgeting and travel in addition to science-related implementations. This strategy locates proportional logic inside meaningful situations, building pertinence. Also, this methodology cultivates transferability (Fielding-Wells et al., 2014; Risdiyanti et al., 2024). Conversely, textbooks from Kazakhstan mainly stress algorithmic processes through exceedingly theoretical, isolated predicaments. Attributable to this, pupils could forfeit prospects for perceiving mathematics' factual worth inside their everyday existence. This realistic worth is vital for motivation along with long-term retention (Banerjee & Bhat, 2025; Boaler, 1998b).

Textbooks from Kazakhstan manifest a distinct inclination toward regimented and frequently iterative drills since they prioritize adherence over comprehension. Learners are infrequently incited via such tasks for interpreting, evaluating, or

justifying their rationale within a wider framework, albeit helpful to developing procedural skill. Since contextualized tasks are nonexistent, prospects are lessened for students toward participating in higher-order thought, like analyzing relationships, modeling real phenomena, or reflecting upon their problem-solving strategies (Hmelo-Silver, 2004; Tursynkulova et al., 2023). Conversely, Singaporean materials commonly include open-ended questions and problems; these questions and problems necessitate estimation, reasoning about units and quantities, and decision-making, each of which remain crucial toward cultivating critical thinking and mathematical flexibility (Zubainur et al., 2020)

Pedagogical Implications of Contextualization: The systematic and intentional inclusion of applied, real-world problems—as seen in the Singapore Math approach—can be understood as an helpful pedagogical strategy grounded in constructivist learning theory. By connecting abstract concepts to tangible experiences, this approach supports cognitive engagement, enhances motivation, and contributes to the development of conceptual understanding (Boaler, 1993; Domondon & Corpuz, 2024). Research has shown that students are more likely to internalize mathematical ideas and remain engaged in their learning when they perceive tasks as relevant and purposeful. Formal additive, such contextualization promotes equity by validating diverse cultural experiences and providing multiple entry points for understanding (Prayekti, 2025).

Implications for Curriculum Reform in Kazakhstan: These identified differences underscore the urgent need to reconsider and revise the methodological frameworks used in the design of educational tasks in Kazakhstani textbooks. In particular, there is a growing necessity to align task design with broader educational goals such as developing practice-oriented mathematical literacy, preparing students for real-world problem-solving, and fostering lifelong learning habits (Coffman, 2022; de la Torre & Minchen, 2014) Proportional reasoning, as a foundational mathematical concept with broad applicability, provides an ideal platform for such pedagogical transformation. Introducing real-life tasks and encouraging interpretative, multi-step problem-solving can significantly elevate the educational value of the curriculum and better prepare students for the complexities of the modern world.

In conclusion, this comparative study not only point out the strengths of the Singaporean approach to embedding mathematical concepts within real-world contexts but also reveals a critical gap in the Kazakhstani educational framework that warrants strategic and evidence-based intervention. Moving forward, national curricula would benefit from adopting a more balanced approach—one that integrates procedural fluency with contextual understanding, and abstract reasoning with applied problem-solving. Such a shift is essential for cultivating mathematically literate individuals who can think critically, act responsibly, and contribute meaningfully to society.

1.7 Comparative analysis of the project assignment and typical learning tasks

One of the key areas of the updated educational content (ICE) in Kazakhstan is the development of functional literacy of students. However, as shown in the analysis of mathematics textbooks for the 6th grade (see sections 2.4.1 and 2.4.2), most tasks related to proportions retain an algorithmic focus and formal nature, without going beyond abstract mathematical operations. Assignments on ratios and proportions, as a rule, involve finding the unknown in an equality, and only in 42% of cases do they include at least a partial practical context.

Meanwhile, in accordance with international studies (PISA, OECD, 2018) and recommendations of national institutes (Y. Altynsarin NAO, NAO NIS), the development of functional literacy requires setting contextualized tasks for students that simulate real-life situations and involve not only calculation, but also analysis, comparison, interpretation, choice of strategy and reflection.

Table 1.7.1 Comparative analysis of the project assignment and typical learning tasks

criteria	Typical Textbook Task	Project-Based Task “Garden Plan 10×10”
Real-life context	Formal, abstract numbers; lacks storyline	Practical: planting plan, seed distribution, water usage, area calculations
Task format	Isolated problem, one-step algorithmic solution	Multi-step project with tables, visualizations, and argumentation
Interdisciplinary links	Rarely present	Includes biology, ecology, geography, and financial literacy
Functional mathematical literacy	Weak; focuses on procedural fluency	High; involves data interpretation, decision-making, critical-thinking
Mathematical content	Basic ratios and finding unknowns in proportions	Ratios, percentages, fractions, areas, relationships, and visual data representation
Cognitive level (Bloom’s Taxonomy)	Level I–II: knowledge, comprehension	Level III–V: application, analysis, synthesis, evaluation
Type of thinking	Routine, algorithmic	Investigative, analytical, and critical

Data representation	Textual or numeric expression only	Includes tables, graphs, visual models, and diagrams
Collaborative work	Not expected	Can be done in groups; encourages planning and peer discussion

As noted in the 2021 State Basic School and the methodological recommendations of the Ministry of Education of the Republic of Kazakhstan, its the life tasks associated with the application of mathematical knowledge in non-standard situations that are an indicator of achieving the goals of the Basic Basic School. However, in current textbooks, such tasks are not enough, and they do not represent a complete didactic model for the development of proportional thinking in schoolchildren.

In response to these limitations, the author developed a project task "Garden Plan 10x10", a full description of which is presented in the appendix (see pbl.docx). The assignment is structured as a five-stage mini-project, in which students work with a garden plan, calculate proportions between plant seeds, determine areas and percentages, compare water consumption, and analyze the results in tables and charts. It focuses on the practical application of mathematical knowledge, the development of critical thinking, the formation of environmental awareness, and visualization skills.

1.8 Summary of the Literature Review

Despite the challenges associated with implementing real-life applications throughout mathematics instruction, this approach is a valuable pedagogical strategy since of the possible benefits for student engagement and academic achievement. Mathematics connects with genuine, real-world scenarios and helps students perceive the subject, which makes them motivated and deepens understanding (Boaler, 1998; English & Watson, 2011). In proportional reasoning, a foundational concept which is supporting of higher-level mathematics and real-life decision-making is essential.

However, research emphasize that students often battle to understand the intrinsic multiplicative relationships in proportional reasoning plus often use additive or superficial strategies (Ayan-Civak & İşıksal-Bostan, 2018; Misailidou & Williams, 2003). To address this, educators must contextualize problems and teach the mathematical structures that govern them. This does involve a deliberate instructional design. Examples are incorporated, also they should be culturally relevant, personally meaningful, and cognitively accessible to learners (Civil, 2007; Gutstein, 2006). In addition, student reflection is being promoted, classroom discourse is being encouraged, and these actions then close the divide between the lived experiences and abstract mathematical concepts.

If educators address these instructional challenges in a careful way, they can maximize the effectiveness of real-life applications. They can adopt also a balanced reflective approach. This fosters improved expertise in proportional reasoning as well as a long-term appreciation of mathematics for understanding the world.

2. METHODOLOGY

As middle school students navigate through the transition from elementary to secondary education, we must foster their engagement and they must achieve academically as a priority which is critical. Important physical, psychological, social, and cognitive changes increase the stress and adversity of young adolescents during this developmental stage (Cauley & Jovanovich, 2006; Borman et al., 2019). Schools are able to implement transition programs for reducing these challenges. The programs can be tailored for all of the students' developmental needs. Such programs are needed to help students thrive during this transition for academic growth and belonging plus social and emotional support (Cauley & Jovanovich, 2006).

Teachers can boost middle school students' engagement and achievement if they incorporate real-life problems with proportions into mathematics instruction. This approach aligns with theories about the importance of addressing students' fundamental psychological needs. Addressing those needs like autonomy fosters intrinsic motivation along with engagement (Alley, 2019). Educators can capture student interest as well as encourage learning ownership by designing activities challenging proportional reasoning application to relatable, actual scenarios. Mathematical concepts relate to students' everyday experiences in tasks like recipes' adjustment or maps' interpretation since they motivate students and nurture student autonomy.

2.1 Theoretical Framework

This study grounds itself in several key theoretical frameworks which relate to student engagement, education in mathematics, as well as apply real-life contexts in learning. Theories for situated learning, constructivism, and engagement theory elucidate the mechanisms through which real-life applications of proportional reasoning can impact student outcomes specifically. The study seeks for improvement of knowledge retention and transfer. Mathematical problems are situated within relatable, authentic contexts as situated learning principles are leveraged. This approach recognizes that learning can be most efficient at a time when it is embedded into meaningful real-world scenarios which allow students in order to connect abstract concepts with their lived experiences.

Furthermore, the constructivist perspective informs the pedagogical approach, emphasizing active student engagement in constructing their own understanding through problem-solving and critical-thinking activities. Constructivism suggests that learners build knowledge actively rather than passively receiving it, and this study seeks to create an environment where students can explore, experiment, and construct their own understanding of proportional reasoning.

Finally, engagement theory provides a lens through which to examine the cognitive, emotional, and behavioral dimensions of student involvement, with the expectation that real-life applications will foster increased motivation, interest, and participation in mathematics. By addressing these multiple dimensions of engagement, the study

aims to provide a comprehensive understanding of how real-life applications can enhance students' overall learning experience and academic outcomes.

2.1.1 Situated Learning Theory

Originally developed by Jean Lave and Etienne Wenger (1991), situated learning theory posits that learning is fundamentally a social and contextual process. According to this perspective, knowledge is not learned in isolation but is co-constructed through meaningful participation in genuine activities situated within real-world environments. In the context of mathematics education, situated learning emphasizes the importance of embedding mathematical concepts in practical, everyday scenarios that mirror how such knowledge is used outside the classroom (Brown, Collins, & Duguid, 1989).

By embedding proportional reasoning within genuine, relatable contexts—such as budgeting, cooking, or measurement—the present study leverages the situated learning model to foster both relevance and transferability. Research suggests that when mathematical problems are framed within familiar and culturally meaningful scenarios, students are more likely to internalize concepts, apply them flexibly, and retain them over time (Boaler, 1998; Cobb & Bowers, 1999). This context-rich approach not only deepens conceptual understanding but also empowers learners to bridge the gap between abstract knowledge and its practical application (Greeno, 1998).

2.1.2 Constructivism

Constructivism posits that learners actively construct their own understanding of the world through experience and reflection rather than passively receiving information (Piaget, 1972). In this study, the implementation of real-life applications is designed to foster student engagement in problem-solving and critical-thinking activities, encouraging them to form meaningful connections between abstract mathematical concepts and everyday phenomena. According to (Fosnot, 2013), such experiential learning environments support the construction of knowledge by allowing students to test ideas, confront misconceptions, and reorganize their thinking through active exploration.

This active construction of knowledge is anticipated to enhance academic achievement and lead to a more profound understanding of proportional reasoning, a fundamental mathematical concept with wide applicability in both academic and real-world contexts. By engaging with genuine, context-rich tasks, students are more likely to internalize mathematical principles deeply, as they become co-creators of their learning rather than passive recipients. As (Bruner, 1961) emphasized, when students discover concepts through inquiry and application, they develop stronger cognitive frameworks that support long-term retention and flexible knowledge transfer.

2.1.3 Engagement Theory

Another foundation of the theoretical framework is engagement theory, as it offers perceptions into learning outcomes plus how student involvement influences

them. Engagement is generally conceptualized by people as a multi-dimensional construct since it comprises cognitive, emotional, and behavioral domains (Fredricks et al., 2004) Cognitive engagement reflects students' investment as they learn with the use of self-regulatory strategies; emotional engagement involves their affective reactions since they feel the subject; behavioral engagement includes them participating throughout classroom tasks and activities.

Within the classroom, real-life applications enhance all three dimensions of engagement (Lein A. E., 2015). Increasing data seems to show this point. Students are apt to have more intrinsic motivation, put forth more cognitive effort, and persist when they see mathematics as relevant and useful (Schunk et al., 2008). Sujatha and Vinayakan (Sujatha & Vinayakan, 2023) did research then found this alignment. They do stress that task relevance drives both academic motivation along with achievement in mathematics.

Engagement theory stresses autonomy as well as competence and also relatedness, as self-determination theory (SDT) outlines (Deci & Ryan, 1985). Real-world contexts may be added by educators into instruction on proportional reasoning for better learning plus academic resilience, fostering purpose and connecting classrooms while increasing students' competence perception (Connell & Wellborn, 1991; Reeve, 2012).

2.2 Justification for the Use of a Single-Group Design

Justification for the Use of a Single-Group Design This study employs a single-group pre-test/post-test quasi-experimental design to investigate the impact of real-life application tasks on students' academic achievement and engagement in proportional reasoning. The choice of a single-group design is grounded in both practical and methodological considerations, and it aligns with the nature and context of the educational setting in which the research is conducted.

One of the primary reasons for choosing a single-group design involves feasibility. Logistical concerns often surface within real classroom settings like middle school in this analysis. Random student assignments for experimental groups and control groups are difficult or impossible given these worries. School scheduling constraints typically pre-determine classes so reorganizing them may disrupt regular instruction regarding research. Since researchers use just one intact class as a group for experimentation, the intervention can be applied in a natural way, with disruption kept to a minimum, and ecological validity is improved as well.

Ethical issues greatly affect the decision when people will not use a no-treatment control group. The intervention in this study can enhance engagement and student learning given real life uses of proportional reasoning. Ethical concerns are indeed raised by deliberately withholding of this potentially helpful instructional strategy from out of a control group, especially when dealing with those young students. All participating students benefit equally under the improved instruction. A single-group design ensures this.

Change measurement becomes possible in the same student group through the design's structure. The method considers this measurement to be occurring for a

period of time. Each student has the ability to control for themselves. This does reduce individual variability as well as strengthens the internal consistency of the results. By a comparison of how students perform and how they engage both before and after the intervention, the research can isolate how real-life application tasks do potentially affect learning, plus it can provide valuable perceptions into the direction and magnitude that gains then take.

Formal additive, the single-group design suits exploratory and practice-based research quite well, such as this study, which seeks to close the divide between theoretical recommendations in mathematics education and how educators implement them practically in real classrooms. This design is often used in pilot studies to establish initial evidence of effectiveness and to inform the development of future, more controlled studies that identify practical challenges. While we acknowledge the lacking of a control group limits the ability to fully eliminate confounding variables (e.g., maturation, external influences), the design remains a valid with informative approach when contextualized properly. Careful planning and also consistent instruction can help to reduce all these limitations. Suitable statistical analysis, as paired-sample t-tests as well as effect size calculations, is able to offer a reliable assessment regarding the intervention's impact. Classroom research's real-world constraints with the ethical responsibility to provide all students with equitable learning opportunities, and the design's suitability for measuring change justify the use of a single-group pre-test/post-test design.

2.3 Participants and Setting

The participants in this research were sixth-grade students enrolled at the Dostyq Education Center in Almaty, Kazakhstan, an educational institution known for both academic excellence as for pedagogical innovation. The study included 24 students from about 11 to 12 years in age. The researcher taught some regular mathematics classes, and from one of them all participants were selected as a part of just a single intact experimental group. We purposefully sampled, designing our approach for retaining the classroom environment. This design ensured the maintenance of ecological validity as well as minimized any disruptions to routines.

Logistical plus ethical issues prevented control group usage in this study. The research used a single-group pre-test/post-test quasi-experimental design instead so the researcher could intervene within an educational setting that occurred naturally. This design does commonly appear in school-based research in cases where researchers cannot randomly assign nor experimentally manipulate (Cohen et al., 2017b). All students received the same instructional content, integrating real-life proportional reasoning tasks, so the findings became relevant within actual classroom practice.

Of critical importance to the design of the study were also the participants' age as well as developmental characteristics. Typically, sixth-grade students are 11–12 years old. This group of students experiences crucial cognitive, social, plus emotional growth. Cognitive development theory by Jean Piaget says students now move from thinking which is concrete operational to thinking which is formal operational. As

noted in “Piaget, 1970”, Piaget developed this theory. Skills in abstract reasoning, hypothetical-deductive logic, and the mental manipulation of variables mark this developmental shift necessary for mastering proportional reasoning (Karplus et al., 1983; Lamon, 2007).

However, this transition is gradual as well as often incomplete at this stage. For many learners, it is still the case that concepts like ratio and proportion pose cognitive challenges that are meaningful for them, and problems will arise. For such focused actions, sixth grade presents a “critical window”. These interventions close the divide linking hands-on work to math concepts (Vergnaud, 1983). This developmental phase becomes especially useful with the introduction of real-life, context-rich mathematical problems by teachers. Learners may situate abstract proportional concepts within familiar meaningful experiences through this introduction that can provide conceptual scaffolding (Boaler, 1998b; Sujatha & Vinayakan, 2023).

From a motivational psychology perspective, middle school students are also highly sensitive to both the relevance and the authenticity of learning tasks. For students within this age group, quite a few studies suggest they are more likely to engage in learning activities when these activities are perceived as connected to “real-life situations” and “personally meaningful goals” (Eccles & Wigfield, 2002; Ryan & Deci, 2000). As a result, the contextualization through mathematics instruction—through problems such as budgeting, comparing product prices, or adjusting recipes—can greatly boost both intrinsic motivation and task persistence because it ultimately leads to deeper conceptual understanding and better academic performance (Jupri, 2017)

Social aspects in learning affect early adolescence years greatly. Academic attitudes are shaped via the classroom environment, which has an essential role as students develop identity as well as belonging. The intervention in this study, designed to foster a supportive plus interactive learning culture, included collaborative group tasks, peer discussions, together with shared problem-solving experiences. Based upon Vygotsky’s sociocultural theory, learning is essentially a social process, and collaboration by peers inside the zone of proximal development (ZPD) can speed up comprehension and engagement because Vygotsky and Wertsch found this in 1978 and 1991. By implementing the instructional intervention in a natural classroom setting where students were already familiar with one another and the instructor, the study was able to maximize rapport and instructional continuity, both of which are essential for maintaining student engagement and experimental integrity (Fredricks et al., 2004). The intact group structure also allowed for true observations of how real-life proportional reasoning tasks influenced not only academic outcomes but also emotional involvement, social participation, and metacognitive strategy use among sixth-grade learners.

In summary, the choice of participants were both pedagogically and developmentally appropriate. The study was carefully designed to respond to the unique cognitive and emotional needs of early adolescents, using a research setting that mirrored real classroom conditions. This design not only supports the validity and transferability of the findings but also offers practical insights for educators

seeking to strengthen mathematics teaching in middle school contexts across Kazakhstan and similar educational systems.

2.4 Questionnaire

To evaluate student engagement in the context of learning mathematics through real-life applications of proportion, this study employed a quantitative data collection method using a structured, paper-based questionnaire. Questionnaires are widely used instruments in educational research as they enable the systematic collection of data from a broad participant base, either through direct (face-to-face) administration or indirect means (e.g., paper or digital forms), providing standardized and comparable data (O'Toole & Beckett, 2010).

This study used a closed-ended questionnaire format, consistent with the recommendations of Sarantakos (2005), who emphasized that closed questions are easier to administer and analyze, especially in school settings. Such formats also enhance the reliability of data by reducing the likelihood of irrelevant or incomplete responses. Given the cognitive and developmental characteristics of middle school students, closed-ended items were deemed most appropriate to ensure clarity, engagement, and high completion rates.

The primary instrument employed in this study were an adapted version of the Student Engagement in Mathematics Classroom (SEMC) questionnaire, originally developed by Kong (2021). The SEMC were selected due to its strong theoretical grounding, clear alignment with the study's objectives, and previously show validity and reliability in large-scale educational settings. It measures student engagement across three core dimensions:

1. Cognitive engagement, which captures students' use of learning strategies, mental effort, and approaches to understanding mathematical content (e.g., surface and deep learning strategies).
2. Affective engagement, which reflects emotional responses to mathematics, including interest, enjoyment, and anxiety.
3. Behavioral engagement, which includes observable actions such as attentiveness, participation, and effort in classroom activities.

In its original development, the SEMC underwent extensive validation procedures, such as classroom observations and student interviews, and were administered to a sample of 546 students in Shanghai. Reliability analyses yielded Cronbach's alpha values exceeding 0.78 for each subscale, confirming internal consistency and scale robustness (Kong, 2021).

For the present study, the SEMC questionnaire were translated and culturally adapted into Bahasa Indonesia to ensure linguistic and contextual relevance for the local population. The translation process involved two bilingual educators with graduate-level expertise in educational research, who reviewed and revised the questionnaire to ensure semantic, conceptual, and cultural equivalence. This approach aligns with best practices for adapting instruments across languages and cultural contexts .

The questionnaire were administered twice—as a pre-test prior to the instructional intervention and as a post-test following the completion of the real-life proportion-based lessons. This repeated-measures design allowed for the examination of changes in engagement over time and enabled within-group and between-group comparisons of engagement levels across cognitive, affective, and behavioral domains.

In addition to the SEMC, other established instruments were considered during the instrument selection phase, such as the Student Course Engagement Questionnaire (SCEQ) developed by Kong et al. (2021), which categorizes engagement into four areas: skills engagement, participation/interaction engagement, emotional engagement, and performance engagement. Although developed for higher education, its framework influenced the categorization of engagement constructs in this study. Similarly, the Attitudes Toward Mathematics Inventory (ATMI) (Herges et al., 2017) provided insights into measuring emotional engagement factors such as enjoyment and confidence in mathematics.

While the adapted SEMC instrument were not re-validated psychometrically within the scope of this study due to resource constraints, it served as a triangulation tool in conjunction with classroom observations and mathematics achievement tests. As Anderson (2014) notes, questionnaires are susceptible to limitations such as non-response bias and respondent fatigue. However, the SEMC's focused structure and relevance to students' learning experiences helped to mitigate such limitations and ensured high completion rates.

Overall, the integration of a well-structured engagement instrument, grounded in validated frameworks and adapted for cultural relevance, provided a reliable basis for assessing the impact of real-life problem-based instruction on middle school students' engagement in learning proportional reasoning

2.5 The ratio and proportion unit assessment

Primary instrument were used to assess academic achievement, adapted from the ratio and proportion unit assessment developed in Coffman's (Coffman, 2022) project-based learning study. This instrument were employed in a test format to collect data pre- and post-intervention. Both assessments measured proficiency in understanding and applying ratios, unit rates, and proportional reasoning (aligned with standards 6.RP.1, 6.RP.2, and 6.RP.3 from the Ohio Learning Standards; Ohio Department of Education, 2017).

The pre-assessment were administered prior to the instructional unit and comprised 12 questions totaling 14 points, covering multiple facets of ratio and proportion content. Question types included multiple choice, fill-in-the-blank, matching, and multipart reasoning problems, many of which were drawn from released standardized test items to ensure validity and alignment with state expectations (Coffman, 2022).

The post-assessment, administered following the completion of the unit, were structurally similar but included an additional question addressing percent applications, for a total of 13 items worth 15 points. The addition reflected formative

insights gained during instruction regarding students' difficulty with percent-related tasks (Coffman, 2022). Both assessments were delivered using the Edulastic platform, which provided automated scoring aligned with pre-identified correct responses. Adjustments were made to accommodate diverse learner needs, including read-aloud options and extended time for students with Individualized Education Programs (IEPs).

Since the number of tasks in the pre- and post-tests differed, a percentage scale of assessment were used to ensure objective comparison. Each task were estimated at one point. The final student performance were calculated using the formula:

$$Score (\%) = \frac{Points\ earned}{Total\ possible\ point} \times 100$$

In this way, the test task allowed us to comprehensively assess the level of development of proportional thinking, both in the theoretical aspect and in practical application.

2.6 Assessment

To measure the impact of the intervention, this study will employ a quantitative approach, focusing on data collection techniques suitable for comparing two groups. Academic achievement in proportional reasoning will be assessed through standardized math problem tests. Quantitative data will be analyzed using statistical methods to examine changes in student learning outcomes within the experimental group. By comparing pre- and post-intervention results, the study aims to evaluate the effectiveness of the real-life application approach in improving students' understanding of proportional reasoning.

This study also aligns with research that point out the importance of creating active learning environments in mathematics education. By using real-world applications, teachers can make mathematics more relevant and engaging for students, fostering a deeper understanding of mathematical concepts and their practical implications (Mebert et al., 2020).

The integration of real-world applications into mathematics instruction can significantly enhance students' understanding and enthusiasm for the subject while equipping them with essential skills for future academic and professional success (Sujatha & Vinayakan, 2023).

Teachers who design lessons that incorporate real-world problems can assist students in overcoming challenges and promote a more profound understanding of mathematical concepts (Zubainur et al., 2020). These approaches collectively emphasize the importance of making mathematics education more relevant, engaging, and practical for students, which leads to improved learning outcomes and readiness for future challenges.

This strategy has the potential to boosts student motivation, engagement, and ultimately academic success in mathematics. These approaches collectively emphasize the importance of making mathematics education more relevant, engaging,

and practical for students, which leads to improved learning outcomes and readiness for future challenges.

This study also aligns with research that stress the importance of creating active learning environments in mathematics education. By using real-world applications, teachers can make mathematics more relevant and engaging for students, fostering a deeper understanding of mathematical concepts and their practical implications. (Mebert et al., 2020).

The integration of real-world applications into mathematics instruction can significantly enhance students' understanding and enthusiasm for the subject while equipping them with essential skills for future academic and professional success (Sujatha & Vinayakan, 2023).

2.7 Procedure

The research were conducted in three distinct phases: pre-test, instructional intervention, and post-test. In the pre-test phase, all 24 participating students completed a standardized, paper-based mathematics test. This assessment were designed to evaluate their baseline understanding of proportional reasoning, serving as a benchmark to measure academic growth over the course of the study.

During the instructional intervention phase, students engaged in real-world proportional problem-solving tasks. These tasks were intentionally contextualized to reflect everyday experiences relevant to middle school students, aiming to create meaningful learning connections. The instructional design were based on the premise that applying mathematics to real-life scenarios can enhance conceptual understanding and increase student motivation.

In the final post-test phase, the same standardized mathematics test used in the pre-test were re-administered to all students. The comparison between pre-test and post-test results allowed for an evaluation of individual academic progress following the intervention.

To assess student engagement, a paper-based questionnaire were administered at the end of the instructional phase. The instrument captured three key dimensions of engagement:

1. Cognitive engagement: the degree to which students applied effort and used strategies to understand and solve proportional reasoning problems;
2. Emotional engagement: students' self-reported levels of interest, enjoyment, and emotional reactions to mathematics throughout the learning experience;
3. Behavioral engagement: observed indicators of participation, attention, and task persistence during lessons.

These dimensions were grounded in the widely recognized framework by Fredricks, Blumenfeld, and Paris (2004), which conceptualizes student engagement as a multidimensional construct involving behavioral, emotional, and cognitive components. Administering the engagement questionnaire after the instructional phase enabled an analysis of how context-based learning influenced students' motivation and active involvement in mathematics.

Phases of Data Collection:

The intervention were carried out over a six-week period, structured into three distinct phases: Pre-test, Instructional Intervention, and Post-test. This phased structure were designed to systematically evaluate the impact of real-life application tasks on students' engagement and academic achievement in proportional reasoning.

Phase 1: Pre-test Phase (01–04 April 2025)

In the initial week of the study, all 24 participating students completed baseline assessments to measure their prior understanding of proportional reasoning and initial levels of engagement in mathematics.

1. **Mathematics Pre-Test:** Adapted from Coffman (2022), this test assessed core proportional reasoning skills such as identifying ratios, solving for unknowns in proportion equations, and interpreting proportional relationships within real-world contexts. It included both procedural items and applied problems to ensure a comprehensive evaluation of students' conceptual and practical understanding.
2. **Student Engagement Questionnaire:** An adapted version of the *Student Engagement in Mathematics Classroom* (SEMC) instrument (Kong, 2021), as used in Syarifuddin's (2013) study, were administered. The questionnaire measured three dimensions of engagement: cognitive, emotional, and behavioral.
3. The SEMC were translated into Bahasa Indonesia using a collaborative translation-validation process. The researcher and two bilingual colleagues independently translated the questionnaire and then reconciled differences to ensure semantic accuracy and cultural appropriateness.

Both instruments were administered during regular school hours under standardized conditions to ensure consistency across participants.

Phase 2: Instructional Intervention (07 April – 02 May 2025)

The instructional phase lasted four weeks and focused exclusively on real-life applications of proportional reasoning. No control group were used in this study; all students participated in the intervention. The instructional design emphasized active, contextualized learning experiences based on constructivist principles.

Each week featured a different real-world mathematical scenario:

- **Week 1 (08–12 April): Shopping Smart** Students analyzed grocery shopping situations, comparing product prices using unit rates and discounts to determine the best value.
- **Week 2 (15–19 April): Recipe Rescaling** Learners adjusted ingredient amounts to scale recipes for different serving sizes, integrating ratio reasoning with measurement conversions.
- **Week 3 (22–26 April): Map Scaling and Distance** Students used scaled maps to calculate actual distances, applying their understanding of ratios and scale factors.

- Week 4 (29 April – 02 May): Budget and Finance Students developed household budgets, proportionally allocating income across categories like food, rent, and transportation—linking math with financial literacy.

Each lesson included:

- An authentic, context-rich problem scenario
- Group-based collaborative problem-solving
- A brief instructional mini-lesson
- A student reflection journal documenting strategies, reasoning, and group dynamics

Students were encouraged to share their findings with peers, encouraging mathematical communication and confidence. Teachers acted as facilitators, guiding inquiry, providing formative feedback, and conducting individual check-ins to support student understanding.

Phase 3: Post-test Phase (06–10 May 2025)

In the final week, the same assessment tools from Phase 1 were re-administered to evaluate learning gains and changes in student engagement:

1. Mathematics Post-Test: The same proportion-focused test were given again to assess students' academic progress throughout the intervention.
2. Engagement Post-Survey: The SEMC questionnaire were re-administered to examine changes in cognitive effort, emotional response, and classroom behavior as a result of the real-life application approach.

This post-intervention phase provided the data necessary to determine how contextual problem-solving impacted students' mathematical understanding and their engagement in learning.

2.8 Data Collection and Analysis

This study employed a paper-based mathematics test and a paper-based student engagement questionnaire to collect quantitative data, both administered in pre-test and post-test formats. The primary focus of data collection was to evaluate student engagement and student performance within the context of learning proportional reasoning through real-life application tasks.

To measure academic achievement, researchers used students' mathematics test scores derived before and after the instructional intervention. Since all participants belonged to a single experimental group, paired sample t-tests were conducted to determine whether there were a statistically significant difference in performance between the pre-test and post-test scores. This method is consistent with recommendations from Fraenkel, Wallen, and Hyun (2012), who advocate the use of t-tests in educational research to measure changes over time within the same group.

Student engagement were assessed using a closed-ended questionnaire, adapted from the *Student Engagement in Mathematics Classroom* (SEMC) instrument developed by Kong (2021) and previously applied in Syarifuddin's (2013) study. The questionnaire evaluated cognitive, emotional, and behavioral dimensions of

engagement. Descriptive statistics—means, standard deviations, and frequency distributions—were used to summarize student responses. Paired sample t-tests were also applied to engagement data to determine whether significant changes occurred in students' engagement levels following the intervention.

The design and analysis approach aligns with findings from Broza and Kolikant (Broza & Kolikant, 2020d), who reported that real-life, context-based mathematical learning positively influenced student engagement, particularly among students who struggle with abstract mathematical concepts. Their research supports the notion that integrating mathematics with students' everyday experiences can enhance both interest and motivation.

By combining academic performance assessment and engagement evaluation, this study used a dual-method quantitative approach, enabling a comprehensive understanding of the intervention's cognitive and motivational outcomes. The validity and reliability of the study's results were supported through methodological triangulation, as recommended by Creswell and Plano Clark (2018) enhancing the credibility of the findings.

2.9 Limitations of the Study

While this research offers meaningful perceptions into the impact of integrating real-life proportional reasoning problems into middle school mathematics instruction, several limitations that may influence the interpretation as well as applicability of the findings are crucial to recognize.

The narrow sample size and scope of the study do limit it in key sorts of ways. Classrooms, small in number, from which the participants were drawn might not adequately represent the socioeconomic and cultural and academic diversity which that is found across broader student populations (Creswell & Plano Clark, 2018). As a result of that, the findings could be contextually bound as well as not generalize to other educational settings, like rural schools, private institutions, or schools serving linguistically diverse populations. The study likewise focused solely upon middle school students cause cognitive development and learning needs are different from older secondary students or younger elementary learners (Eccles & Roeser, 2011). Therefore, real-life applications for fostering engagement and student performance may be effective to varying degrees across different age groups.

Another limitation exists. The study did rely exclusively upon Real-Life Problems of Proportion as being the primary instructional strategy. Direct instruction, inquiry-based learning, and blended educational settings might yield positive outcomes though other methods were not explored within the scope. As a consequence, people have concluded that the real-life problems are effective. These conclusions may not transfer smoothly into classrooms that employ different instructional models.

Also, the study were too short to measure retention over time. Its short length perhaps kept them from watching continued activity. Repeated exposure and practice in time is often required by proportional reasoning a complex skill. Interventions of a short term may capture gains that are immediate, which is a result that is positive.

Yet, if these gains endure or shift later is unclear. Implementation consistency along with outcomes might be affected cause resource availability plus classroom climate plus teacher experience were factors not held constant.

Given these constraints, future research should aim to:

1. Expand the sample size and diversity, including students from varied geographic, cultural, and socioeconomic backgrounds to enhance the external validity of the findings.
2. Include a broader age range, such as upper elementary and high school students, to determine whether the benefits of real-life problem-based instruction extend across developmental stages.
3. Compare multiple instructional strategies to identify the most effective pedagogical approaches for integrating real-life applications into mathematics education.
4. Conduct longitudinal studies to explore the durability of student gains in proportional reasoning and their transferability to novel or complex problem-solving contexts.
5. Examine the role of teacher professional development in effectively delivering real-life mathematical tasks, as teacher beliefs and instructional competencies significantly impact student learning outcomes (Ikhsan, 2020).

By addressing these dimensions in future studies, researchers can build a more comprehensive and nuanced understanding of how real-life applications support mathematics learning, and how best to implement such approaches to serve diverse student populations effectively.

2.10 Data Analysis

This research adopts a single-group, quasi-experimental design to investigate the impact of real-life applications on 6th-grade students' academic achievement and engagement in proportional reasoning. The study were conducted with one class of 24 students at the Dostyq Education Center in Almaty, all of whom formed the experimental group. Over a four-week intervention period, students received instruction in proportional reasoning through real-life contextual scenarios such as cooking, map reading, budgeting, and solving problems involving speed, time, and distance.

Instructional materials were developed using principles of experiential and constructivist learning, encouraging active participation, inquiry-based thinking, and collaborative problem-solving. The study were intentionally delimited to examine how real-life applications function as a pedagogical tool in teaching proportional reasoning, with a focus on their effect on student engagement and academic performance. Other instructional strategies or mathematical domains were beyond the scope of this investigation.

Data Collection Instruments

Two primary instruments were used to collect data:

1. Student Engagement Survey: A modified version of the Student Course Engagement Questionnaire (Towler, 2005), adapted from its use in

Syarifuddin's study on active learning in linear algebra, were employed to assess three dimensions of engagement: cognitive, emotional, and behavioral.

2. Mathematics Achievement Test: This paper-based test were designed to evaluate students' conceptual understanding and application of proportional reasoning. The assessment included a mix of procedural and applied items.

To provide a statistical basis for evaluating change, both instruments were administered as pre-tests and post-tests, allowing the study to measure gains in achievement and engagement over the intervention period.

Data Analysis Approach

The data analysis for this study employed a quantitative approach to evaluate the effectiveness of using real-life applications in enhancing sixth-grade students' student performance and engagement in proportional reasoning. The analysis focused on comparing pre-test and post-test scores for both mathematics achievement and student engagement within the same group of 24 students.

1. Academic Achievement Analysis

To assess changes in students' understanding of proportional reasoning, scores from the mathematics pre-test and post-test were analyzed using a paired sample t-test. This statistical method were selected to determine whether there were a statistically significant difference in student performance before and after the four-week instructional intervention. The significance level (α) were set at 0.05, and assumptions of normality were verified using the Shapiro-Wilk test prior to the t-test.

Student Engagement Analysis

Student engagement were measured using a closed-ended survey instrument encompassing cognitive, emotional, and behavioral dimensions. Each dimension were assessed using Likert-scale responses. Descriptive statistics, such as means, standard deviations, and frequency distributions, were used to summarize the data for each engagement dimension.

To analyze changes in engagement levels before and after the intervention, a paired sample t-test were again employed for each dimension of engagement. This allowed for the identification of specific areas where engagement increased as a result of the instructional approach. Where significant differences were found, effect sizes were computed to better interpret the practical significance of observed changes.

2. Software

All statistical analyses were conducted using Jamovi, an open-source statistical software platform designed for accessibility and clarity in data analysis. Jamovi were selected for its user-friendly interface and reliable implementation of standard statistical tests, making it especially suitable for educational research involving pre/post comparison within small sample sizes.

To ensure compliance with ethical standards, all student data were anonymized and coded prior to entry into the analysis system. No personally identifiable information were retained. The analysis were conducted with full respect for research ethics, such as including confidentiality, voluntary participation, and the right to withdraw.

The findings were interpreted with caution, bearing in mind the limitations of the single-group design, which lacks a control group for comparison. While the design allowed for valuable within-group comparisons, generalizations to broader populations should be made carefully. Nevertheless, the results provide robust initial evidence supporting the instructional benefits of real-life problem-based mathematics teaching at the middle school level.

2.11 Ethical Considerations

When conducting research involving young students, it is imperative to adhere to stringent ethical standards as outlined by institutional review boards (IRBs). Central to these standards is the requirement for informed consent, which must be collected from both the students and their parents or legal guardians prior to participation. The consent process should clearly communicate the purpose of the study, the procedures involved, the voluntary nature of participation, and the participants' unconditional right to withdraw at any stage without facing any adverse consequences (American Educational Research Association, 2011; British Educational Research Association, 2018).

Participants must also be assured of the confidentiality and anonymity of their responses. All identifying information should be securely stored and, where possible, anonymized to safeguard the privacy of participants. Researchers have an ethical obligation to avoid any form of psychological, emotional, or academic harm, and to be particularly sensitive to the developmental vulnerabilities of children and adolescents (Alderson & Morrow, 2020). This includes designing data collection tools that are age-appropriate, culturally sensitive, and non-invasive.

Another point is that, data handling must comply with relevant data protection legislation, such as the General Data Protection Regulation (GDPR) in applicable contexts, and institutional policies regarding secure storage, data access, and retention timelines. Ensuring ethical transparency throughout the research process not only protects participants but also enhances the credibility and trustworthiness of the study (Creswell & Plano Clark, 2018).

By implementing these safeguards, researchers contribute to the ethical integrity of educational research and affirm their responsibility to protect the rights and well-being of young learners throughout the research process.

3. RESULTS

As part of this study, a comparative analysis of pre- and post-intervention scores were conducted using paired sample t-tests across eight key dimensions of student engagement: Surface and Deep Learning Strategies, Reliance, Interest, Achievement Orientation, Anxiety, Attentiveness, and Diligence. These scales reflect the cognitive, emotional, and behavioral components of student engagement.

3.1 Surface Strategy

To evaluate the extent to which surface learning strategies were used before and after the intervention, descriptive statistics were computed. In the pre-test, the mean score were $M = 3.21$, $SD = 0.54$, while in the post-test, the mean decreased to $M = 2.93$, $SD = 0.55$. This decrease may suggest a reduced reliance on surface strategies as a result of the instructional intervention.

To examine the assumption of normality, the Shapiro–Wilk test were performed for both datasets. The results suggest no significant deviation from a normal distribution for either the pre-test ($W = 0.97$, $p = .553$) or the post-test ($W = 0.92$, $p = .065$).

Table 3.1.1 Descriptive Statistics and Shapiro–Wilk Test Results for Surface Strategy

Descriptive	N	Mean	SD	Shapiro-Wilk	
				W	p
Pre-test (Surface Strategy)	24	3.21	0.538	0.965	0.553
Post-test (Surface Strategy)	24	2.93	0.552	0.922	0.065

Since both p-values are above the 0.05 threshold, it can be concluded that the data follow a normal distribution. This allows for the use of parametric statistical methods for further analysis, such as the paired samples t-test.

To determine whether the observed decrease in the use of surface learning strategies were statistically significant, a paired samples t-test were conducted. The results revealed a significant difference between the pre-test and post-test scores: $t(23) = 3.85$, $p < .001$.

This show that the reduction in the use of surface strategies following the intervention were statistically significant at the $p < .001$ level.

Table 3.1.2 Paired Samples T-Test Results for Surface Learning Strategy

Paired Samples T-Test

		statistic	df	p
Pre-test (Surface Strategy)	Post-test (Surface Strategy)	Student's t 3.85	23.0	<.001

Note. $H_a \mu_{\text{Measure 1}} - \mu_{\text{Measure 2}} \neq 0$

These results provide strong evidence that the intervention had a meaningful effect on reducing the reliance on surface learning strategies.

3.2 Deep Learning Strategy

Descriptive statistics were calculated to assess the use of deep learning strategies before and after the intervention. In the pre-test, the mean score were $M = 3.21$ ($SD = 0.773$), and in the post-test, it increased to $M = 3.42$ ($SD = 0.550$), indicating a slight improvement in the use of deep strategies.

To assess the normality of the data distributions, the Shapiro–Wilk test were conducted. The results indicated that both distributions did not significantly deviate from normality:

Pre-test: $W = 0.951, p = 0.283$

Post-test: $W = 0.925, p = 0.075$

Since both p-values exceed the 0.05 threshold, the data can be considered approximately normally distributed. In this way, parametric methods, such as the paired samples t-test, are appropriate for further analysis.

Table 3.2.1 Descriptive Statistics and Shapiro–Wilk Test Results for Deep Strategy

Descriptives

	N	Missing	Mean	SD	Shapiro-Wilk	
					W	p
Pre-Test (Deep Strategy)	24	1	3.21	0.773	0.951	0.283
Post-test (Deep Strategy)	24	1	3.42	0.550	0.925	0.075

To determine whether the observed increase in deep learning strategy use were statistically significant, a paired samples t-test were conducted. The results revealed a significant difference between the pre-test and post-test scores: $t(23) = -2.66, p = .014$.

This finding suggest that the post-intervention increase in deep strategy use were statistically significant, suggesting that the intervention positively influenced participants' adoption of deeper learning approaches.

Table 3.2.2 Paired Samples T-Test Results for Surface Learning Strategy

Paired Samples T-Test

		statistic	df	p
Pre-Test (Deep Strategy)	Post-test (Deep Strategy)	Student's t -2.66	23.0	0.014

Note. $H_a \mu_{\text{Measure 1}} - \mu_{\text{Measure 2}} \neq 0$

These results support the effectiveness of the intervention in enhancing participants' use of deep learning strategies.

3.3 Reliance (Self-Confidence)

Descriptive statistics were calculated to assess participants' self-reported reliance before and after the intervention. In the pre-test, the mean score were $M = 3.70$ ($SD = 0.497$), and in the post-test, the mean increased to $M = 3.95$ ($SD = 0.437$). This show a moderate improvement in reliance-related behaviors or attitudes following the intervention.

To determine whether the data were normally distributed, the Shapiro–Wilk test were performed. The results prove no significant deviations from normality in either condition:

Pre-test: $W = 0.933, p = 0.113$

Post-test: $W = 0.988, p = 0.990$

As both p-values are above the conventional threshold of 0.05, the distributions can be considered approximately normal. This supports the use of parametric analyses, such as the paired samples t-test, for further testing of mean differences.

Table 3.3.1 Descriptive Statistics and Shapiro–Wilk Test Results for Reliance

Descriptives

	N	Mean	SD	Shapiro-Wilk	
				W	p
Pre-test (Reliance)	24	3.70	0.497	0.933	0.113
Post-test (Reliance)	24	3.95	0.437	0.988	0.990

To evaluate whether the increase in reliance observed after the intervention were statistically significant, a paired samples t-test werewas conducted. The analysis revealed a statistically significant difference between the pre-test and post-test scores: $t(23) = -4.70, p < .001$.

These results suggest that the intervention had a strong positive effect on participants' reliance, with significantly higher scores observed after the intervention.

Table 3.4.2 Paired Samples T-Test Results for Surface Reliance

Paired Samples T-Test

			statistic	df	p
Pre-test (Reliance)	Post-test (Reliance)	Student's t	-4.70	23.0	<.001

Note. $H_a \mu_{\text{Measure 1}} - \mu_{\text{Measure 2}} \neq 0$

Overall, the statistically significant increase in reliance scores provides strong evidence that the intervention were effective in enhancing this particular cognitive or behavioral attribute.

3.5 Interest in Mathematics

Descriptive statistics were computed to examine participants' levels of interest before and after the intervention. The pre-test mean were $M = 3.55$ ($SD = 0.548$), while the post-test mean increased to $M = 3.84$ ($SD = 0.517$). This rise in the average suggests a positive change in interest following the intervention.

To assess the normality of the score distributions, the Shapiro–Wilk test were performed. The test showed no significant deviation from normality in either phase:

Pre-test: $W = 0.976, p = 0.822$

Post-test: $W = 0.928, p = 0.087$

Because both p-values are well above the 0.05 threshold, the assumption of normality is met. This permits the use of parametric tests, such as the paired samples t-test, to assess the significance of the observed change.

Table 3.5.1 Descriptive Statistics and Shapiro–Wilk Test Results for Interest

Descriptives

	N	Mean	SD	Shapiro-Wilk	
				W	p
Pre-test (Interest)	24	3.55	0.548	0.976	0.822
Post-test (Interest)	24	3.84	0.517	0.928	0.087

The t-test results revealed a significant increase in interest from pre- to post-test: $t(23) = -5.21, p < .001$

This result provides strong evidence that the intervention had a significant positive effect on participants' level of interest.

Table 3.5.2 Paired Samples T-Test Results for Interest

Paired Samples T-Test

			statistic	df	p
Pre-test (Interest)	Post-test (Interest)	Student's t	-5.21	23.0	<.001

Note. $H_a \mu_{\text{Measure 1}} - \mu_{\text{Measure 2}} \neq 0$

Taken together, the data suggest that the intervention were effective in significantly enhancing students’ reported interest levels.

3.6 Achievement Orientation

Descriptive statistics were computed to assess participants’ achievement orientation before and after the intervention. The pre-test mean were $M = 4.23$ ($SD = 0.363$), while the post-test mean increased slightly to $M = 4.36$ ($SD = 0.356$). This suggests a modest increase in achievement-oriented attitudes or behaviors following the intervention.

To test whether the assumption of normality were met, the Shapiro–Wilk test were applied. The results showed no significant departure from normality:

Pre-test: $W = 0.957, p = 0.378$

Post-test: $W = 0.919, p = 0.055$

Table 3.6.1 Descriptive Statistics and Shapiro–Wilk Test Results for Achievement Orientation

Descriptives

	N	Mean	SD	Shapiro-Wilk	
				W	p
Pre-test (Achievement Orientation)	24	4.23	0.363	0.957	0.378
Post-test (Achievement Orientation)	24	4.36	0.356	0.919	0.055

While the post-test p-value is close to the .05 threshold, both values are above the cutoff, and thus the data can be considered to approximately follow a normal distribution. Therefore, the paired samples t-test is an appropriate method for further analysis.

Table 3.6.2 Paired Samples T-Test Results for Achievement Orientation

Paired Samples T-Test

			statistic	df	p
Pre-test (Achievement Orientation)	Post-test (Achievement Orientation)	Student's t	-4.00	23.0	<.001

Note. $H_a \mu_{\text{Measure 1}} - \mu_{\text{Measure 2}} \neq 0$

The results of the paired samples t-test revealed a statistically significant difference between pre- and post-test scores: $t(23) = -4.00, p < .001$

This reveal a significant increase in achievement orientation following the intervention.

3.7 Anxiety

Descriptive statistics were calculated to evaluate participants' anxiety levels before and after the intervention. In the pre-test, the mean score were $M = 3.47$ ($SD = 0.491$), while in the post-test, the mean decreased to $M = 3.33$ ($SD = 0.398$). This suggests a reduction in anxiety following the intervention.

To assess whether the data met the assumption of normality, the Shapiro–Wilk test werewas applied. The test results indicated no significant departures from normal distribution:

Pre-test: $W = 0.934, p = 0.120$

Post-test: $W = 0.928, p = 0.088$

Table 3.7.1 Descriptive Statistics and Shapiro–Wilk Test Results for Anxiety

Descriptives

	N	Mean	SD	Shapiro-Wilk	
				W	p
Pre-test (Anxiety)	24	3.47	0.491	0.934	0.120
Post-test (Anxiety)	24	3.33	0.398	0.928	0.088

As both p-values exceeded the 0.05 threshold, the distributions can be considered approximately normal. This justifies the use of a paired samples t-test to assess the significance of the difference.

The paired samples t-test revealed a statistically significant reduction in anxiety: $t(23) = 2.85, p = 0.009$

This result reveal that the intervention led to a significant decrease in anxiety levels among participants.

Table 3.7.2 Paired Samples T-Test Results for Anxiety

Paired Samples T-Test

			statistic	df	p
Pre-test (Anxiety)	Post-test (Anxiety)	Student's t	2.85	23.0	0.009

Note. $H_a \mu_{\text{Measure 1}} - \mu_{\text{Measure 2}} \neq 0$

3.7 Frustration

Participants' degrees of frustration both before and after the intervention were assessed using descriptive statistics. With a standard deviation of $SD = 0.337$ and a mean frustration score recorded at $M = 2.16$, the pre-test phase revealed a rather low but quantifiable level of frustration among participants at the outset. A post-test was done following the intervention and showed a rather lower mean frustration score of $M = 2.05$ with a standard deviation of $SD = 0.381$. This noted decline points to a modest decline in participants' self-reported degree of frustration. Though the pre- and post-intervention means seem to be rather small, this could still show a favorable trend in the efficacy of the intervention in reducing frustration. This small change calls for more research, maybe using paired-sample t-tests or inferential statistical tests to find whether the decrease is statistically significant and not the result of random variance. It also provides opportunities for investigating the particular elements of the intervention that helped to produce the noted change in emotional response.

Normality were assessed using the Shapiro–Wilk test. The results showed no significant deviations from a normal distribution:

Pre-test: $W = 0.932, p = 0.111$

Post-test: $W = 0.937, p = 0.136$

Table 3.7.1 Descriptive Statistics and Shapiro–Wilk Test Results for Frustration

Descriptives

	N	Mean	SD	Shapiro-Wilk	
				W	p
Pre-test (Frustration)	24	2.16	0.337	0.932	0.111
Post-test (Frustration)	24	2.05	0.381	0.937	0.136

Both p-values are above 0.05, satisfying the assumption of normality and supporting the use of a paired samples t-test.

The t-test revealed a statistically significant reduction in frustration levels: $t(23) = 2.34, p = 0.029$

This suggests that the intervention had a meaningful effect in decreasing participants' frustration.

Table 3.7.2 Paired Samples T-Test Results for Frustration

Paired Samples T-Test

		statistic	df	p	
Pre-test (Frustration)	Post-test (Frustration)	Student's t	2.34	23.0	0.029

Note. $H_a \mu_{\text{Measure 1}} - \mu_{\text{Measure 2}} \neq 0$

The statistically significant decrease in frustration after the intervention reveal that the program were effective in reducing participants' emotional discomfort or perceived difficulty levels.

3.8 Attentiveness

Descriptive statistics were calculated to assess participants' attentiveness before and after the intervention. The pre-test mean were $M = 3.82$ ($SD = 0.357$), and the post-test mean slightly increased to $M = 3.89$ ($SD = 0.342$), suggesting a minor improvement in attentiveness.

To verify the normality assumption, the Shapiro–Wilk test were used. Results indicated that both distributions were approximately normal:

Pre-test: $W = 0.941, p = 0.176$

Post-test: $W = 0.963, p = 0.504$

Table 3.8.1 Descriptive Statistics and Shapiro–Wilk Test Results for Attentiveness

Descriptives

	N	Mean	SD	Shapiro-Wilk	
				W	p
Pre-test (Attentiveness)	24	3.82	0.357	0.941	0.176
Post-test (Attentiveness)	24	3.89	0.342	0.963	0.504

Since both p-values exceed the 0.05 threshold, the normality assumption were satisfied, allowing for the use of a paired samples t-test.

Table 3.8.2 Paired Samples T-Test Results for Attentiveness

Paired Samples T-Test

			statistic	df	p
Pre-test (Attentiveness)	Post-test (Attentiveness)	Student's t	-2.37	23.0	0.026

Note. $H_a \mu_{\text{Measure 1}} - \mu_{\text{Measure 2}} \neq 0$

The paired samples t-test revealed a statistically significant increase in attentiveness:

$$t(23) = -2.37, p = 0.026$$

These findings indicate that the intervention had a positive and statistically significant effect on participants' attentiveness levels.

The statistically significant increase in attentiveness demonstrates the intervention's effectiveness in encouraging sustained cognitive focus and engagement.

3.9 Diligence

Descriptive statistics were computed to assess participants' diligence levels before and after the intervention. The pre-test mean were $M = 3.94$ ($SD = 0.336$), and the post-test mean increased to $M = 4.11$ ($SD = 0.271$), suggesting a notable improvement in diligence following the intervention.

To evaluate normality, the Shapiro–Wilk test were conducted. The results showed no significant deviations from normality:

$$\text{Pre-test: } W = 0.976, p = 0.806$$

$$\text{Post-test: } W = 0.918, p = 0.053$$

Table 3.9.1 Descriptive Statistics and Shapiro–Wilk Test Results for Diligence

Descriptives

	N	Mean	SD	Shapiro-Wilk	
				W	p
Pre-Test (Diligence)	24	3.94	0.336	0.976	0.806
Post-Test (Diligence)	24	4.11	0.271	0.918	0.053

While the post-test p-value approaches the 0.05 threshold, both values remain above it, indicating that the distributions are approximately normal. As a result, a paired samples t-test were considered appropriate.

The t-test revealed a statistically significant increase in diligence after the intervention:

$$t(23) = -4.63, p < .001$$

This result shows a strong and significant positive effect of the intervention on participants' diligence.

Table 3.9.2 Paired Samples T-Test Results for Diligence

Paired Samples T-Test

		statistic	df	p	
Pre-Test (Diligence)	Post-Test (Diligence)	Student's t	-4.63	23.0	<.001

Note. $H_a: \mu_{\text{Measure 1}} - \mu_{\text{Measure 2}} \neq 0$

The statistically significant increase in diligence demonstrates that the intervention effectively enhanced participants' sustained effort and task-focused behavior.

The findings of this study suggest notable enhancements across the three core dimensions of student engagement—cognitive, affective, and behavioural—as a result of incorporating real-life proportional problems into mathematics instruction.

Cognitive engagement: The results of the study indicate a significant increase in students' cognitive engagement after the introduction of real-life learning tasks in the study of proportions. Students began to demonstrate a higher level of intellectual engagement, which were expressed in the desire not only to memorize formulas and algorithms, but also to comprehend mathematical concepts. In the process of completing tasks related to everyday contexts (e.g. budgeting, recalculating recipes, scaling plans), students illustrate the development of analytical thinking, the ability to apply solving problem strategies, as well as self-regulation and self-control skills.

Most participants began to take the initiative in choosing a solution strategy, independently analyzing the conditions of the problems and formulating logical justifications for their decisions. This suggests that the use of realistic problems contributes not only to the memorization of knowledge, but also to a deep understanding of the material, the development of metacognitive skills and the formation of competence in the application of mathematical knowledge in various life contexts.

Affective engagement: The affective engagement of students also improved significantly as a result of the implementation of contextualized tasks. Students' attitudes towards mathematics became more positive: they showed greater interest in the subject, emotional involvement in the process, and a sense of satisfaction from completing the tasks. This is especially true for secondary school students, who are known to often experience a decrease in motivation and interest in mathematics.

The use of ethnopedagogical elements (e.g. tasks related to national traditions, cooking, the market, and everyday life) contributed to the formation of a sense of

personal significance of learning. Students noted that such tasks helped them to realize the usefulness of mathematics in real life, which, in turn, increased their intrinsic motivation. The positive emotions that arose while completing the tasks strengthened students' self-confidence and helped to reduce anxiety, which could previously hinder the successful acquisition of proportional thinking.

Behavioural engagement: Finally, high behavioural engagement were noted, which were show by the active participation of students in learning activities. The number of interactions between students in the classroom increased, students asked questions more often, discussed solutions to problems in pairs and groups, and also showed initiative in completing assignments. Students became more diligent, more often completed assignments and showed responsibility for their learning.

The had Real-Life Applications of Proportion positive effect, as students not only solved mathematical problems, but also planned, analyzed data, worked with tables and graphs. This contributed to the formation of stable learning habits, such as planning, self-organization and cooperation. Behavioural changes became an indicator of a higher level of engagement and intrinsic motivation.

Table 3.9.3 Mean Values and Standard Devaitions of the Aspects of Engagement

Elements of Engagement	Pre-Test		Post-Test	
	Mean	Standard deviation	Mean	Standard deviation
Cognitive engagement:				
Surface Strategy	3.21	0.538	2.93	0.552
Deep Strategy	3.21	0.773	3.42	0.550
Reliance	3.70	0.497	3.95	0.437
Affective Engagement:				
Interest	3.55	0.548	3.84	0.517
Achievement Orientation	4.23	0.363	4.36	0.356
Anxiety	3.47	0.491	3.33	0.398
Frustration	2.16	0.337	2.05	0.381
Behavioural Engagement:				
Attentiveness	3.82	0.357	3.89	0.342
Diligence	3.94	0.336	4.11	0.271

3.10 Academic Achievement Analysis

A total of 24 students participated in the study, and data were collected before and after the intervention. The mean score before the intervention were $M = 57.3$,

with a standard deviation of $SD = 20.1$, and after the intervention, $M = 68.8$, $SD = 19.6$, indicating an improvement in the results.

To test the normality of the data distribution, the Shapiro-Wilk test were performed, the results of which showed no significant deviations from the normal distribution:

- Pretest: $W = 0.966$, $p = 0.560$
- Posttest: $W = 0.953$, $p = 0.318$

P-values above 0.05 confirm that the data meet the criteria for normality, and therefore, the use of the parametric test (t-test) is correct.

Table 3.10.1 Descriptive Statistics and Shapiro–Wilk Test Results for Ratio and Proportion Unit Test

	Descriptives			Shapiro-Wilk	
	N	Mean	SD	W	p
Academic.a pre-test	24	57.3	20.1	0.966	0.560
Academic.a post-test	24	68.8	19.6	0.953	0.318

A paired Student's t-test were performed to assess the statistically significant difference between the pre- and posttest results. The results of the analysis showed that the differences are significant:

$$t(23) = -5.92, p < .001.$$

This reveal a reliable improvement in the academic performance of students after the intervention.

Table 3.10.2 Paired Samples T-Test Results for Ratio and Proportion Unit Test

Paired Samples T-Test

			statistic	df	p
Academic.a post-test	Academic.a pre-test	Student's t	5.92	23.0	<.001

Note. $H_a \mu_{\text{Measure 1}} - \mu_{\text{Measure 2}} \neq 0$

The analysis of the data earned during the experiment showed a significant improvement in both student engagement and their students performance when using tasks close to real life in teaching proportions. Positive changes were recorded in the following indicators:

- Superficial and deep learning strategies: a transition from passive memorization to a more meaningful and structured assimilation of the material is noted;

- Self-confidence and interest in mathematics have significantly increased among the participants of the experiment, especially in the context of practical tasks;
- Academic performance demonstrates a stable improvement - the results of the final testing exceed the preliminary indicators;
- Indicators of engagement: such aspects as attentiveness, persistence, motivation to achieve and reduced anxiety have also improved;
- Critical thinking and analytical skills are more pronounced when completing project tasks, compared to traditional algorithmic problems.

Thus, the collected results confirm the hypothesis of the high efficiency of using real-life tasks for developing proportional thinking and increasing motivation for learning.

CONCLUSION

This study aimed to investigate the effectiveness of using real-life problems when teaching proportions in a 6th-grade mathematics course. The aim of the dissertation were to identify the impact of contextualized mathematical tasks on students' learning motivation, engagement, and academic performance. The study used a quasi-experimental method and conducted a comparative analysis of the content of Kazakhstani and Singaporean textbooks. The results collected allow us to draw the following general conclusions:

1. Increasing students' learning motivation and engagement: Integrating tasks that reflect real-life situations (e.g., calculating discounts, recalculating recipes, budgeting, etc.) has a significant affect on students' cognitive, emotional, and behavioral engagement. Students showed more interest in mathematics, participated more actively in lessons, and consciously approached problem solving. Thus, contextualized learning contributes to the formation of sustainable positive learning motivation.

2. Improving academic performance: Analysis of the results before and after the educational intervention showed that students who were taught using real-life tasks illustrate a statistically significant increase in the results of the final test. This confirms that contextual teaching contributes to a better assimilation of concepts, the development of proportional thinking and the ability to apply knowledge in non-standard situations.

3. Methodological feasibility: As part of the study, a project task "Garden plan 10x10" were developed and tested, which serves as an example of the effective implementation of the principles of the competency-based approach. The task allowed students to work with real data, calculate proportions, analyze information and visualize the results. This form of organizing educational activities contributes to the development of critical thinking, functional literacy and meta-subject skills.

4. Comparative analysis of textbooks: A comparison of the content of Kazakhstan and Singapore textbooks on the topic of proportions revealed significant differences in the didactic approach. In Kazakhstani textbooks, the tasks are mostly abstract and algorithmic, while in Singaporean textbooks, tasks focused on real-life contexts dominate. This contrast suggest the need to modernize domestic teaching materials in accordance with international educational standards and the requirements of functional mathematical literacy.

5. Theoretical justification The study is based on modern educational theories: constructivism, the theory of situational learning, and the theory of engagement. These approaches substantiate that knowledge is formed most effectively when students interact with the material in a meaningful, socially grounded context. The use of tasks close to real life allows students not only to memorize algorithms, but also to meaningfully build an understanding of mathematical relationships, such as proportions, and apply them in a new environment.

Thus, during the study, all the goals and objectives were consistently implemented and achieved in full, which is confirmed by both the theoretical analysis and the results of the empirical part of the work.

Firstly, as a result of the analysis of scientific literature, as well as the practical study of the educational process, the key difficulties that students face in traditional teaching of the topic of proportions were identified. It was found that many schoolchildren tend to use additive, superficial strategies instead of a deep understanding of multiplicative relationships, which is due to the excessive abstractness of the material, the lack of context and insufficient elaboration of the semantic connections between the tasks and everyday life. This, in turn, reduces interest in the subject, causes anxiety and prevents the formation of stable mathematical concepts.

Secondly, innovative pedagogical strategies were developed and tested to develop students' conscious and sustainable understanding of proportional relationships. These strategies include: the introduction of project-based research tasks (e.g., the mini-project "10x10 Garden Plan"), the active use of real-life situations in learning, data visualization, group work, and stimulating independent choice of solving problem strategies. These approaches allowed students not only to understand the structure of proportional relationships, but also to realize their significance and applicability in real-life situations.

Thirdly, based on a quasi-experimental study, it was empirically proven that contextualized learning based on real-life situations has a positive effect on students' learning motivation, engagement, and academic performance. Statistical analysis shows an increase in both cognitive activity and emotional satisfaction with the learning process. Students who studied the program using real-life problems illustrate a higher level of understanding, confidence, and interest in mathematics, as well as better results in the final testing.

Fourth, a critical assessment of the current Kazakhstani mathematics textbooks for grade 6 were conducted, revealing their insufficient focus on the development of functional literacy. Most of the presented problems are formal and algorithmic in nature, not going beyond the scope of educational abstraction. A comparative analysis with Singaporean textbooks revealed the need to update and revise the content of domestic textbooks with an emphasis on the applied significance of the material, multi-step tasks, interdisciplinary connections, and the development of critical thinking.

Fifth, specific recommendations for teachers, methodologists, and curriculum developers were formulated based on the analysis and practical observations. These recommendations include: targeted inclusion of problems close to the life experience of students in the educational process; use of interdisciplinary connections; encouragement of group and project work; and the organization of systematic reflection and discussion of solving problem strategies in educational dialogue. All this is aimed at improving the effectiveness of teaching mathematics and implementing the goals of the updated educational content in Kazakhstan.

In general, the results of this dissertation have high practical significance. They represent the basis for improving school mathematics education in the context of modernization and the transition to a competency-based approach. The inclusion of real-life problems not only helps to increase the motivation and involvement of students, but also develops key 21st century skills: the ability to analyze, argue, make independent decisions, think interdisciplinary and meaningfully apply knowledge in a variety of situations.

Thus, the study makes a substantial and multifaceted contribution to both the theoretical foundations and methodological approaches underpinning the integration of life-oriented problems into mathematics education. By emphasizing the relevance and applicability of mathematical concepts to real-world contexts, it not only enriches the pedagogical framework but also fosters deeper engagement and understanding among students. This, in turn, opens promising avenues for the continued evolution of educational practices, particularly those aimed at cultivating functional mathematical literacy among school-aged learners. The findings underscore the importance of aligning curriculum design with practical life skills, thereby equipping students with the competencies needed to navigate everyday quantitative challenges effectively and confidently.

REFERENCES

- Ali, R., Akhter, A., & Khan, M. A. (2020). Effect of teaching strategies on students' academic performance in mathematics at secondary level. *Bulletin of Education and Research*, 42(1), 129–144. http://pu.edu.pk/images/journal/ier/PDF-FILES/10_42_1_20.pdf
- Al-Mutawah, M., Mahmoud, E., Thomas, R., Preji, N., & Alghazo, Y. (2022). Math and Science Integrated Curriculum: Pedagogical Knowledge-Based Education Framework. *Education Research International*, 2022, 1–10. <https://doi.org/10.1155/2022/2984464>
- American Educational Research Association. (2011). *Code of Ethics*. https://www.aera.net/Portals/38/docs/About_AERA/AERA%20Code%20of%20Ethics.pdf
- Anderson, A. J. M. A. N. D. J. W. A. N. D. J. B. A. N. D. J. (2014). Exploring the Ups and Downs of Mathematics Engagement in the Middle Years of School. *The Journal of Early Adolescence*, 35(2), 199–244. <https://doi.org/10.1177/0272431614529365>
- Aniskin, V. N., & Rakhmatullina, D. K. (2023). Mathematical modeling as a method of forming cognitive universal learning actions and competences of students in the conditions of a holistic educational environment. *Vestnik of Samara University. Natural Science Series*, 29(3), 79–92. <https://doi.org/10.18287/2541-7525-2023-29-3-79-92>
- Arhin, Y. D. A. A. N. D. E. K. O. A. N. D. S. A.-A. A. N. D. A. K. (2018). *Connecting Mathematics To Real Life Problems: A Teaching Quality That Improves Students' Mathematics Interest*.
- Arthur J., et al. (2018). Measuring student engagement in mathematics. *International Journal of STEM Education*.
- Arthur, Y. D., Owusu, E. K., Asiedu-Addo, S., & Arhin, A. K. (n.d.). *Connecting Mathematics To Real Life Problems: A Teaching Quality That Improves Students' Mathematics Interest*. 8(4), 65–71. <https://doi.org/10.9790/7388-0804026571>
- Ayan, R., & Isiksal-Bostan, M. (2019). Middle school students' proportional reasoning in real life contexts in the domain of geometry and measurement. *International Journal of Mathematical Education in Science and Technology*, 50(1), 65–81. <https://doi.org/10.1080/0020739X.2018.1468042>
- Ayan-Civak H., & İşiksal-Bostan, M. (2018). Examining Middle School Students' Proportional Reasoning. *International Journal of Science and Mathematics Education*.
- Banerjee, P., & Bhat, A. (2025). *Mathematics in Everyday Life: Exploring Practical Applications and Real-World Impact*. <https://orcid.org/0000-0002-9689-2351>
- Basharina, O. V, & Litvinova, Y. R. (2023). Значимость межпредметных связей в процессе изучения математических дисциплин и профессиональных модулей. *Инновационное Развитие Образования*. <https://cyberleninka.ru/article/n/znachimost-mezhpredmetnyh-svyazey-v->

protsesse-izucheniya-matematicheskikh-distsiplin-i-professionalnyh-moduley-dlya-formirovaniya

- Beswick, K. (2012). Teachers' beliefs about school mathematics and mathematicians' mathematics and their relationship to practice. *Educational Studies in Mathematics*, 79(1), 127–147. <https://doi.org/10.1007/s10649-011-9333-2>
- Bintara, I. A., & Suhendra. (2021). Analysis toward learning obstacles of junior high school students on the topic of direct and inverse proportion. *Journal of Physics: Conference Series*, 1882(1), 012083. <https://doi.org/10.1088/1742-6596/1882/1/012083>
- Boaler, J. (1998a). Open and Closed Mathematics: Student Experiences and Understandings. *Journal for Research in Mathematics Education*.
- Boaler, J. (1998b). Open and Closed Mathematics: Student Experiences and Understandings. *Journal for Research in Mathematics Education*.
- British Educational Research Association. (2018). *Ethical Guidelines for Educational Research* (4th ed.). <https://www.bera.ac.uk/publication/ethical-guidelines-for-educational-research-2018>
- Broza, O., & Kolikant, Y. B.-D. (2020a). Student struggles with proportions: Analyzing classroom interactions. *Educational Studies in Mathematics*.
- Broza, O., & Kolikant, Y. B.-D. (2020b). The Potential of Rich Digital Game-Based Learning Environments to Promote Low-Achieving Students' Participation in Mathematics. *International Journal of Game-Based Learning*, 10(4), 40–54. <https://doi.org/10.4018/IJGBL.2020100103>
- Broza, O., & Kolikant, Y. B.-D. (2020c). The Potential of Rich Digital Game-Based Learning Environments to Promote Low-Achieving Students' Participation in Mathematics. *International Journal of Game-Based Learning*, 10(4), 40–54. <https://doi.org/10.4018/IJGBL.2020100103>
- Broza, O., & Kolikant, Y. B.-D. (2020d). The Potential of Rich Digital Game-Based Learning Environments to Promote Low-Achieving Students' Participation in Mathematics. *International Journal of Game-Based Learning*, 10(4), 40–54. <https://doi.org/10.4018/IJGBL.2020100103>
- Bruner, J. S. (1961). The Act of Discovery. In E. R. Hilgard (Ed.), *Instruction: Selected Readings* (pp. 87–96). Scott, Foresman and Company. <https://doi.org/10.1037/11116-005>
- Buan, A. T., Ali, A. Z. M., & Gomez, R. (2021). Development and validation of contextualized lesson in mathematics. *Journal of Physics: Conference Series*, 1835(1), 012100. <https://doi.org/10.1088/1742-6596/1835/1/012100>
- Bushmeleva, N. A., Sakhieva, R. G., Konyushenko, S. M., & Kopylov, S. M. (2018). Technology for Teaching Students to Solve Practice-Oriented Optimization Problems in Mathematics. *EURASIA Journal of Mathematics, Science and Technology Education*, 14(10). <https://doi.org/10.29333/ejmste/93678>
- Calder, N. (Ed.). (2011). *Processing Mathematics Through Digital Technologies*. SensePublishers. <https://doi.org/10.1007/978-94-6091-627-4>
- Çalışıcı, H. (2018). Middle School Students' Learning Difficulties in the Ratio-proportion Topic and a Suggested Solution: Envelope Technique. *Universal*

- Journal of Educational Research*, 6(8), 1848–1855.
<https://doi.org/10.13189/ujer.2018.060830>
- Casler-Failing, S. L. (2018a). ROBOTICS AND MATH: USING ACTION RESEARCH TO STUDY GROWTH PROBLEMS. In *Canadian Journal of Action Research* (Vol. 19, Issue 2).
- Casler-Failing, S. L. (2018b). The Effects of Integrating LEGO Robotics Into a Mathematics Curriculum to Promote the Development of Proportional Reasoning. *Proceedings of the Interdisciplinary STEM Teaching and Learning Conference*, 2(1). <https://doi.org/10.20429/stem.2018.020105>
- Coffman, K. (2022). *CREATING MEANINGFUL LEARNING THROUGH PROJECT-BASED LEARNING IN THE MIDDLE SCHOOL MATHEMATICS CLASSROOM*.
- Cohen, L., Manion, L., & Morrison, K. (2017a). *Research Methods in Education*. Routledge. <https://doi.org/10.4324/9781315456539>
- Cohen, L., Manion, L., & Morrison, K. (2017b). *Research Methods in Education*. Routledge. <https://doi.org/10.4324/9781315456539>
- Connell, J. P., & Wellborn, J. G. (1991). Competence, autonomy, and relatedness: A motivational analysis of self-system processes. In M. R. Gunnar & L. A. Sroufe (Eds.), *Self Processes and Development: The Minnesota Symposium on Child Psychology* (Vol. 23, pp. 43–77). Lawrence Erlbaum Associates. <https://www.worldcat.org/title/competence-autonomy-and-relatedness-a-motivational-analysis-of-self-system-processes/oclc/24640674>
- Coughlin, E., Burkhardt, G., Monsour, M., Valdez, G., & Dawson, M. (2003). *Cheryl Lemke CEO, Metiri Group*. www.metiri.com
- Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and Conducting Mixed Methods Research* (3rd ed.). SAGE Publications. <https://us.sagepub.com/en-us/nam/designing-and-conducting-mixed-methods-research/book241842>
- de la Torre, J., & Minchen, N. (2014). Cognitively Diagnostic Assessments and the Cognitive Diagnosis Model Framework. *Psicología Educativa*, 20(2), 89–97. <https://doi.org/10.1016/j.pse.2014.11.001>
- Deci, E. L., & Ryan, R. M. (1985). *Intrinsic Motivation and Self-Determination in Human Behavior*. Plenum Press. <https://doi.org/10.1007/978-1-4899-2271-7>
- Domondon, C., Corpuz, M. J., Carranza, M., Moroki, I., Ching, F., & Elipane, L. (2024). Reflections on teaching ratio and proportion using Lesson Study. *Diversitas Journal*, 9(1_Special). https://doi.org/10.48017/dj.v9i1_special.2834
- Eccles, J. S., & Roeser, R. W. (2011). Schools as Developmental Contexts During Adolescence. *Journal of Research on Adolescence*, 21(1), 225–241. <https://doi.org/10.1111/j.1532-7795.2010.00725.x>
- Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology*, 53(1), 109–132. <https://doi.org/10.1146/annurev.psych.53.100901.135153>
- Ergene, Ö., & Karaboğaz, Y. (2024). The effect of the flipped classroom model on students proportional reasoning. *Journal of Pedagogical Research*. <https://doi.org/10.33902/JPR.202425424>

- Fielding-Wells, J., Dole, S., & Makar, K. (2014). Inquiry pedagogy to promote emerging proportional reasoning in primary students. *Mathematics Education Research Journal*, 26(1), 47–77. <https://doi.org/10.1007/s13394-013-0111-6>
- Fosnot, C. T. (2013). *Constructivism: Theory, Perspectives, and Practice* (2nd ed.). Teachers College Press. <https://www.tcpress.com/constructivism-9780807754358>
- Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2012). *How to Design and Evaluate Research in Education* (8th ed.). McGraw-Hill. <https://www.mheducation.com/highered/product/how-design-evaluate-research-education-fraenkel-wallen/M9780078110399.html>
- Fredricks J. A., B. P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research*.
- Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School Engagement: Potential of the Concept, State of the Evidence. *Review of Educational Research*, 74(1), 59–109. <https://doi.org/10.3102/00346543074001059>
- Herges, R. M., Duffield, S., Martin, W., & Wageman, J. (2017). Motivation and Achievement of Middle School Mathematics Students. In *The Mathematics Educator* (Vol. 26, Issue 1).
- Hermans, F. (2018). The Implementation of Educational Reform in Kazakhstan: Insights from Secondary Education. In *Policy Studies in Education Reform*. Springer. https://link.springer.com/chapter/10.1007/978-3-030-32829-9_7
- Hilton, A., Hilton, G., Dole, S., & Goos, M. (2016). Promoting middle school students' proportional reasoning skills through an ongoing professional development programme for teachers. *Educational Studies in Mathematics*, 92(2), 193–219. <https://doi.org/10.1007/s10649-016-9694-7>
- Hmelo-Silver, C. E. (2004). Problem-Based Learning: What and How Do Students Learn? *Educational Psychology Review*, 16(3), 235–266. <https://doi.org/10.1023/B:EDPR.0000034022.16470.f3>
- Hollingsworth, T. M. G. A. N. D. M. (2012). Improving Student Engagement with 21st Century Learning Practices. *Northwest Journal of Teacher Education*, 10(1). <https://doi.org/10.15760/nwjte.2012.10.1.1>
- Ikhsan, C. M. Z. A. N. D. R. J. A. N. D. R. H. A. N. D. M. (2020). Teachers' understanding about the characteristics of realistic mathematics education. *Journal of Education and Learning (EduLearn)*, 14(3), 456–462. <https://doi.org/10.11591/edulearn.v14i3.8458>
- Jalali, S. K. A. N. D. T. (2021). Linking Real-Life Situation with Content of School Mathematics at Secondary Level: Exploring Current Practice and Challenge in Bangladesh. *Journal of Education and Practice*. <https://doi.org/10.7176/jep/12-3-19>
- Jupri, W. A. A. N. D. Al. (2017). Student Obstacles in Ratio and Proportion Learning. *Journal of Physics Conference Series*, 812, 12048. <https://doi.org/10.1088/1742-6596/812/1/012048>

- Kalinin, N., & Pankratova, T. (2022). *Globalisation, Nation-Building and History Education*. Springer. <https://link.springer.com/content/pdf/10.1007/978-3-031-44813-3.pdf>
- Karplus, R., Pulos, S., & Stage, E. K. (1983). Early adolescents' proportional reasoning on "rate" problems. In R. Lesh & M. Landau (Eds.), *Acquisition of Mathematics Concepts and Processes* (pp. 45–90). Academic Press.
- Kazemi E., & Stipek, D. (2009). Promoting conceptual thinking in four upper-elementary mathematics classrooms. *Journal of Education*.
- Kazima, M. (2013). Students' Preferences for Contexts and their Relevance to School Mathematics in Malawi. *African Journal of Research in Mathematics, Science and Technology Education*, 17(3), 244–254. <https://doi.org/10.1080/10288457.2013.848537>
- Kong, Y. (2021). The Role of Experiential Learning on Students' Motivation and Classroom Engagement. *Frontiers in Psychology*, 12. <https://doi.org/10.3389/fpsyg.2021.771272>
- Lamon, S. J. (2007). Rational numbers and proportional reasoning: Toward a theoretical framework. *Second Handbook of Research on Mathematics Teaching and Learning*.
- Lein A. E., et al. (2015). Student engagement and learning in mathematics classrooms. *Mathematics Education Research Journal*.
- Lein, A. E., Jitendra, A. K., Starosta, K. M., Dupuis, D. N., Hughes-Reid, C. L., & Star, J. R. (2016). Assessing the Relation Between Seventh-Grade Students' Engagement and Mathematical Problem Solving Performance. *Preventing School Failure: Alternative Education for Children and Youth*, 60(2), 117–123. <https://doi.org/10.1080/1045988X.2015.1036392>
- Mahmudi, F. M. A. N. D. A. (2021). An analysis of proportional reasoning ability of junior high school students. *Jurnal Riset Pendidikan Matematika*, 8(1), 22–32. <https://doi.org/10.21831/jrpm.v8i1.14995>
- Mardika, F., & Mahmudi, A. (2021). An analysis of proportional reasoning ability of junior high school students. *Jurnal Riset Pendidikan Matematika*, 8(1), 22–32. <https://doi.org/10.21831/jrpm.v8i1.14995>
- Martin, A. J., Way, J., Bobis, J., & Anderson, J. (2015). Exploring the Ups and Downs of Mathematics Engagement in the Middle Years of School. *The Journal of Early Adolescence*, 35(2), 199–244. <https://doi.org/10.1177/0272431614529365>
- Matney, G., Jackson, J. L., & Bostic, J. (2013). Effects of Minute Contextual Experience on Realistic Assessment of Proportional Reasoning. *Investigations in Mathematics Learning*, 6(1), 41–68. <https://doi.org/10.1080/24727466.2013.11790329>
- Mebert, C. J., Griffin, D., & Adams, C. (2020). Measuring Student Engagement in a Standards-Based Grading System. *Journal of Educational Research and Practice*, 10(1), 123–136. <https://scholarworks.waldenu.edu/cgi/viewcontent.cgi?article=1335&context=jerap>

- Medina Herrera, L. M., Juárez Ordóñez, S., & Ruiz-Loza, S. (2024). Enhancing mathematical education with spatial visualization tools. *Frontiers in Education*, 9. <https://doi.org/10.3389/educ.2024.1229126>
- Meterbayeva, K., Karmenbayeva, Zh., Tleulinova, M., Auhadieva, Z., & Egimberdieva, G. (2015). Pedagogical Bases of Professional Competence Formation of the Future Specialists. *Procedia - Social and Behavioral Sciences*, 185, 240–243. <https://doi.org/10.1016/j.sbspro.2015.03.465>
- National Council of Teachers of Mathematics. (2000). *Principles and Standards for School Mathematics*. NCTM. <https://www.nctm.org/standards/>
- Nissa, B. R. A. F. A. N. D. I. C. (2019). EXPLORING STUDENT MATHEMATICAL ENGAGEMENT USING ADAPTED WATSON' ANALYTICAL TOOL. *Jurnal Cakrawala Pendidikan*, 38(1), 188–202. <https://doi.org/10.21831/cp.v38i1.21478>
- Norton, S. J. (2005). *THE CONSTRUCTION OF PROPORTIONAL REASONING* (Vol. 4).
- O'Brien, M. T. A. N. D. D. (2023). The importance of crafting a good introduction to scholarly research: strategies for creating an effective and impactful opening statement. *International Journal of Medical Education*, 14, 84–87. <https://doi.org/10.5116/ijme.6499.82af>
- Ojose, B. (2015). Proportional Reasoning and Related Concepts: Analysis of Gaps and Understandings of Middle Grade Students. *Universal Journal of Educational Research*, 3(2), 104–112. <https://doi.org/10.13189/ujer.2015.030206>
- O'Toole, J., & Beckett, D. (2010). *Educational Research: Creative Thinking and Doing*. Oxford University Press. <https://global.oup.com/academic/product/educational-research-9780195568451>
- Piaget, J. (1972). *Psychology and Epistemology: Towards a Theory of Knowledge*. Penguin Books. <https://archive.org/details/psychologyepiste0000piag>
- Pons, A., Amoroso, J., Herczynski, J., Kheyfets, I., Lockheed, M., & Santiago, P. (n.d.). *OECD Reviews of School Resources: Kazakhstan 2015*.
- Prayekti, N. (2025). Improving mathematical reasoning ability through project-based learning in middle school classrooms. *Jurnal Konseling Dan Pendidikan*, 13(2), 89–98. <https://doi.org/10.29210/1150400>
- Rakhymbayeva, D. M. D. A. N. D. O. M. A. N. D. A. S. A. N. D. D. Z. A. N. D. Z. (2020). Updated Content of Education in Kazakhstan: Longitudinal Trajectories of Learning Performance in Mathematics and Science. *Journal of Education and Human Development*, 9(1). <https://doi.org/10.15640/jehd.v9n1a9>
- Reeve, J. (2012). A Self-determination Theory Perspective on Student Engagement. In S. L. Christenson, A. L. Reschly, & C. Wylie (Eds.), *Handbook of Research on Student Engagement* (pp. 149–172). Springer. https://doi.org/10.1007/978-1-4614-2018-7_7
- Risdiyanti, I., Zulkardi, Z., Putri, R. I. I., Prahmana, R. C. I., & Nusantara, D. S. (2024). Ratio and proportion through realistic mathematics education and pendidikan matematika realistik Indonesia approach: A systematic literature review. *Jurnal Elemen*, 10(1), 158–180. <https://doi.org/10.29408/jel.v10i1.24445>

- Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, 55(1), 68–78. <https://doi.org/10.1037/0003-066X.55.1.68>
- Sarantakos, S. (2005). *Social Research* (3rd ed.). Palgrave Macmillan. <https://www.macmillanihe.com/page/detail/Social-Research/?K=9781403941521>
- Sawatzki, C., Downton, A., & Cheeseman, J. (2019). Stimulating proportional reasoning through questions of finance and fairness. *Mathematics Education Research Journal*, 31(4), 465–484. <https://doi.org/10.1007/s13394-019-00262-5>
- Schunk, D. H., Pintrich, P. R., & Meece, J. L. (2008). *Motivation in Education: Theory, Research, and Applications* (3rd ed.). Pearson Merrill Prentice Hall. <https://www.pearson.com/en-us/subject-catalog/p/motivation-in-education-theory-research-and-applications/P200000003724/9780132280353>
- Skilling, K., Bobis, J., & Martin, A. J. (2021). The “ins and outs” of student engagement in mathematics: shifts in engagement factors among high and low achievers. *Mathematics Education Research Journal*, 33(3), 469–493. <https://doi.org/10.1007/s13394-020-00313-2>
- Stein, M. K., Smith, M. S., Henningsen, M. A., & Silver, E. A. (2000). *Implementing Standards-Based Mathematics Instruction: A Casebook for Professional Development*. Teachers College Press.
- Stillman, G., Brown, J., & Galbraith, P. (2010). Research on teaching and learning mathematical modelling: Some findings and implications. In V. Durand-Guerrier S. Soury-Lavergne & F. Arzarello (Eds.), *Proceedings of the Sixth Congress of the European Society for Research in Mathematics Education (CERME 6)*. <https://hal.science/hal-00790434/document>
- Sujatha, S., & Vinayakan, K. (2023). *INTEGRATING MATH AND REAL-WORLD APPLICATIONS: A REVIEW OF PRACTICAL APPROACHES TO TEACHING*. 8, 55–60.
- Suwarsono, N. S. A. N. D. D. J. A. N. D. S. (2019). Gender bias on the students’ scheme in ratio and proportion solving problems. *Journal of Physics Conference Series*, 1265(1), 12001. <https://doi.org/10.1088/1742-6596/1265/1/012001>
- Syarifuddin, H. (2013). *Science and Mathematics Education Centre Effectiveness of the Use of Activity, Classroom Discussion, and Exercise (ACE) Teaching Cycle in Elementary Linear Algebra Course at Padang State University*.
- Taibolatov, K., Tynybayeva, M., & Zhakparova, G. (2024). Problems in the publication and popularization of domestic monographs in the field of pedagogical sciences. *Journal of Educational Sciences*, 81(4). <https://doi.org/10.26577/JES2024v81.i4.1>
- Tokanov, M., Smagulov, Y., & Temerbekova, A. (2024). DEFINING THE ROLE OF EDUCATIONAL PLATFORMS IN MATHEMATICS IN THE EFFECTIVE TRAINING OF FUTURE MATHEMATICS TEACHERS. *National Center for Higher Education Development*, 3(47). <https://doi.org/10.59787/2413-5488-2024-47-3-31-37>

- Towler, M. M. H. A. N. D. W. L. B. A. N. D. N. S. A. N. D. A. (2005). A Measure of College Student Course Engagement. *The Journal of Educational Research*, 98(3), 184–192. <https://doi.org/10.3200/joer.98.3.184-192>
- Tunç, M. P. (2020). Investigation of Middle School Students' Solution Strategies in Solving Proportional and Non-proportional Problems. *Türk Bilgisayar ve Matematik Eğitimi Dergisi*, 11(1), 1–14. <https://doi.org/10.16949/turkbilmat.560349>
- Turganalina, Z. S., & Malone, K. L. (2023). Teachers' perspectives of national assessment reform in Kazakhstani secondary education. *SN Social Sciences*, 3(3), 57. <https://doi.org/10.1007/s43545-023-00644-4>
- Tursynkulova, E., Madiyarov, N., Sultanbek, T., & Duysebayeva, P. (2023). The effect of problem-based learning on cognitive skills in solving geometric construction problems: a case study in Kazakhstan. *Frontiers in Education*, 8. <https://doi.org/10.3389/feduc.2023.1284305>
- Vergnaud, G. (1983). Multiplicative structures. In R. Lesh & M. Landau (Eds.), *Acquisition of Mathematics Concepts and Processes*.
- Vinayakan, S. S. A. N. D. K. (2023). *Integrating Math and Real-World Applications: A Review of Practical Approaches to Teaching*.
- Wriston, J. M. (2015). *The Importance of a Strong Mathematical Foundation*. http://ideaexchange.uakron.edu/honors_research_projectshttp://ideaexchange.uakron.edu/honors_research_projects/177
- Yezbick, L. M. A. N. D. R. C. B. A. N. D. J. D. A. N. D. L. G. A. N. D. F. G.-N. A. N. D. G. S. A. N. D. J. M. S. A. N. D. E. L. (2020). Fostering student engagement through a real-world, collaborative project across disciplines and institutions. *Higher Education Pedagogies*, 5(1), 30–51. <https://doi.org/10.1080/23752696.2020.1750306>
- Zapata-Rivera, D., Torre, I., Lee, C. S., & others. (2024). Generative AI in education. *Frontiers in Artificial Intelligence*. <https://doi.org/10.3389/frai.2024.1532896>
- Zubainur, C. M., Veloo, A., & Khalid, R. (2020). The impact of the Indonesian realistic mathematics education approach on students' mathematics achievement and attitudes. *European Journal of Educational Research*, 9(3), 1141–1151. <https://files.eric.ed.gov/fulltext/EJ1264157.pdf>
- Минакова, П. С., & Клещёва, А. А. (2023). PROBABILITY THEORY AS A TOOL FOR META-SUBJECT LEARNING. *Вестник Адыгейского Государственного Университета, Серия «Педагогика и Психология»*, 4(308), 90–98. <https://doi.org/10.53598/2410-3004-2022-4-308-90-98>
- Семёнова, И. Н., Александрович, Е., & Екатеринбург, Ш. Г. (n.d.). *THEORY AND METHODOLOGY OF TEACHING AND UPBRINGING*. https://doi.org/10.52772/25420291_2023_3_81
- الهدور, ز., & Aldbyani, A. (2023). A meta-analysis on the effectiveness of strategies and programs used to address the mathematics learning difficulties. *Eurasia Journal of Mathematics, Science and Technology Education*, 2337. <https://doi.org/10.29333/ejmste/13607>

APPENDIX

Appendix 1 Student Engagement Test

Этот опрос анонимный и не будет показан никому, кроме исследовательской группы. Вся информация хранится конфиденциально и используется исключительно для научно-исследовательской работы.

№	Вопросы	Почти никогда	Редко	Иногда	Часто	Почти всегда
1	«Я считаю, что запоминание формул — это лучший способ выучить математику».	Почти никогда	Редко	Иногда	Часто	Почти всегда
2	«Изучая математику, я предпочитаю запоминать все необходимые формулы, а не понимать принципы, лежащие в их основе».	Почти никогда	Редко	Иногда	Часто	Почти всегда
3	«Я думаю, что запоминание фактов и деталей темы лучше, чем ее целостное понимание».	Почти никогда	Редко	Иногда	Часто	Почти всегда
4	«При изучении математики очень полезно запомнить методы решения текстовых задач».	Почти никогда	Редко	Иногда	Часто	Почти всегда
5	«запоминание различных методов решения; это очень эффективный способ обучения».	Почти никогда	Редко	Иногда	Часто	Почти всегда
6	«Я считаю, что лучший способ изучения математики — это запоминание фактов путем многократной работы над математическими задачами».	Почти никогда	Редко	Иногда	Часто	Почти всегда
7	«Я думаю, что заучивание математики эффективнее, чем ее понимание».	Почти никогда	Редко	Иногда	Часто	Почти всегда
8	«Когда я изучаю математику, я задаюсь вопросом, насколько то, чему я научился, можно применить в реальной жизни».	Почти никогда	Редко	Иногда	Часто	Почти всегда
9	«Когда я узнаю что-то новое, я думаю о том, что я уже узнал, и пытаюсь по-новому понять то, что я знаю».	Почти никогда	Редко	Иногда	Часто	Почти всегда
10	«Когда я читаю учебник по математике, я стараюсь выделить те вещи, которые необходимо тщательно понять, а не просто читать дальше».	Почти никогда	Редко	Иногда	Часто	Почти всегда

11	«Я бы попытался связать то, чему я научился на уроках математики, с тем, с чем я сталкиваюсь в реальной жизни или на других предметах».	Почти никогда	Редко	Иногда	Часто	Почти всегда
12	«Я бы потратил внеклассное время на углубление своего понимания интересных аспектов математики».	Почти никогда	Редко	Иногда	Часто	Почти всегда
13	При изучении математики я всегда стараюсь задавать себе вопросы, и эти вопросы помогают мне понять суть математики.	Почти никогда	Редко	Иногда	Часто	Почти всегда
14	Я бы использовал свое свободное время для изучения тем, которые мы обсуждали на занятиях.	Почти никогда	Редко	Иногда	Часто	Почти всегда
15	Лучший способ учить математику — следовать указаниям преподавателя.	Почти никогда	Редко	Иногда	Часто	Почти всегда
16	Наиболее эффективный способ изучать математику — это следовать указаниям преподавателя.	Почти никогда	Редко	Иногда	Часто	Почти всегда
17	Я бы учил то, что преподает лектор.	Почти никогда	Редко	Иногда	Часто	Почти всегда
18	«Я бы учился так, как меня наставляет лектор»	Почти никогда	Редко	Иногда	Часто	Почти всегда
19	Я бы решал задачи так же, как это делает лектор.	Почти никогда	Редко	Иногда	Часто	Почти всегда
20	Я решаю задачи в соответствии с тем, что преподает лектор.	Почти никогда	Редко	Иногда	Часто	Почти всегда
21	«При изучении математики, независимо от того, что говорит преподаватель, я буду следовать его указаниям».	Почти никогда	Редко	Иногда	Часто	Почти всегда
22	«На уроках математики я нахожу математические знания интересными, а изучение математики — приятным».	Почти никогда	Редко	Иногда	Часто	Почти всегда
23	«Изучение математики доставляет мне удовольствие, и мне интересно решать математические задачи».	Почти никогда	Редко	Иногда	Часто	Почти всегда
24	Я чувствую удовлетворение, когда выполняю математические упражнения на занятиях.	Почти никогда	Редко	Иногда	Часто	Почти всегда
25	Мне всегда интересно изучать новые вещи в математике, и я нахожу обучение математике увлекательным.	Почти никогда	Редко	Иногда	Часто	Почти всегда

26	Я волнуюсь, когда начинаем новую тему в математике.	Почти никогда	Редко	Иногда	Часто	Почти всегда
27	Мне очень интересно узнать, как решать новые математические задачи. Математика всегда приносит мне удовольствие.	Почти никогда	Редко	Иногда	Часто	Почти всегда
28	Хотя изучение математики трудно, я чувствую радость, когда могу завершить задачи.	Почти никогда	Редко	Иногда	Часто	Почти всегда
29	Хотя изучение математики скучное, я радуюсь, когда получаю хороший результат.	Почти никогда	Редко	Иногда	Часто	Почти всегда
30	Изучать математику трудно, но чтобы получить хороший результат, усилия стоят того.	Почти никогда	Редко	Иногда	Часто	Почти всегда
31	Изучать математику трудно, но я доволен, когда получаю хороший результат после приложенных усилий.	Почти никогда	Редко	Иногда	Часто	Почти всегда
32	Изучать математику трудно, но я счастлив, пока могу получить хороший результат.	Почти никогда	Редко	Иногда	Часто	Почти всегда
33	Хотя изучение математики трудно, я чувствую удовлетворение, когда получаю хороший результат.	Почти никогда	Редко	Иногда	Часто	Почти всегда
34	Я нахожу себя очень нервным на математическом тесте.	Почти никогда	Редко	Иногда	Часто	Почти всегда
35	Я переживаю на математических экзаменах.	Почти никогда	Редко	Иногда	Часто	Почти всегда
36	Во время математических экзаменов, когда я сталкиваюсь с задачами, которые не могу понять, я чувствую себя очень нервным.	Почти никогда	Редко	Иногда	Часто	Почти всегда
37	Я всегда боюсь, что получу плохой результат на математическом тесте.	Почти никогда	Редко	Иногда	Часто	Почти всегда
38	Во время математического теста, когда я сталкиваюсь с задачами, которые не могу решить, я чувствую сильную тревогу.	Почти никогда	Редко	Иногда	Часто	Почти всегда
39	Мне некомфортно, когда учитель начинает новую тему.	Почти никогда	Редко	Иногда	Часто	Почти всегда

40	Мне надоело учить новую тему на занятиях.	Почти никогда	Редко	Иногда	Часто	Почти всегда
41	Мне не нравится посещать математические занятия.	Почти никогда	Редко	Иногда	Часто	Почти всегда
42	Мне не нравится заниматься математикой.	Почти никогда	Редко	Иногда	Часто	Почти всегда
43	Мне надоело учить математику.	Почти никогда	Редко	Иногда	Часто	Почти всегда
44	Я внимательно слушаю указания преподавателя.	Почти никогда	Редко	Иногда	Часто	Почти всегда
45	В обсуждении новых тем я активно участвую и высказываю свои точки зрения.	Почти никогда	Редко	Иногда	Часто	Почти всегда
46	Я действительно прилагаю усилия на уроках математики.	Почти никогда	Редко	Иногда	Часто	Почти всегда
47	Я сильно концентрируюсь, когда преподаватель вводит новые математические концепции.	Почти никогда	Редко	Иногда	Часто	Почти всегда
48	Я использую все возможные способы, чтобы понять, что преподаватель объясняет на уроке математики.	Почти никогда	Редко	Иногда	Часто	Почти всегда
49	Я всегда участвую в обсуждениях на уроках математики.	Почти никогда	Редко	Иногда	Часто	Почти всегда
50	Для сложных задач я буду усердно учиться, пока не пойму их.	Почти никогда	Редко	Иногда	Часто	Почти всегда
51	Если я не смогу сразу найти правильный ответ, я попробую снова позже.	Почти никогда	Редко	Иногда	Часто	Почти всегда

52	Если я не смогу решить задачу, я попробую снова позже.	Почти никогда	Редко	Иногда	Часто	Почти всегда
53	Если я сделаю ошибку при решении задач, я буду работать, пока не исправлю их.	Почти никогда	Редко	Иногда	Часто	Почти всегда
54	Если я буду работать над задачами настойчиво, я уверен, что найду правильный ответ.	Почти никогда	Редко	Иногда	Часто	Почти всегда
55	Если я не смогу решить задачу сразу, я буду настойчиво пробовать разные методы, пока не найду решение.	Почти никогда	Редко	Иногда	Часто	Почти всегда

Appendix 2 Lesson Plan

Предмет	Математика			
Класс	блрс-1			
День				
Тема Урока	Садовый проект: работа с отношениями, долями и площадями			
Цели урока	Формирование у учащихся навыков применения дробей, процентов и отношений на практике через разработку и реализацию проекта по засадке садового участка с учётом заданных условий.			
Время	Этап	Деятельность учителя	Деятельность учащихся	Материалы
2 мин	Приветствие и настрой	Организация учеников		
4 мин	Введение в проект	Презентация задания: "Каждый ученик выбирает сад и должен засадить его полностью"	Задают уточняющие вопросы, выбирают размер сада (10×10 или 10×15)	Слайд с условиями, шаблоны
5 мин	Анализ условий	Обсуждает таблицу: сколько клеток занимает каждое растение	Записывают данные, обсуждают в парах	Раздаточный материал
15 мин	Планирование сада	Дает задание: распланировать сад с использованием минимум 4 видов растений и без пустых клеток	Составляют план, делают расчёты, заполняют сад	Раздаточный материал
10 мин	Подсчёты и таблица	Помогает составить таблицу: вид растения – количество семян – занятая площадь – процент от общего	Вносят свои данные, считают проценты	Раздаточный материал
7 мин	Диаграмма	Объясняет, как строить столбчатую диаграмму по своей таблице	Строят диаграммы на листах	Раздаточный материал
7 мин	Физкультминутка	Игра «нарисуй число телом» или лёгкая зарядка	Повторяют числа и двигаются	Музыка
8 мин	Презентация проекта	Каждая группа защищают свой сад: что посадили, почему, сколько клеток заняли	Защищают проект, отвечают на вопросы	
8 мин	Рефлексия	Написать небольшой рассказ «Как я засадил(а) свой сад» с расчётами	Записывают задание	
3 мин	Домашнее задание			

Appendix 3 PBL Project

Данные садового проекта

1-шаг (счет семян)

Используйте план сада чтобы определить соотношения. Запишите каждое соотношение тремя способами

Соотношения	:	к	дробь
Томата к Перцу			
Гороха к Моркови			
Капуста к Фасоли			
Фасоли к Томату			
Моркови к Капусте			
Томата ко всем растениям			
Перца ко всем растениям			
Капусты ко всем растениям			
Моркови ко всем растениям			
Фасоли ко всем растениям			

Шаг-2 (счет клеток)

Используйте свой план сада, чтобы определить площадь посаженных овощей каждого сорта. Запишите дробь в простейшей форме.

Овощи	Процент площади	Десятичная дробь	Обыкновенная дробь
Томат			
Перец			
Морковка			
Фасоль			
Капуста			

Шаг-3

Используя свой план Сада, посчитайте количества потребляемой воды для каждого растения.

Овощи	Кол. воды на одно семя	Кол. семян растений	Общее кол. воды	Процент от всей воды
Томат	$1\frac{1}{2}$			
Перец	2			
Морковка	1			
Фасоль	1			
Капуста	4			

Шаг-4

Используйте процент воды для каждого овоща и процент площади, занимаемой им в саду, чтобы составить соотношение, сравнивающее потребность в воде с потребностью в пространстве для каждого овоща. Запишите ваше соотношение в виде дроби.

Овощи	Процент Площади	Процент Воды	Отношение воды к площади
Томат			
Перец			
Морковка			
Фасоль			
Капуста			

5-шаг

Используйте данные о вашем саду, полученные на шагах 1–4, для создания процентной столбчатой диаграммы.

- 1.) Какой тип растений потребляет наименьшее количество воды по сравнению с занимаемым им пространством?
- 2.) Какой тип растений потребляет наибольшее количество воды по сравнению с занимаемым им пространством?