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Enhancing PISA Performance through Adapted Educational Practices: A Comparative Case Study of Finland, Estonia, and Singapore

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Abstract

The continued differences in the performance of all learners in the Programme for International Student Assessment (PISA) have sparked curiosity about how educational practices can be made more adaptable to enhance student performance. High-performing systems tend to adopt new teaching practices and wholehearted support that cannot be attributed solely to socio-economic advantages. This paper explores how learning activities can be adjusted to improve students' performance on PISA. A qualitative research design was used, incorporating a thematic analysis and a comparative case study method, with references to OECD reports and associated case studies. Three high-performing countries, Finland, Estonia and Singapore were chosen to be compared. Thematic coding was done on the qualitative data, and a comparative matrix was created to assess the extent of implementation in cases.

Key practice levers were identified, such as active learning, extracurricular learning opportunities, parental involvement, student well-being, teacher training and professional development, and technology integration with digital literacy. Although current OECD briefs cover these aspects separately, this work makes a clear contribution by methodically bringing them together under a single comparative model that assesses implementation depth and adaptability to context in high-performing systems. The results also show that achievement in PISA is not based on individual practice but rather on the coordination of these levers within context-specific educational systems.

In practice, the research offers a generalizable, evidence-based model that can be implemented by policymakers and teachers to contextualize high-impact practices to their settings, and to go beyond descriptive benchmarking to implement system-level reform plans.

Key Words: PISA, Active Learning, Educational Practices, International Assessment, Teacher Training, Educational Policy

1. Introduction

International assessments like PISA have become a global benchmark for evaluating education systems. Administered every three years to 15-year-olds in dozens of countries, PISA not only compares student proficiency in reading, mathematics, and science, but also reveals significant performance gaps between and within nations. The persistence of these disparities demonstrates a need for evidence-based strategies aimed at boosting students' performance in lower-performing systems. In recent years, research work has increasingly shifted from merely identifying outcome gaps to understanding how educational practices (learning and teaching practices) can be improved to boost students' performance in such assessments. Countries achieving high performance constantly have demonstrated the effective classroom practices and supportive policies, not just wealth or culture alone play a significant role in superior PISA outcomes. However, many education systems struggle to adapt effective

supportive policies and classroom practices to their own contexts, signalling a knowledge gap in practical implementation. Recent research highlights various factors and interventions that can influence PISA performance. For example, AlAli and Wardat (2024) discovered that in low-performing contexts, limited teacher professional development and insufficient use of active learning contribute to weak PISA results. AlAli and Wardat (2024) recommend incorporating ongoing teacher training and activity-based pedagogies to foster the critical thinking skills that translates to better performance in PISA. Likewise, parental involvement and student well-being have been correlated with achievement in international assessments, suggesting that a holistic approach beyond core academics is important. There is also growing recognition of the role of technology: the OECD's PISA 2022 Results (Volume III) emphasizes that thoughtfully integrating digital tools and developing students' digital literacy can enhance engagement and problem-solving skills. What remains less clear is how to systematically implement these insights across diverse educational settings. Policymakers and educators need a consolidated understanding of which pedagogical adaptations and support mechanisms have proven effective in boosting PISA performance, and how those can be tailored to different national or local contexts.

This paper addresses that gap by focusing on the research question: "How can educational practices be modified or adapted to enhance students' performance in PISA assessments?" This question is of both practical and scholarly significance. By examining the approaches of top-performing countries (Finland, Singapore, Estonia) alongside thematic evidence from global data, the study aims to distil actionable strategies that transcend any one specific system. In doing so, the paper seeks to inform curriculum design, teaching practice, and policy reforms that align with the competencies evaluated by PISA. The following sections describe the mixed-methods approach taken to investigate this question, present the thematic findings and comparative analysis, and discuss the implications for educational improvement and future research.

2. Methods

Research Design and Data Sources.

The research design used in this study is qualitative, consisting of document analysis and a comparative case study. The study adopts a purely qualitative design, rather than a mixed-methods approach, to analyse the impact of educational practices on student performance in PISA tests, using solely secondary sources. This design enables a detailed analysis of policy systems, pedagogical approaches, and contextual influences in high-performing education systems.

The academic sources included policy documents on education, official reports, and case studies, which were systematically reviewed to identify common themes and patterns. These sources were highly informative, providing contextualized insights into the implementation of educational practices and their connection to PISA results. The comparative view was ensured through the analysis of three education systems that consistently achieve high results: Finland, Singapore, and Estonia, which enabled cross-contextualization and deeper insight into successful practices.

The documents were selected based on their relevance to educational practices and PISA performance. Important resources included OECD reports and frameworks, as well as national and international case studies of the chosen countries. Two main documents were examined regarding each country: the OECD PISA 2022 country report and a supplementary practice-oriented report. This choice was made to have a balance between the performance data and the description of the educational strategies.

Thematic content analysis was used to analyze qualitative data (Vaismoradi & Snelgrove, 2019). An inductive approach to coding was used with Atlas. ti software which allowed systematic organization and analysis. The codebook was first created based on the research question and available literature, and refined through the coding process. The analysis led to the discovery of eight themes of educational practices, including active learning, extracurricular activities, parental involvement, student well-being, teacher training, technology integration, digital literacy, and digital tools usage. The themes were well defined, and evidence for each theme was obtained from the data sources.

To increase analytical rigour, a comparative framework was established through the development of a cross-case matrix. The matrix was used to map the identified themes to the three countries, with each practice rated by the extent of its practice and the impact observed. These were grouped as High (system-wide implementation with distinct results), Moderate (partial or mixed implementation) or Developing (emerging or pilot-stage initiatives). Cross-validation of the Ratings was conducted to ensure consistent and reliable results.

Triangulation and peer debriefing were also used to enhance the rigour of the methodologies. To minimize possible bias, different data sources were used to cross-check their results, and a second reviewer was invited to discuss coding choices and theme interpretations. Since the study is based solely on secondary data, ethical considerations focused on appropriate attribution and recognition of sources, as well as the context-specificity of the qualitative results.

On the whole, the given qualitative document analysis and the parallel case study approach allow the development of a powerful framework to answer the research question, as they offer both depth of knowledge and cross-contextual insights into how educational practices could be modified to improve PISA performance.

3. Results

Thematic Findings: Key Practices to Enhance PISA Performance

Using both a thematic literature review and a comparative examination of high-performing education systems, this study analysis multiple domains of practice that are pivotal to improving student outcomes on PISA. Through thematic coding of the key sources and additional relevant literature, several core factors emerged as crucial for boosting PISA results. Notably, integrating technology and digital literacy into the curriculum, strengthening teacher training and professional development, and supporting student well-being were consistently highlighted across sources as high-impact areas. These findings underscore that investing in educators' skills and modernizing pedagogical practices can positively influence learning outcomes. In line with this, the analysis suggests that education stakeholders implement strategies such as enhanced digital literacy programs, active learning methodologies, and enriched curriculum content to better prepare learners for PISA's demands and real-world problem solving. Below, eight major themes (educational practice levers) are described, along with illustrative findings from the data, as areas where adapting practices can enhance PISA performance.

Active Learning**:** Active learning emerged across sources as an essential practice for improving PISA outcomes. Active learning refers to pedagogical approaches that engage students in constructive, hands-on activities, such as discussions, problem-solving tasks, and project-based work, as opposed to passive lecture-based instruction. These strategies cultivate critical thinking and the ability to apply knowledge in novel situations, competencies directly tested by PISA. For example, project-based learning and interdisciplinary tasks require students to integrate and apply concepts, mirroring PISA's real-world problem scenarios. AlAli and Wardat (2024) emphasize that teacher professional development should incorporate activity-based approaches to strengthen students' creative and analytical thinking. Indeed, the data suggest that when curricula are aligned with PISA's skill domains, for instance, emphasizing problem-solving in math class or inquiry in science labs, student performance improves. Moreover, familiarizing students with PISA-like tasks through regular classroom practice can reduce test anxiety and enhance test-taking skills. In sum, making learning more student-centered, inquiry-driven, and participatory helps students build the higher-order thinking skills necessary for success in PISA. Therefore, education systems that incorporate active learning and adapt curricula to promote problem-solving and critical thinking are likely to improve student performance in PISA assessments (AlAli and Wardat 2024; OECD 2024).

Extracurricular Learning Opportunities**:** Student involvement in extracurricular activities (ECAs), such as academic clubs, competitions, arts, and sports programs, was identified as another lever to boost PISA-related skills. While not part of the formal curriculum, ECAs provide additional contexts for students to practice teamwork, leadership, creativity, and problem-solving. Several sources highlight that ECAs can reinforce what is learned in class and contribute to the competencies measured by PISA. For instance, Lamaey (2022) found that policy support for ECAs in schools leads to improved student character development and academic excellence, partly by giving students practical outlets to apply their knowledge (e.g., science clubs where students apply scientific reasoning). Similarly, Kakungulu (2024) observed that students engaged in diverse extracurricular programs developed competencies like creative thinking and collaborative problem-solving, although direct score gains on PISA depended on how closely the activities were aligned with test content. OECD analysis of PISA 2022 data for some countries (e.g., Ecuador) showed that while creativity and problem-solving skills can be enhanced through participation in ECAs, this does not automatically translate into higher PISA scores unless the skills practiced closely map to the test's requirements. Nonetheless, there is general consensus that well-designed extracurricular programs can complement academic learning by boosting student engagement, confidence, and a diverse skill set. Notably, the OECD's Education at a Glance 2024 reported that students in smaller schools, with presumably more inclusive ECA participation rates, demonstrated higher literacy and critical thinking outcomes. Thus, encouraging extracurricular participation, especially in activities that promote inquiry and collaboration, can be a strategic way to enhance the broader competencies underpinning PISA performance.

Parental Involvement**:** Increased parental involvement in education is strongly linked to better student achievement, including performance on PISA assessments. In this analysis, parental involvement encompasses activities such as parents helping with homework, communicating with teachers, attending school events, and fostering a supportive home learning environment. Studies show that active parental engagement can positively influence student motivation, consistency in study habits, and overall achievement. Sebastian et al. (2017) specifically found that school-based parental involvement correlated with higher student scores, affirming the importance of parents' role in academic success. The mechanism is that engaged parents reinforce the value of education at home, which translates into better attendance, homework completion, and attitudes toward learning. AlAli and Wardat (2024) similarly note a positive relationship between active parental involvement and student achievement, suggesting that when parents participate in their children's education, it boosts the likelihood of

success at school. Additionally, family socio-economic status (SES) is a factor. OECD data indicate that higher-SES households, which tend to be more involved in schooling, provide resources and literacy activities that improve performance, particularly in reading. Importantly, the PISA 2022 Volume III report highlighted that systems with strong parent engagement frameworks have seen improved reading, math, and science outcomes. The evidence here reinforces that adapting educational practices to actively include parents, through parent–teacher partnerships, workshops guiding parents on supporting learning at home, etc, can enhance PISA performance. In practical terms, schools might implement regular parent–teacher meetings focused on student learning goals or involve parents in academic enrichment events, as ways to extend learning support beyond the classroom.

Student Well-Being: Ensuring student well-being is a critical, though sometimes overlooked, factor in academic performance. This theme covers the emotional, mental, and social health of students within the learning environment. The stress of high-stakes testing and rigorous curricula can impair student well-being, which in turn may hinder achievement. Thus, educational practices that promote a positive school climate, reduce excessive stress, and support student mental health can indirectly raise PISA performance. The OECD's Education at a Glance 2024 report emphasizes that schools balancing strong academic content with well-being measures see better outcomes, as happier, less anxious students are more effective learners. Interventions such as counselling services, anti-bullying programs, mindfulness training, and ensuring adequate breaks (recess and co-curricular activities) contribute to this balance. In high-performing systems, well-being is often built into the educational model. For example, Finland provides free school meals, daily recess, and comprehensive school health services, reflecting a belief that "nature, fresh air, and regular breaks are engines of learning" (EDUFI, 2024). According to AlAli and Wardat (2024), excessive pressure and a narrow focus on test preparation can undermine holistic development and eventually performance. Conversely, when students feel safe, included, and supported, they are more likely to develop the confidence and resilience needed to tackle complex PISA tasks. Comparative PISA survey data underscore this point: in PISA 2022, 79% of Finnish students reported feeling that they "belong at school" (this score was above the OECD average) and only 5% felt unsafe in class (OECD, 2023b; EDUFI, 2024). Singapore similarly reported 73% of students with a strong sense of belonging and just 4% feeling unsafe (OECD, 2023a; UNESCO, 2023), and Estonia reported 78% and 7% on these measures, respectively (OECD, 2024; Enterprise Estonia, 2024). These figures suggest that top performers have cultivated supportive environments. In summary, adapting educational practice to prioritize student well-being (through supportive school policies, stress-reduction measures, and health services) is a key strategy for enhancing performance: a holistic approach to education fosters better outcomes in high-stakes tests like PISA.

Teacher Training and Professional Development: The quality of teaching is a well-documented determinant of student achievement (Meroni et al., 2015). In the context of this research, teacher training refers to both pre-service education and in-service professional development that equip teachers with the skills to teach for deep understanding and to address PISA's competency frameworks. The findings underscore that strengthening teacher training is vital for amplifying students' PISA performance. Teachers need preparation not only in subject content, but also in modern pedagogical strategies, such as facilitating inquiry-based learning, integrating technology effectively, and fostering creativity in the classroom. According to Cordero and Gil-Izquierdo (2018), teaching strategies can significantly affect student outcomes; their analysis, linking teacher survey data to PISA results, showed that certain instructional practices led to measurable gains in achievement. AlAli and Wardat (2024) similarly argue that teacher training programs should focus on the competencies measured by PISA, problem-solving, critical thinking, creativity, to better prepare students for the challenges of the assessment. A notable insight from the OECD's PISA 2022 Volume III report is that students whose teachers encourage creativity and use innovative teaching methods tend to perform slightly better on tasks measuring creative thinking. However, the report also observed variability across countries in how well creative pedagogy is incorporated into teacher education, suggesting room for improvement in many systems. Effective teacher development initiatives cited in the data include continuous professional learning communities, coaching/mentoring systems for teachers, and training educators to use data, like PISA results or formative assessments, to inform instruction. In practice, adapting educational systems to invest in high-quality teacher training, for example, requiring intensive research-based teacher education as in Finland (EDUFI 2024), or offering micro-credentialing in specific skills as in Singapore (OECD, 2023a; UNESCO, 2023), is a cornerstone reform for enhancing student performance in PISA and beyond.

Technology Integration and Digital Literacy: The rapid digitization of education has made technology integration and digital literacy important levers for student success. This theme covers both how schools incorporate digital tools into teaching and whether students develop the skills to use technology effectively for learning. The OECD's Creative Minds, Creative Schools report, highlights that integrating digital technology can enrich learning experiences and engagement, but it must be done purposefully. This study found that successful integration involves using technology in a student-centered way, for instance, interactive software that adapts to students' learning needs, online platforms for collaboration, and simulations that enable problem-based learning. In systems where technology use is aligned with curriculum goals, students can practice the kind of independent research,

data interpretation, and multi-step problem-solving that PISA assesses. Education at a Glance, 2024 noted that technology allows more individualized pacing and practice e.g., adaptive quizzes, which can improve mastery of concepts. Importantly, digital literacy, the ability to critically find, evaluate, and use information from digital sources, is increasingly tested by PISA for example, through reading tasks involving online navigation and credibility of sources. An OECD policy paper, Students, Digital Devices, and Success, 2024, pointed out that merely providing devices is not enough; students must be taught how to use technology as a learning tool and how to avoid digital distractions. This report cautioned that using devices for leisure (e.g., social media or gaming) during class is strongly associated with lower performance, emphasizing the need for guided, educational use of tech. Thus, a balanced approach is needed. In terms of practice adaptation, schools might introduce digital literacy curricula, ensure equitable access to ICT resources, and train teachers in effective educational technology pedagogies. When technology is well-integrated, as noted in some high-performing systems that use data dashboards or AI-driven tutors, it provides timely feedback and personalized learning pathways that can boost student achievement. On the other hand, policymakers must also address the digital divide so that all students can benefit; disparities in ICT access can widen performance gaps if not mitigated. Overall, enhancing students' digital literacy and thoughtfully incorporating technology into instruction are key adaptations for improving outcomes in PISA's digital era.

Comparative Analysis: Insights from High-Performing Education Systems (Finland, Singapore, Estonia).

To effectively illustrate how educational practices can be adapted for better PISA performance, a comparative analysis was conducted on three consistently high-performing systems: Singapore, Finland, and Estonia. Despite differing cultural and economic contexts, these countries achieve exceptional PISA results through deliberate educational strategies. By examining their approaches to the practice levers identified above, this study obtains practical lessons on what works to boost student outcomes. The comparative findings are summarized in Table 1, Comparative Analysis Matrix, and discussed below by theme.

Table 1 Comparative Analysis Matrix

Practice	Singapore	Finland	Estonia
Active Learning	**Implementation - High** Student Learning Space (SLS) with interactive modules, adaptive analytics, and peer collaboration.	**Implementation - High** Phenomenon-based projects (1 week/term) integrating real-world challenges.	**Implementation - High** ProgeTiger Programme: Robotics/coding embedded in core curriculum.
Technology Integration	**Implementation - High** SLS real-time dashboards and one-to-one devices for targeted feedback.	**Implementation - High** Digital tools integrated into cross-disciplinary modules.	**Implementation - High** eKool portal used by over 90% of students for assignments and monitoring.
Digital Literacy	**Implementation - High** AI-driven writing assistants and computational tools in daily assignments.	**Implementation - High** National framework for critical digital competence and screen-time management.	**Implementation - High** Early coding (ProgeTiger) and tech fluency.
Extracurricular Activity	**Implementation - High** After-school ICT clubs, hackathons, and teacher-led clinics.	**Implementation - High** Municipality-supported clubs (media/digital workshops, environmental research)	**Implementation - High** ProgeTiger maker workshops, weekend coding sessions, and civic tech competitions.
Student Well-being	**Implementation - High** Cyber Wellness modules, increased counselors, 73% sense of belonging.	**Implementation - High** Free lunches, daily recess, health services; 79% sense of belonging.	**Implementation - High** eKool absenteeism alerts, free meals, inclusive education; 78% sense of belonging.

Parental Involvement	**Implementation - High** Parent Support Groups co-design activities (e.g., math game nights)	**Implementation - High** Portfolio-based conferences for joint goal-setting	**Implementation - High** eKool real-time alerts and performance data for parents.
Teacher Training	**Implementation - High** Micro-credentials, career pathways, and learning analytics (National Institute of Education).	**Implementation - High** Research-oriented master's programs with classroom experimentation.	**Implementation - High** Master's programs with digital fluency (AI, coding) and practicums.
Academic Performance	**Implementation - High** Top PISA rankings, narrowing socio-economic gaps	**Implementation - High** Above OECD average, Europe's smallest equity gap.	**Implementation - High** Leading EU scores with 15% lower per-pupil funding.

Active Learning in the Classroom: All three case countries make active learning a foundation of their pedagogy, though via different methods suited to their context. In Singapore, a notable initiative is the nationwide Student Learning Space (SLS), a digital platform where every curriculum topic is accompanied by interactive, inquiry-based modules. For example, Singaporean learners might tackle online math puzzles or perform virtual science experiments that require critical thinking. The Student Learning Space also enables collaborative learning through discussion forums and tracks individual student responses in real time, thus providing the much-needed data on time. Further, educators capitalize on data analytics from the platform to identify misconceptions and deliver targeted mini-clinics to small groups or individual learners who might need help (OECD, 2023a; UNESCO, 2023). Using this approach classrooms are transformed from traditional lecture halls into interactive learning labs, ensuring each learner actively construct knowledge. Similarly, Finland education system embeds active learning through phenomenon-based learning projects. For example, schools devote one week each term to interdisciplinary projects where learners investigate real-world phenomena e.g., climate change or city planning, by integrating multiple subjects. Educators act as facilitators, guiding students as they formulate research questions, collect data, and present findings. This method, rooted in Finland's national curriculum, encourages deep conceptual understanding and mirrors PISA's emphasis on applying knowledge to unfamiliar contexts (EDUFI, 2024). Indeed, Finnish students report frequent project-based activities and score above the OECD average in the new creative thinking domain of PISA, suggesting these structured investigations yield measurable benefits (OECD, 2023b). Estonia takes yet another route: early integration of coding and STEM projects through the national ProgeTiger program. From primary school onward, Estonian students engage in hands-on projects involving robotics, programming, and design thinking, often as part of their regular classes. Teachers encourage an iterative, problem-solving mindset rather than rote instruction. According to PISA 2022 data, Estonian students who frequently partake in such "maker" activities scored significantly higher in science reasoning tasks (OECD, 2024; Enterprise Estonia, 2024). Despite different implementations, a tech-driven approach in Singapore, a project-week model in Finland, and a coding emphasis in Estonia, all three countries dedicate time and resources to active, inquiry-based learning. This confirms that frequent, protected opportunities for problem-solving practice are a non-negotiable ingredient of high PISA performance.

Technology Integration: The use of technology in education is a common strength across the trio, but it manifests uniquely in each context. Singapore provides a cutting-edge example: with one-to-one device programs and the SLS platform, Singaporean schools leverage real-time data for personalized learning. Teachers have dashboards that display each student's progress and "micro-errors" on assignments, enabling immediate intervention when misconceptions arise. This just-in-time feedback loop helps address arising misunderstandings from growing into larger learning gaps. Singapore's model shows that success is not about simply having gadgets, but about deliberately designing technology use that connects closely with curriculum and assessment that drives improvement (OECD, 2023a; UNESCO, 2023). The Education in Finland 2023 report explains how digital tools are embedded in phenomenon-based modules, helping students gain essential digital skills while avoiding passive screen time. For instance, Finnish students might use tablets to record and analyze data during fieldwork, or practice online source criticism in history projects, blending tech use with active learning (EDUFI, 2024; OECD, 2023b). Estonia, often called a digital society, has rolled out the eKool platform nationwide, with over 90% of students, teachers, and parents reportedly using it. EKool works as a full learning management system: teachers post assignments and grades; students access materials and feedback; parents and administrators track progress. This level of connectivity smooths communication and helps discover issues, like missing homework or falling performance, early (OECD, 2024; Enterprise Estonia, 2024). The evidence is clear: technology boosts achievement when it is tied directly to learning goals. All three countries went beyond simply providing hardware, focusing instead on planning how tech supports learning, through adaptive practice, interdisciplinary inquiry, or

accountability and transparency. The message for other systems is to create a unified ICT strategy that stresses feedback, accessibility, and alignment with pedagogy rather than technology for its own sake

Digital Literacy: Related to tech integration is the emphasis on digital literacy skills. PISA's evolving framework now touches on students' ability to navigate and evaluate digital information, so it is noteworthy that each of these high performers has national initiatives in this area. Singapore incorporates digital literacy directly into subject teaching via the SLS platform: for instance, students regularly use AI-driven writing assistants and data analysis tools in their coursework, implicitly learning digital skills alongside academic content. This approach normalizes the use of digital tools for learning and ensures students become proficient in tasks like online research and collaborative document editing through frequent practice (OECD, 2023a; UNESCO, 2023). Finland treats digital literacy as a foundational life skill. According to the Finnish National Agency's 2023 report, there is a national framework that requires schools to teach students how to manage screen time, critically evaluate online sources, and practice safe and effective internet usage. Finnish students therefore learn "learning-to-learn" skills in digital contexts, for example, comparing multiple websites for credibility, which was reflected in Finland's above-OECD-average performance in a PISA digital navigation exercise (EDUFI, 2024; OECD, 2023b). Estonia combines an early start with continual practice: coding classes begin in elementary grades, via ProgeTiger, and digital fluency is reinforced through platforms like eKool and nationwide competitions in ICT. A striking outcome is that by the 2022 PISA cycle, 89% of Estonian students attained at least the baseline proficiency in PISA's creative thinking test, which often involved digital problem scenarios, compared to an OECD average of 78% (OECD, 2024; Enterprise Estonia, 2024). This suggests that normalizing programming and tech fluency from a young age can cultivate the ideation and problem-solving abilities that PISA measures. In summary, these countries demonstrate that purposeful cultivation of digital literacy, whether through embedded classroom practices or dedicated curricula and programs, yields students who are better prepared for the digital aspects of modern assessments and learning in general.

Extracurricular Structures**:** Extending learning beyond the classroom, all three systems provide structured extracurricular opportunities linked to academic and skill development. Singapore features after-school problem-solving clubs and ICT societies that tie into the formal curriculum; for example, students might join coding clubs that use data from their SLS activities to fuel projects or prepare for national hackathon competitions. These clubs often have teacher mentors and benefit from Ministry of Education support, ensuring they complement what is taught in classes rather than being purely recreational (OECD, 2023a; UNESCO, 2023). Finland has a tradition of municipality-supported clubs, such as science camps, nature expeditions, and media workshops, which operate outside regular hours but are integrated with community education programs. Finnish students thus engage in inquiry, e.g., environmental science field research clubs, that bolsters their scientific literacy and collaborative skills in informal settings (EDUFI, 2024; OECD, 2023b). Estonia leverages its tech focus by offering ProgeTiger network workshops during weekends and school breaks, including national robotics competitions and creative tech challenges open to all students. Progress in these activities can be tracked via the eKool platform, which also helps involve parents in students' out-of-class achievements (OECD, 2024; Enterprise Estonia, 2024). A common thread is that these extracurricular programs are strategically aligned with educational goals: they reinforce core competencies, sustain student engagement, and promote collaboration. The analysis found that such alignment likely contributes to maintaining high performance, students remain engaged year-round and develop a broader range of skills. Countries looking to enhance PISA outcomes should consider investing in extracurricular frameworks that explicitly support the development of competencies measured by PISA, rather than treating ECAs as mere add-ons. The experiences of Singapore, Finland, and Estonia show that a well-structured extracurricular ecosystem can be a powerful extension of the classroom, fostering innovation, teamwork, and sustained academic interest.

Student Well-Being and Support Systems**:** Each of these high-performing systems prioritizes student well-being as part of their educational model, which correlates with stronger outcomes on PISA and other metrics. In Singapore, the government has introduced Cyber Wellness modules via the SLS platform to teach students healthy online habits and resilience against cyberbullying. Additionally, Singapore significantly increased the number of school counsellors in recent years. The impact is evident: according to PISA 2022 survey data, 73% of Singaporean students reported feeling they belong at school, and very few (4%) felt unsafe in classrooms (OECD, 2023a; UNESCO, 2023). These figures are better than OECD averages and suggest that the supportive environment helps students focus on learning. Finland takes a holistic well-being approach by ensuring universal student services. Every student receives free daily meals, there are mandated recesses and outdoor breaks for physical activity, and comprehensive school health and special education services are provided (EDUFI, 2024). Finnish policies view well-being not as separate from learning but as a prerequisite for it. Consequently, 79% of Finnish students reported a strong sense of belonging at school and only 5% felt unsafe in class (OECD, 2023b). Estonia, working with tighter budgets, has innovated by using technology for student welfare. The eKool system can automatically flag if a student has two consecutive absences, triggering a quick follow-up by school staff. Estonia also provides free lunches and learning materials to all students, and emphasizes inclusive education, with most students, including those with special needs, taught in mainstream classrooms with additional support as

needed. As a result, 78% of Estonian students feel they belong at school, similar to Finland, and safety concerns are very low (OECD, 2024; Enterprise Estonia, 2024). The overarching insight is that proactive well-being support, whether through counsellors, health and nutrition programs, or early-warning systems for disengagement, appears to unlock students' ability to learn effectively and perform well in exams like PISA. Other systems can glean that investing in well-being is not at odds with academic excellence but rather a facilitator of it.

Parental Engagement**:** The role of parents in education is strongly emphasized in all three countries, moving beyond conventional involvement to true collaboration. Singapore has institutionalized Parent Support Groups (PSGs) in nearly every school. These PSGs co-design learning activities such as reading festivals or math game nights, effectively turning parents into partners in pedagogy. For example, Singapore provides training workshops for parents so that they can be well equipped to extend learning beyond school effectively. According to PISA data, students in Singapore reported high parental support for reading, which positively correlates with the country's strong reading literacy score (OECD, 2023a; UNESCO, 2023). On the other hand, formal structures like portfolio-based student-led conferences, where students, parents, and teachers meet regularly to review work and set goals helps Finland foster parent engagement effectively. With this, transparency and trust are built and parents are well informed about their child's learning progress. This robust home-school partnership in Finland has often been cited as one contributor to its educational equity and success despite its limited resources compared to other bigger economies (EDUFI, 2024; OECD, 2023b).

In regards to Parental engagement, Estonia uses the eKool platform to keep parents in the loop. The system enables parents to receive real-time alerts about their child's assignments, attendance issues, and even grades. Further, the country provides parents with comparative performance information about schools, thus empowering parents to advocate for educational quality in the country (OECD, 2024; Enterprise Estonia, 2024). By designing data-driven, dialogue-oriented relationships with parents, Singapore, Finland and Estonia ensures that learning is reinforced beyond the classroom and that any emerging problems are jointly addressed by all key stakeholders. The benefit of these efforts for PISA outcomes is noted in the recorded lower student's anxiety, reduced absenteeism, and more consistent academic effort. For example, engaged parents can help with homework or encourage good study habits, directly affecting student's performance. The takeaway from this is that educational practices adapted to involve parents as true stakeholders, through involvement in learning, regular communication, and accessible learner's progress data, can lead to measurable improvements in student achievement.

Teacher Training and Professionalism: In regards to teacher training and professionalism, Singapore, and Estonia have all invested heavily in building robust system to train their teachers. In Singapore, teachers undergo training at the National Institute of Education (NIE), a body that is well known for its rigorous curriculum blending theory and practicum. After entering the profession, the teachers then have opportunities for continual upskilling through well-defined career pathways and micro-credentials that reward effective teaching. Notably, teachers remain in the classroom while pursuing these advancements, which helps the teachers do directly translate professional development into practice (UNESCO, 2023; OECD, 2023a). In Finland's' case, all teachers must earn a research-based master's degree. This teacher education programs involve conducting original research on learning or pedagogy that inculcates an inquiry mindset in teachers. This academic rigor and emphasis on reflective practice encourage teachers to continuously experiment and improve their methods. Consequently, Finnish teachers enjoy a high level of professional autonomy and are adept at curriculum development and formative assessment, skills that likely help maintain Finland's strong PISA performance (EDUFI, 2024; OECD, 2023b). Estonia, building on its European tradition, now mandates that new teachers also obtain a master's degree, which blends subject content, pedagogy, and practical training with mentoring. In addition, Estonia has woven digital competencies into teacher training: teachers learn to use AI tools, coding, and the national e-school systems, like eKool, as part of their preparation. This ensures that educators are comfortable with the technology platforms students will use and can fully exploit them in instruction (Enterprise Estonia, 2024; OECD, 2024). All three systems also make teaching a competitive, respected profession, such as through selective admissions to teacher programs, competitive salaries or support, which helps attract and retain talent. The overarching result is that these countries have teachers who are highly skilled in data interpretation and adaptive teaching, enabling them to diagnose student needs, including through PISA and other assessment data, and adjust instruction dynamically. These professional qualities directly translate into better student outcomes; a finding aligned with global research that teacher expertise is one of the most powerful school-level factors in performance. For systems aiming to improve, replicating the principles of these models is necessary, requiring robust teacher education, offering ongoing development in modern pedagogies, and granting teachers the autonomy and tools to innovate can significantly uplift student achievement.

Academic Performance and Equity Outcomes**:** Finally, the integrated effect of these practices is reflected in academic performance indicators. Each of the examined countries not only achieves high average scores on PISA, but also addresses equity in outcomes. Singapore continues to rank at or near the top globally in all domains, and

notably it has been narrowing its socio-economic achievement gaps over recent PISA cycles. This suggests that targeted support. For example, levelling resources for lower-income students, as Singapore has done with various learning support programs, alongside broad excellence strategies can lift the lower-performing segment of students. Finland, while no longer number one as it was in the early 2000s, remains well above the OECD average and is distinguished by one of Europe's smallest equity gradients, meaning the difference in performance between the most and least advantaged students is minimal. Finland's focus on inclusive education and socio-economic equality, through extensive welfare supports and uniformly high school quality, likely underpins this outcome. Estonia has emerged as Europe's top performer in recent years, and remarkably it does so with roughly 15% lower per-pupil spending than the EU average. Estonia's efficient use of resources, for example, leveraging digital solutions to overcome issues of scale and rural access, demonstrates that strategic innovation can compensate for budget constraints without sacrificing outcomes. In all three cases, high PISA performance is not a coincidence or solely a product of culture; it is the result of an interconnected ecosystem of practices and policies. Real-time data feedback sparks student inquiry, empowered teachers and involved parents ensure that feedback leads to action, comprehensive well-being and extracurricular programs keep students motivated and engaged. In such environments, continuous cognitive growth and strong assessment results become a predictable output of the system, rather than an exceptional feat. This comparative insight suggests that other education systems, despite different contexts, can adapt these core principles, active learning, holistic support for students, stakeholder engagement, and data-informed teaching, to drive improvements in PISA performance.

4. Discussion

This study set out to determine how educational practices can be modified or adapted to enhance students' performance in PISA assessments. The findings, drawn from both a thematic analysis of global data and a comparative examination of high-performing systems, suggest that meaningful improvements in PISA outcomes require multi-dimensional changes in educational practice. In particular, the results highlight a set of interrelated domains; pedagogy, curricular enrichment, family engagement, student support, teacher development, and technology use. When addressed in concert, these interrelated domains create a learning environment conducive to high performance. One key insight is the centrality of student-centered, active learning approaches. The evidence indicates that shifting away from rote learning to pedagogies that involve students actively, through discussions, projects, and problem-solving tasks, cultivates the very skills PISA measures: critical thinking, transfer of knowledge, and creativity. This aligns with a broad consensus in the literature that active learning strategies improve understanding and retention, which in turn can boost standardized assessment results. This study's findings extend this understanding to secondary education and the international assessment context, showing how countries have operationalized active learning to achieve results. It suggests that education systems aiming to improve should invest in training teachers for active learning pedagogies and redesign curricula to include more inquiry-based activities. This may require overcoming challenges such as large class sizes or rigid syllabus demands, but the experiences of the case countries show it is feasible and effective.

Another important finding is the significance of support structures beyond the core academic curriculum. The role of extracurricular activities and parental involvement in enhancing academic performance, while sometimes underestimated, came through strongly in this study. These factors resonate with ecological models of education that view student outcomes as a product of both school and home/community environments. The results echo prior research that parental engagement has a positive effect on student achievement and that well-rounded experiences including arts, sports, or clubs contribute to skills like teamwork and time management which indirectly support academic success (Marsh & Kleitman, 2002). The implication for educators is to actively facilitate channels for parents to engage, such as the parent support groups and learning workshops seen in Singapore, and to provide diverse extracurricular opportunities, especially for students who might not otherwise have access. Policymakers could consider funding after-school programs or community partnerships to extend learning for disadvantaged groups, thereby potentially raising overall performance and closing gaps.

The emphasis on student well-being in the findings is also noteworthy. This suggests a paradigm shift from viewing well-being initiatives as add-ons to seeing them as integral to academic success. High levels of student stress and anxiety can negatively impact test performance and long-term learning (Cefai & Cavioni, 2015). The high-performing countries in this study have proactively addressed this by building supportive school climates and safety nets (counsellors, health services, anti-bullying policies). This finding serves as a reminder that educational improvement efforts must be holistic. An implication is that an education system singularly focused on test preparation without regard for student mental health may achieve short-term gains at best, and could even backfire by causing burnout or disengagement. Thus, reforms aimed at improving PISA scores should also consider strategies for reducing excessive academic pressure and fostering student resilience and well-being. This could involve integrating social-emotional learning into the curriculum or ensuring students have adequate downtime, as Finland does.

The role of teachers cannot be overstated. This study reinforces that teacher quality and preparedness are cornerstones of student achievement. High-performing systems treat teaching as a high-skill profession, requiring

extensive education and providing ongoing development opportunities. This aligns with substantial literature (Meroni et al., 2015) showing that well-prepared, knowledgeable teachers are linked to better student outcomes. The success of Singapore, Finland, and Estonia in PISA can be partly attributed to their sustained investment in teachers through rigorous training, competitive selection, and professional autonomy. For other countries, this implies that reforms such as raising teacher education standards, implementing mentorship programs, and rewarding effective teaching practices may be necessary precursors to seeing improvement in student performance. However, implementing such changes can be challenging in contexts with limited resources or political will. Teacher training reform is often a long-term endeavour, and results might only manifest over years as new cohorts of teachers enter the workforce.

Technology and digital literacy emerged from this research as double-edged swords, with great potential benefits when used wisely, but also pitfalls if misused. The comparative analysis illustrated that technology, when guided by a clear pedagogy, can accelerate learning gains and help personalize education. This is consistent with some studies that find positive effects of computer-assisted instruction on test scores (Cheung & Slavin, 2013) and the idea that immediate feedback via educational software improves mastery learning. On the other hand, the findings also caution about the digital divide and distraction risk: unequal access to digital tools can widen achievement gaps, and unstructured or recreational screen time can detract from studying. Limniou (2021) similarly reported that off-task use of digital devices had a measurable negative effect on student performance. Therefore, the takeaway is that integrating technology in education should be done deliberately. Education systems should provide infrastructure and connectivity for all students to prevent inequity and ensure digital tools are introduced with appropriate guidance and digital literacy training. It's also crucial to balance tech-based learning with traditional methods and ensure that students maintain fundamental skills to succeed in PISA's varied formats.

When interpreting these findings, it is important to consider the contextual differences between education systems. The practices of Finland or Singapore are embedded in their unique socio-cultural contexts. Directly transplanting a policy from one country to another may not yield the same results, a point often raised in comparative education literature (Steiner-Khamsi, 2014). For example, while phenomenon-based learning works well in Finland with its highly trained teachers and flexible curriculum, it might face implementation challenges in a system with a rigid national exam or less teacher autonomy. Thus, the recommendation is for policymakers to adapt the principles behind these successful practices rather than copying them wholesale. As the results imply, the design logic is shared among high performers: focus on critical skill development, engage learners actively, support them holistically, and use data to inform instruction. These principles can guide reforms in any context, but the specific programs need tailoring to local realities.

In terms of practical implications, education authorities aiming to enhance PISA performance could start with a diagnostic of their current practices in the identified areas. Based on any gaps, targeted interventions can be planned. For instance, if a country finds that its curriculum is heavily content-driven with little room for problem-solving tasks, it could revise curricula or introduce capstone projects at each grade. If teacher preparation is identified as weak in fostering higher-order thinking, partnerships could be established with universities to update teacher education programs. Additionally, monitoring and evaluation should accompany these changes, for example, using interim assessments or school-level indicators to gauge if the adaptations are improving the desired skills. Over time, one would expect these practice improvements to be reflected in better PISA outcomes, as students who experience improved teaching and support throughout their schooling approach the PISA age of 15.

5. Limitations

It is important to acknowledge the limitations of this study. First, the analysis was largely qualitative and based on secondary sources (OECD reports, case studies, etc.) rather than primary data collection. This means the findings are constrained by the scope and accuracy of those sources. While efforts were made to triangulate information, there may be biases in how each country's practices are portrayed in official documents. Second, the comparative aspect focused only on three high-achieving countries. These were chosen to extract best practices, but they represent a small sample. Other nations, such as Canada, South Korea, or Japan, also perform well and might have different strategies worth examining. Future research could expand the comparative lens to include a broader set of systems or even contrast high vs. low performers to more definitively isolate what high performers do differently. Third, this study does not claim causal proof that the identified practices cause higher PISA scores, the relationships discussed are correlational and inferential based on the convergence of evidence. Educational outcomes are influenced by myriad factors. While the practices discussed are grounded in evidence, implementing them is not guaranteed to directly raise PISA scores in isolation. They should be viewed as part of a comprehensive improvement effort.

Building on this work, future studies could quantitatively examine the impact of specific interventions on PISA outcomes. For example, researchers could use PISA datasets to conduct multilevel analyses testing whether schools with certain characteristics statistically outperform others, controlling for background factors. Such

analyses could lend further weight to the qualitative conclusions drawn here. Additionally, longitudinal studies within countries undergoing reforms would be valuable, if a system implements a new active learning curriculum or a digital literacy initiative, tracking cohorts of students before and after in PISA would provide more causal insights. There is also room for more fine-grained qualitative research, such as interviewing teachers and students in high-performing countries to get their perspectives on what specific classroom practices they believe make a difference. This could reveal subtleties not captured in policy documents. Finally, as PISA evolves it will be important for educators to continuously adapt. The eight themes identified in this study are likely to remain relevant, but how they manifest may need updating. The concept of what constitutes effective education is dynamic Hence, international benchmarks like PISA will keep pushing the boundaries. The findings of this research encourage education stakeholders to proactively create adaptive, innovative learning environments rather than reactively teaching to the test. In doing so, they not only aim for better PISA scores but, more importantly, for the broader goal of preparing students to thrive in a complex, knowledge-driven world.

6. Conclusion

To answer to Research Question, "How can educational practices be modified or adapted to enhance students' performance in PISA assessments?", this study concludes that meaningful improvements in PISA performance arise from a strategic, multi-faceted adaptation of educational practices. Key recommendations include adopting active, skills-oriented pedagogies, actively engaging parents as partners, enriching learning through extracurricular and cross-disciplinary projects, prioritizing student well-being in school culture, integrating technology along with digital literacy education and investing in rigorous teacher training focused on modern competencies. The analysis of of high-performing nations like Singapore, Estonia and Finland, demonstrates that these elements form a mutually reinforcing system that elevates student learning outcomes. For education systems worldwide, the implication is clear: to boost PISA performance, reforms must go beyond superficial curriculum tweaks and address the broader ecosystem of teaching and learning. Lastly by replicating these core principles, adapted to local contexts, educators and policymakers can create an environment where learners are better equipped to excel in PISA and, more importantly, in critical thinking and real-life problem solving.

Declarations

Availability of data and materials

Not applicable. This article is a review and synthesis of existing literature, policy documents, and publicly available reports (e.g., from the OECD). No new datasets were generated or analyzed during this study.

Competing interests

The author declare that they have no competing interests.

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The sole author was responsible for all aspects of this work, including: conceptualization of the research question, design of the methodology, data collection (literature and document review), formal analysis and interpretation, original draft preparation, and review & editing of the manuscript.

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