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The SOAR Model for Transforming Students' Scientific Argumentation Skills Using Strength-Based Science Education Conceptualisation

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Abstract
Scientific Argumentation Skills (SAS) are fundamental to fostering scientific literacy and higher-order reasoning within science education and are particularly vital in Chemistry classrooms, where learners must navigate complex and abstract concepts. However, their classroom implementation often remains fragmented and content-focused, offering limited opportunities for students to construct and justify claims through authentic scientific reasoning. This concept paper investigates the potential application of the SOAR model as a strength-based strategic framework consisting of Strengths, Opportunities, Aspirations and Results that theoretical foundation for strengthening SAS in Chemistry education. Adopting a qualitative conceptual design, this paper synthesizes recent literature and theoretical perspectives to propose a SOAR-oriented framework for empowering teachers and students in scientific discourse. The framework encourages educators to capitalize on existing pedagogical strengths, identify authentic opportunities for inquiry, align aspirational goals with reasoning processes and evaluate outcomes through reflective practice. Anticipated findings suggest that integrating SOAR could cultivate a more positive learning culture, enhance students' argumentation competence and strengthen alignment between pedagogy and assessment. However, this paper is limited by its conceptual nature, as the proposed framework has not yet been empirically validated within classroom contexts. Future research is therefore encouraged to operationalize and test the SOAR-based model in diverse educational settings, enabling deeper insights into its transformative potential for strengthening SAS across disciplines. Despite these limitations, this study advances a strategic and forward-looking vision for how the SOAR model can transform the culture of scientific argumentation in science education, using Chemistry learning as an exemplar for bridging pedagogical innovation with reflective, evidence-based practice.
Keyword: Scientific Argumentation Skills, SOAR Model, Science Education, Chemistry

Introduction

The 21st century is marked by rapid scientific and technological advancement that continuously reshapes how education plays a pivotal role in equipping future generations with the cognitive and reasoning capacities necessary to navigate complex global challenges. Consequently, science education is shifting from rote memorization of fragmented facts toward the cultivation of analytical and reflective thinking skills such as argumentation, reasoning and interpretation of scientific phenomena (National Research Council, 2013). Within this paradigm, Scientific Argumentation Skills (SAS) emerge as an essential competency that enables learners to construct, justify and evaluate scientific claims using evidence and logical reasoning. In the context of Chemistry education, SAS not only promote deeper conceptual understanding but also mirror the authentic processes of scientific inquiry, where explanations are built, contested and refined based on empirical data. SAS generally refers to students' ability to construct, justify, critique and revise scientific claims using appropriate evidence and logical reasoning in social discourse contexts (González-Howard & McNeill, 2020).

A growing body of research underscores the significance of scientific argumentation in enhancing science learning. Their study emphasised that cultivating classrooms where students "argue to learn" and collaboratively co-create meaning requires navigating multiple and at times conflicting, pedagogical approaches to support students' cognitive agency. Similarly, Allchin and Zemplén (2020) affirmed that argumentation constitutes a critical dimension of the nature of science education, highlighting its role in nurturing the cognitive skills necessary for citizens and consumers to evaluate the credibility of scientific claims when making informed decisions. However, research in Chemistry education indicates that many secondary and pre-university learners still struggle to connect data, evidence and theory into coherent arguments as students often state correct claims but fail to articulate warrants, counterarguments, or rebuttals (Al-Ajmi & Ambusaidi, 2022).

Systematic reviews in Chemistry education that reported by Putri, Suyanta and Rohaeti (2025) have consistently shown that scientific argumentation does not emerge naturally from content instruction alone. Rather, its development demands deliberate pedagogical structuring and sustained scaffolding. Consequently, explicit instructional models, guided frameworks and supportive classroom environments are essential to enable students to construct and evaluate explanations of complex chemical concepts such as acids-bases, electrochemistry and stoichiometry. Within this pedagogical challenge, the SOAR model that focusing on Strengths, Opportunities, Aspirations and Results has emerged as a strength-based strategic framework that promotes reflective planning and goal-oriented improvement (Stavros, 2020).

To transform students' scientific argumentation skills using a strength-based science education conceptualisation, it is necessary to understand both the societal demand for more scientifically literate citizens and the pedagogical shift toward recognising learners' existing capabilities rather than their deficits. Students in today's classrooms are increasingly required to analyze evidence, express arguments and engage in reasoned debate as scientific education aligns with global calls for critical thinking and inquiry-driven learning. However, many traditional approaches continue to emphasize rectifying faults, which might hinder students' confidence and engagement in argumentation activities. A strength-based approach reframes this difficulty by emphasizing students' past knowledge, cultural assets and various modes of thinking as the foundations for more advanced scientific discourse. This perspective, which is based on sociocultural and constructivist theories, advocates for a more inclusive and empowered learning environment in which argumentation is accessible and meaningful to all learners.

Within educational settings, the SOAR framework serves as a strategic lens through which teachers and instructional leaders can collaboratively identify existing pedagogical strengths, articulate aspirational learning goals and align these intentions with actionable strategies that promote meaningful educational outcomes (Cole, Stavros, Cox, & Stavros, 2022). Anchored in this conceptual paradigm, the SOAR framework emerges as a catalytic model that bridges strategic foresight with pedagogical innovation, enabling educators to advance students' SAS through a sustained focus on metacognitive awareness, inquiry-based reasoning and transformative learning practices across science education.

From a national standpoint, the reinforcement of students' scientific reasoning skills is inextricably linked to Malaysia's long-term aspiration to sustain its position as a STEM-driven and knowledge-intensive economy. According to a recent scoping review on Science, Technology, Engineering and Mathematics (STEM) education within the Asia-Pacific region, Malaysia emerges as a significant contributor to regional STEM development, with approximately 43.5% of tertiary graduates specialising in STEM-related disciplines. Nevertheless, evidence continues to highlight enduring challenges in pedagogical implementation, learning orientations and the development of higher-order soft skills, particularly critical thinking and communication (Jamaluddin, Razak, & Rahim, 2025). Such challenges are particularly evident within secondary education and continue to manifest in higher learning contexts, reinforcing the call for pedagogical practices that extend beyond factual understanding to nurture higher-order skills such as scientific argumentation (Rizqi Nurul Laily & Rohaeti, 2024) (Putri et al., 2025).

At the same time, national policy documents emphasise that education is central to Malaysia's economic development agenda. The Education 2030 Report on Sustainable Development Goal 4 (SDG 4) notes that education has consistently received at least 20 percent of the federal budget since 2016 and that the Malaysia Education Blueprint 2013–2025 continues to guide reform efforts toward quality, equity and higher-order skills (UNICEF Malaysia, 2023). Within this context, a conceptual framework that positions SAS as a key outcome of science learning and that offers a structured way for teachers to design and reflect on learning experiences which is highly relevant for Malaysian science and chemistry classrooms.

Malaysia's commitment to SDG 4 is to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" that will provides an additional global rationale for focusing on SAS (UNICEF Malaysia, 2023). SDG 4 explicitly links education with broader goals such as decent work, innovation and sustainable development, underscoring the importance of skills for work, problem-solving and informed decision-making. Recent national budgets reinforce this direction: Budget 2024 allocated RM 75 billion to the education and higher-education sectors, representing about 19 percent of the national budget (Ministry of Finance Malaysia, 2024), while Budget 2025 increased this figure to RM

82.1 billion, with explicit emphasis on upgrading school facilities, expanding access for disadvantaged groups, strengthening TVET and supporting STEM and Artificial Intelligent (AI) related programmes (Ministry of Finance Malaysia, 2025). Hence, this conceptual paper not only strengthens Chemistry pedagogy but also contributes to the development of STEM human capital that is scientifically literate, rational in argumentation and capable of competing in a knowledge and technology-driven global economy.

The SOAR Model (Strengths, Opportunities, Aspirations, Results) is a compelling rationale for using a strength-based science education conceptualisation to transform students' scientific argumentation skills because of its inherently affirmative, future-focused structure, which is closely aligned with strength-based pedagogical principles. Unlike typical deficit-oriented frameworks, SOAR begins by finding and amplifying students' existing strengths, developing agency, drive and engagement—all of which are significantly linked to self-efficacy and deeper learning. According to empirical studies in educational environments, strengths-based teaching approaches are associated with higher levels of academic and general self-efficacy among students. Given that argumentation is cognitively demanding and frequently causes anxiety or reluctance (especially when students believe their skills are lacking), using a model that emphasizes students' strengths provides a theoretically richer and more inclusive path to improving their capacity for scientific discourse. However, despite SOAR's extensive adoption in organizational development, there is a notable gap in its application in science education settings, notably to scaffold argumentation processes, revealing a promising but underexplored prospect for innovation in research.

Soar Model Assessment - Strategic Planning Tool

SOAR analysis becomes valuable and powerful method for strategic planning, SOAR analysis originated from the collaborative efforts of Jacqueline Stavros, David Cooperrider and D. Lynn Kelley, introduced in their seminal paper titled “SOAR: A new approach to strategic planning,” which was published in 2003. It stands for strengths, opportunities, aspirations and results, to help organizations leverage their strengths, explore new opportunities, set ambitious goals and achieve tangible results.

SOAR: A new approach to strategic planning, published in 2003, has a potent technique for strategic planning. It stands for strengths, opportunities, aspirations and results, assisting firms in making the most of their advantages, investigating fresh prospects, establishing challenging objectives and producing measurable outcomes. The philosophy behind the SOAR framework is an appreciative inquiry, used to formulate plans that are aligned with the planned insights (Aziz et al., 2019).

SOAR model is also applied worldwide. For instance, Sugiarti et al. (2023) study shows that the results of the SWOT analysis, then re-analysed with SOAR, create new co-creations for digital marketing businesses. Kamran et al., (2025)used a qualitative research method to explore the strengths, opportunities, aspirations and results (SOAR) factors that could optimise the teaching and learning process for children with special educational needs in the context of an inclusive school located in Karachi, Pakistan. Putri & Pertiwi (2025) recently analysed and described the public information disclosure strategy through the Information and Documentation Management Officer (PPID) of East Java Province using SOAR analysis. The SOAR Analysis Model can be illustrated as in Figure 1.0 as below:

Figure 1.0: SOAR Model Assessment Framework

In the SOAR matrix, strengths are the foundational elements that set research apart. These are internal attributes that contribute to its competitive research advantage. Identifying and leveraging strengths are crucial for a successful SOAR action plan in research. These are the internal attributes, capabilities or resources that give an organization a competitive advantage or contribute to its success. Identifying strengths helps organizations understand what they do well and what sets them apart from others in the digital era (Omran et al., 2023).

Opportunities, in the SOAR Matrix, is used to recognize and capitalize on opportunities that are key to staying agile in research and responsive to the education market dynamics. Aspirations encompass the visionary goals and ambitions that guide research towards future success. In the SOAR matrix, this part is about picturing what the educational organization (schools, HEI, etc) wants to achieve and deciding where it wants to go for growth. Results in SOAR analysis focus on the positives and measurable outcomes in the research topic. This involves evaluating the effectiveness of strategic initiatives and ensuring that the organization (schools, HEI, etc) achieves its objectives.

SOAR has been contrasted to the classic SWOT diagnostic analysis that diverts organizational resources away from strengths and opportunities by focusing on weaknesses and threats. Rather, SOAR is dialogue-based (Cole et al., 2022). It has been demonstrated that SOAR is a flexible and successful strategic framework that fosters innovation, energy and organizational engagement. Strength, Opportunity, Aspiration and Result are the acronyms for SOAR. It is a dynamic, contemporary and creative method for developing strategic thinking, assessing individual and group performance, developing strategies and formulating plans in SOAR's strategic thinking and strategic planning.

SOAR is a framework that emphasizes the development and application of positive strategies through the identification of strengths, chances for constructive creativity, encouraging individuals and groups to share goals and determining quantifiable and significant outcomes. Thus, strategic planning is accelerated by this approach. The Strength, Opportunities, Aspirations and Results (SOAR) analytical approach has gained popularity as a planning and analysis tool for strategic initiatives over the past ten years. By applying this technique to identify environmental correlations, a firm can engage with its surroundings and establish business strategy. For more than 20 years, SOAR has established a reputation as a framework that provides a flexible way to think strategically and develop strategies (Muhammad & Hromada, 2023).

Organizations have found success using the SOAR Model to improve student performance, motivation and engagement while facilitating change and development. The SOAR framework's goal is to accomplish the product target management aspiration by using the strategic planning approach based on the development of opportunities and strengths. In order to create plans that are in line with the planned insights, the SOAR framework is based on an appreciative inquiry. The analysis integrates the group's thoughts and promotes cooperation inside the company.

The SOAR framework also provides a flexible approach to strategic thinking, planning and leadership that invites the entire system into a strategic planning or strategy process by incorporating all who have an interest in the future success of the organization. These stakeholders can be internal workers such as employees or external participants such as suppliers, consumers and societies. SOAR (Strengths, Opportunities, Aspirations, Results) analysis is an appreciative inquiry tool that is uniquely tailored to enable strategic planning around well-defined goals. SOAR analysis differs from the well-known SWOT (strengths, weaknesses, opportunities and threats) analysis within two dimensions; it focuses on the future prospects and results from a subject of interest while SWOT aims at inherent weaknesses and perceived threats (Prabu et al., 2023).

The SOAR Model: Concept and Educational Relevance

The SOAR model as an acronym for Strengths, Opportunities, Aspirations and Results has evolved from its origins in organizational strategy to become a powerful framework for educational transformation. Grounded in Appreciative Inquiry (AI) and Positive Organizational Scholarship (POS), SOAR emphasizes generative dialogue, collaboration and shared vision to foster growth and innovation (Stavros & Cole, 2013). Rather than focusing on deficiencies, SOAR reframes strategic conversations around possibilities, aligning with 21st-century educational values such as inclusivity, creativity and evidence-based reflection. Within educational contexts, it empowers teachers to identify instructional strengths, explore opportunities for pedagogical enhancement, articulate aspirational learning goals and evaluate results systematically (Aziz et al., 2019). Empirical studies have also confirmed SOAR’s psychometric validity as a strengths-based strategic framework, showing that it enhances positive thinking, reflective capacity and collaborative performance in complex learning environments (Cole et al., 2022). When applied in science education, SOAR encourages teachers to design learning environments that foreground inquiry, reasoning and reflection of essential elements for cultivating students’ SAS. By bridging strategic foresight with pedagogical innovation, the SOAR framework provides a theoretically grounded, capacity-building approach for re-envisioning teaching and learning processes in ways that nurture scientific literacy and higher-order reasoning across disciplines.

Studies in chemistry education consistently highlight that students’ ability to construct evidence-based explanations and arguments remains limited due to fragmented instruction, content-heavy pedagogy and lack of reflective engagement (Putri et al., 2025) (Putri et al., 2025 ; Laliyo et al., 2023). By focusing on what works rather than what is lacking, SOAR helps educators to reframe these challenges into opportunities for innovation in encouraging instructional reflection, inquiry-oriented design and continual improvement rather than remediation (Cole et al., 2022; Stavros & Cole, 2013). In this sense, SOAR becomes an intellectual bridge between strategic planning and pedagogical empowerment, fostering the kind of reflective teaching that strengthens students' reasoning and argumentation capacities.

SOAR is most effectively implemented during curriculum planning and lesson design phases, especially when teachers aim to integrate higher-order thinking, scientific reasoning and 21st-century competencies into learning outcomes. In formative and summative assessment cycles, it can also serve as a reflective framework to evaluate how instructional strengths and opportunities have contributed to the growth of students' SAS (Suyono et al., 2021; Ula & Suyono, 2023). Teachers can use SOAR in pre-lesson conferences to set aspirations for student reasoning and revisit it post-lesson to measure progress of creating a sustainable reflection loop between planning, implementation and evaluation.

The SOAR model can be applied across secondary and tertiary science classrooms, particularly within inquiry-based and argument-driven learning environments (Satriya & Atun, 2024). Its use is particularly relevant in chemistry topics that require multi-level reasoning such as acid-base equilibrium, stoichiometry and chemical phenomena where students must move between macroscopic, sub microscopic and symbolic representations (Laliyo et al., 2023). Whether in laboratory investigations, online learning modules or reflective discussions, SOAR aligns well with contexts that demand interpretation of evidence, evaluation of claims and articulation of reasoning.

The SOAR framework benefits multiple educational stakeholders. For teachers, it functions as a reflective and strategic tool for aligning pedagogy with curriculum reform and sustainability goals (Aziz et al., 2019). For students, it offers a metacognitive scaffold that enhances awareness of their learning process in helping them identify their argumentation strengths, recognize areas for growth and set personal aspirations for improved reasoning performance. For school leaders and curriculum developers, SOAR serves as an evaluation lens to guide professional development and evidence-based improvement initiatives in science education (Cole et al., 2022). Figure 2 shows that SOAR operation through a cyclical and participatory process.

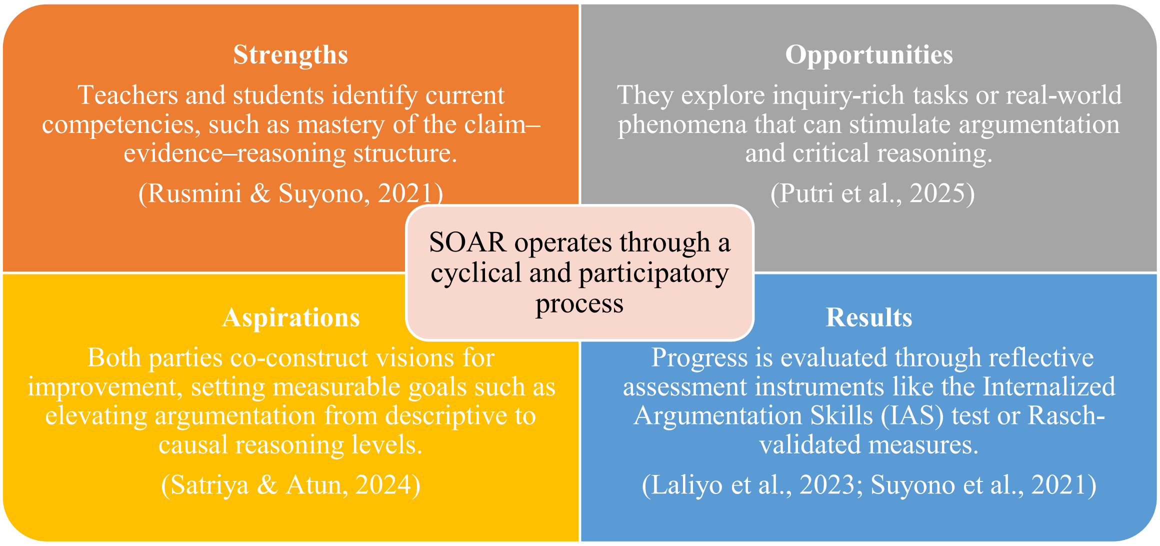

Figure 2: SOAR operates through a cyclical and participatory process.

Through this mechanism, SOAR transforms scientific argumentation from a procedural activity into a strategic, reflective and growth-oriented learning process that ultimately nurturing scientifically literate learners capable of evidence-based reasoning and decision-making.

Strength (S) - The Pedagogical and Theoretical Potential of SAS through Soar

The integration of SAS into science education represents a significant pedagogical strength in fostering inquiry, reasoning and higher-order thinking among students. Empirical research consistently affirms that when students engage in argument-driven inquiry, they demonstrate substantial improvements in both conceptual understanding and critical reasoning (Satriya & Atun, 2024). This pedagogical orientation is particularly impactful in chemistry, where abstract concepts such as acid-base interactions or chemical equilibrium that require learners to justify their claims through logical reasoning and evidence-based explanations (Putri et al., 2025). The SAS framework, therefore, not only enhances scientific literacy but also transforms students' cognitive engagement by positioning them as active constructors of knowledge rather than passive recipients.

From a theoretical perspective, SAS is anchored in the epistemic practices of science, reflecting how scientists develop and defend knowledge claims through empirical and theoretical justification (Yovita, Sonia, Vebrianto, Susanti, & Berlian, 2024). Its strength lies in promoting metacognitive awareness of students learn how to know and why to believe what they know. Such cognitive empowerment is aligned with the SOAR model's principle of leveraging existing Strengths as the foundation for improvement. In this sense, SAS acts as a natural extension of SOAR's positive core: both emphasize reflection, evidence and transformation. Cole et al. (2022) highlight that the SOAR framework strengthens the development of SAS by helping educators identify instructional assets, set aspirational goals and evaluate outcomes aligned with students' reasoning through claims, data and warrants.

Furthermore, SAS-based instruction aligns with the global movement toward 21st-century education, which values critical thinking, collaboration and scientific communication. Studies have shown that structured argumentation elevates students' engagement and autonomy by providing opportunities for self-expression, evidence evaluation and peer discourse (Laliyo et al., 2023). This intellectual empowerment not only improves scientific understanding but also nurtures confidence, curiosity and agency of qualities essential for lifelong learning. The strength of SAS also lies in its adaptability; it can be embedded across various science disciplines and contexts, whether through laboratory investigations, problem-based learning, or technology-enhanced modules (Rusmini & Suyono, 2021). By synthesizing the reflective and appreciative elements of the SOAR model with the cognitive rigor of SAS, educators can design science lessons that celebrate what works students' existing knowledge, inquiry curiosity and communicative potential while systematically guiding them toward higher levels of reasoning and scientific discourse. This strength-oriented integration redefines science learning not merely as the acquisition of content, but as a process of intellectual empowerment and reflective transformation as a cornerstone for producing scientifically literate, argumentatively competent and future-ready learners.

Opportunities (O) - Expanding the Horizon for Strength-Based Argumentation Pedagogy
The current landscape of science education offers more opportunities to reimagine how students engage with knowledge, evidence and reasoning. In the 21st century learning paradigm, inquiry, argumentation and reflective discourse have been recognised as core competencies for developing scientifically literate and future-ready learners (Hendratmoko, Madlazim, Widodo, Suyono, & Supardi, 2024). The rise of inquiry-based and debate-oriented learning environments provides fertile ground for embedding the SOAR framework into classroom practice, where teachers and students co-construct learning experiences grounded in Strengths, Opportunities, Aspirations and Results. Inquiry and debate strategies have been shown to significantly enhance students' ability to construct, defend and evaluate scientific claims, positioning argumentation as a transformative pedagogical opportunity rather than an isolated skill (Hendratmoko et al., 2024; Ling Heng & Surif, 2014).

This opportunity aligns closely with Malaysia's national STEM education agenda and the Malaysia Education Blueprint (2013–2025), which emphasise inquiry, problem-solving and creative innovation as central to human capital development (Shahali, Ismail, & Halim, 2020). The *Guideline for the Implementation of STEM in Teaching and Learnin*g (MoE, 2016) similarly encourages pedagogical practices that integrate science, technology and critical reasoning to cultivate scientifically minded citizens who can thrive in a knowledge-based economy. Within this policy environment, applying SOAR to SAS offers a timely and strategic opportunity to fulfil both national aspirations and global sustainability goals (SDG 4: Quality Education).

At the global level, empirical studies indicate that argumentation-centred pedagogies enhance not only content mastery but also higher-order thinking, creativity and collaboration. Nejla and Kılıç (2021) demonstrated that integrating argumentation-based teaching in chemistry lessons substantially improves students' critical thinking, as they learn to connect conceptual knowledge with reasoning. Similarly, ÖZELMA and Seyhan (2022) reported that argumentation-based learning (ABL) boosts science achievement and argumentation willingness, proving its relevance for cultivating analytical and reflective learners. These findings reinforce the opportunity for SOAR to act as a guiding scaffold for helping educators identify effective pedagogical strengths, envision new strategies for student-centred learning and align teaching practices with measurable learning outcomes.

Moreover, digital transformation in education presents a strategic advantage for integrating SOAR and SAS frameworks.

Studies such as Ping, Halim and Osman (2020) show that technology-enhanced argumentation platforms facilitate real-time reasoning and peer feedback, creating spaces for students to explore evidence collaboratively and refine their claims through social dialogue . When paired with the reflective and goal-oriented nature of SOAR, these tools allow teachers to transform classroom interactions into data-informed, strength-based learning ecosystems where students' argumentation performances can be tracked, visualised and improved through continuous feedback loops. Collectively, these opportunities position the SOAR–SAS integration as an innovative response to both pedagogical and policy challenges in STEM education. By embracing SOAR as a catalyst for reform, educators can bridge the persistent gap between science content mastery and reasoning competency, transforming classrooms into collaborative communities of inquiry. This shift not only meets the evolving needs of learners in Chemistry and broader science education but also reflects Malaysia's vision of nurturing resilient, reflective and research-oriented citizens equipped for the challenges of a STEM-driven future.

Aspirations (A) - Towards a Reflective, Reasoning and Sustainable Science Education Culture

The aspiration to integrate the SOAR framework within SAS pedagogy reflects Malaysia's broader vision of nurturing a generation of future-ready, reasoning and reflective learners. The Malaysia Education Blueprint (MEB) 2013–2025 envisions learners who are not only academically competent but also possess higher-order thinking skills (HOTS), creativity and ethical integrity to thrive in the 21st century (MoE, 2024). It emphasises that education must go beyond rote learning toward cultivating reasoning, character and unity, aligning with the national focus on "humanising education" through balanced intellectual, emotional and moral development (OECD, 2013). In this vision, SAS-based instruction becomes a crucial pedagogical vehicle for realising these aspirations. Through argumentation, students learn to reason scientifically, evaluate evidence critically and articulate claims responsibly competencies directly aligned with the UNICEF Education 2030 Report on Malaysia's progress toward SDG4 (UNICEF Malaysia, 2023).

The report highlights the need for "transformative education that empowers learners with critical, creative and digital competencies" and positions scientific reasoning as central to lifelong learning and civic participation. At the policy level, the National Science, Technology and Innovation Policy (NSTIP) 2021–2030 (MOSTI, 2021) and National Science Agenda (MESTECC, 2020) both identify scientific literacy and reasoning as strategic enablers of Malaysia's innovation-driven economy. They call for an education system that builds analytical, creative and evidence-based decision-making capacities in youth with a vision mirrored in the aspirational goals of SOAR's "Aspirations" dimension, which focuses on envisioning ideal futures grounded in strength and potential. By linking SOAR's appreciative lens with the cognitive rigor of SAS, science education can transform from content transmission into a process of empowerment, where students are equipped not just to learn science, but to think scientifically for sustainability and social good.

This aspiration ensures that academic research transcends theoretical significance and produces tangible influence on educational policy and practice (Wan Hussin and Mohd Matore, 2023). Furthermore, Malaysia's participation in global frameworks such as the Next Generation Science Standards (NGSS) reinforces this aspiration. NGSS advocates for science learning that integrates argumentation, inquiry and modelling as essential practices, helping students construct coherent understandings of natural phenomena through reasoning and communication (National Research Council, 2013).

Embedding SOAR into SAS pedagogy provides teachers with a structured pathway to realise these principles, promoting appreciative reflection and goal-directed growth that align with both NGSS competencies and Malaysia's education transformation roadmap. At its core, this aspiration seeks to create a culture of reasoning and reflective practice within Malaysia's science education ecosystem. Through SOAR, educators can envision classrooms that celebrate students' cognitive strengths, nurture their curiosity and channel scientific discourse toward solving real-world challenges from sustainability to innovation. When learners are empowered to argue, justify and reflect scientifically, they not only achieve academic excellence but also embody Malaysia's long-term vision of developing knowledgeable, ethical and resilient citizens capable of advancing the nation's sustainable future (Allchin & Zemplén, 2020; MoE, 2024).

Results (R) - Measuring Transformative Outcomes through SAS–SOAR Integration

The "Results" dimension of the SOAR framework represents the culmination of strategic aspiration and pedagogical action. This is a reflection of how visionary goals materialise into measurable outcomes in science education. In integrating SOAR with SAS, the central objective is not merely to enhance performance, but to generate evidence of deep learning transformation where students reason scientifically, reflect critically and communicate persuasively. A key measurable outcome lies in students' scientific reasoning index, which indicates their capacity to connect claims with data and justify explanations using sound evidence. Research demonstrates that explicit argumentation-based instruction enhances not only conceptual understanding but also epistemic cognition, fostering learners' awareness of how knowledge is constructed and validated (Berlan and McNeill, 2010; Hasnunidah et al., 2020).

Within a SOAR-guided classroom, this outcome can be captured through argumentation rubrics, reasoning-level descriptors and claim–evidence–reasoning (CER) matrices, enabling teachers to visualise progression across stages of argumentation quality and reflective depth. Another core indicator is the *Reflective Learning Growth Scale*, which measures how students internalise metacognition and scientific empathy that the ability to evaluate perspectives and question assumptions through evidence. As (Cole et al., 2022) note, SOAR's reflective dimension motivates individuals to recognise what works, envision what could be and assess what has been achieved through meaningful dialogue. When translated into SAS pedagogy, this means that "Results" are not test outcomes but cognitive artefacts recorded reflections, peer critiques and written argumentations that show the evolution of scientific reasoning.

Importantly, the Results dimension also captures instructional and institutional transformation. Teachers who adopt SOAR–SAS practices report enhanced professional reflection, greater alignment between pedagogy and assessment and improved classroom discourse quality. For example, structured argumentation cycles encourage teachers to use formative evidence in student rebuttals, claim accuracy, reasoning complexity as indicators of pedagogical effectiveness. These data can then inform continuous improvement through teacher reflection logs or collaborative lesson study frameworks, promoting a sustainable cycle of learning enhancement. Finally, the success of SAS–SOAR integration can be evaluated across three interrelated domains of transformation:

- **Pedagogical transformation** – measurable through improved teacher facilitation of evidence-based inquiry and reflection cycles.
- **Cognitive transformation** – observable in students' reasoning, argumentation structure and conceptual transfer.
- **Cultural transformation** – manifest in classroom discourse, where collaboration, curiosity and constructive debate become norms of practice.

Overall, the integration of SOAR and SAS marks a major change in how success in education is understood. Success is not only seen through exam results or completion of the syllabus, but also through real evidence of reasoning, empathy and reflection. When assessment tools follow the SOAR philosophy of "measuring what matters," science educators can assess both students' learning progress and the positive changes created by effective teaching.

Summary

The integration of the SOAR framework into SAS teaching offers a positive and future-oriented way to improve science education in the 21st century. Through its four dimensions which are Strengths, Opportunities, Aspirations and Results by the SAS–SOAR model shows how reflective and evidence-based practices can make science learning more active and engaging. Instead of simply receiving information, students are encouraged to build, evaluate and communicate scientific ideas, while developing the thinking skills needed for lifelong scientific understanding. The findings from this conceptual review show that SOAR-based strategies help create a positive learning environment. Teachers are encouraged to reflect on their teaching strengths, students take part in discussions supported by evidence and learning outcomes go beyond content knowledge to include reasoning, teamwork and reflective growth. This approach represents a major shift from focusing on weaknesses to building on strengths, supporting Malaysia's STEM goals while aligning with global standards such as the NGSS and SDG 4. However, due to its conceptual nature, this study does not yet offer empirical validation of the SAS–SOAR framework in classroom contexts. Future research should explore how the SOAR model can be applied and expanded across different education systems using mixed-method and cross-national approaches. Comparative studies in ASEAN countries such as Malaysia, Indonesia, Thailand and Philippines can offer meaningful insights into how cultural and curriculum differences affect the use of strength-based science argumentation models. Such studies could focus on the adaptability of SOAR within STEM teacher training frameworks, development of regional scientific reasoning indices to benchmark student growth; and the use of AI-supported analytics to track the quality of argumentation and reflective learning progress.

Beyond the ASEAN region, the SOAR model has strong potential to inspire global innovation in science education. Its emphasis on positive inquiry and reflective measurement aligns with international efforts to promote human-centred STEM education, where learning is not only intellectually challenging but also emotionally meaningful. Ultimately, this concept paper contributes a transformative vision for science education as one that reframes argumentation not as a challenge to overcome, but as a strength to cultivate. By merging the strategic clarity of SOAR with the cognitive depth of SAS, educators can build classrooms that do not merely teach science, but think, question and innovate scientifically. The next stage of this journey lies in global collaboration, where the SAS–SOAR model continues to evolve as a catalyst for reflective, resilient and reasoning-based education worldwide.

References

Al-Ajmi, B., & Ambusaidi, A. (2022). The Level of Scientific Argumentation Skills in Chemistry. *Science Education International*, *33*(1), 66–74.

Allchin, D., & Zemplén, G. (2020). Finding the place of argumentation in science education: Epistemics and Whole Science. *Science Education*, *104*(5), 907–933. https://doi.org/10.1002/sce.21589

Aziz, R. C., Hamzah, S., Hashim, N. A. A. N., Rahim, M. A., Zulkifli, W. F. W., & Ahmad, G. (2019). S.O.A.R Model: An Alternative Approach for 21th Century Education to Shift from "Classroom Management" to "Classroom Leadership." *International Journal of Academic Research in Progressive Education and Development*, *8*(2), 485–493. https://doi.org/10.6007/ijarped/v8-i2/6142

Berlan, L. K., & McNeill, K. L. (2010). The "Results" dimension of the SOAR framework represents the culmination of aspiration and action—a reflection of how strategic intentions translate into measurable educational transformation. In the context of science education, applying SOAR to enhance. *International Journal Science Education*, *94*(5), 765–793. Retrieved from https://doi.org/10.1002/sce.20402

Cole, M. L., Stavros, J. M., Cox, J., & Stavros, A. (2022). Measuring Strengths, Opportunities, Aspirations and Results: Psychometric Properties of the 12-Item SOAR Scale. *Frontiers in Psychology*, *13*(April), 1–17. https://doi.org/10.3389/fpsyg.2022.854406

González-Howard, M., & McNeill, K. L. (2020). Acting with epistemic agency: Characterizing student critique during argumentation discussions. *Science Education*, *104*(6), 953–982. https://doi.org/10.1002/sce.21592

Hasnunidah, N., Susilo, H., Irawati, M., & Suwono, H. (2020). The contribution of argumentation and critical thinking skills on students' concept understanding in different learning models. *Journal of University Teaching and Learning Practice*, *17*(1), 1–13. https://doi.org/10.53761/1.17.1.6

Hendratmoko, A. F., Madlazim, M., Widodo, W., Suyono, S., & Supardi, Z. A. I. (2024). Inquiry and Debate in Science Learning: Potential Strategy for Improving Students' Scientific Argumentation Skills. *International Journal of Education in Mathematics, Science and Technology*, *12*(1), 114–138. https://doi.org/10.46328/ijemst.3152

Jamaluddin, F., Razak, A. Z. A., & Rahim, S. S. A. (2025). Exploring self-leadership strategies and the successful transition of STEM students to higher education in Malaysia: Academic anxiety as a bridge. *STEM Education*, *5*(4), 643–685. https://doi.org/10.3934/steme.2025030

Kamran, M., Bano, A., & Sohni, K. (2025). *Optimising the teaching and learning process for children with special educational needs in an inclusive school : A SOAR analysis in Karachi , Pakistan*. *52*(1), 37–48. https://doi.org/10.1111/1467-8578.12569

Laliyo, L. A. R., Utina, R., Husain, R., Umar, M. K., Katili, M. R., & Panigoro, C. (2023). Evaluating students' ability in constructing scientific explanations on chemical phenomena. *Eurasia Journal of Mathematics, Science and Technology Education*, *19*(9).

https://doi.org/10.29333/ejmste/13524

Ling Heng, L., & Surif, J. (2014). Sains Humanika Memahami Kesilapan Pelajar dalam Membentuk Penghujahan Saintifik. *Sains Humanika*, *2*(1), 23–33. Retrieved from www.sainshumanika.utm.my

MESTECC. (2020). *Sinergisme Ke Arah Kemampanan Negara dan Kesejahteraan Rakyat*. Putrajaya, Malaysia: Unit Komunikasi Korporat Kementerian Tenaga, Sains, Teknologi, Alam Sekitar dan Perubahan Iklim (MESTECC).

Ministry of Finance Malaysia. (2024). Economy Outlook 2024. *Creative Economy Outlook 2024*.

Ministry of Finance Malaysia. (2025). *Budget Speech*. Ministry of Finance Malaysia. Retrieved from https://belanjawan.mof.gov.my/pdf/belanjawan2025/ucapan/ub25-en.pdf

MoE. (2016). Panduan Pelaksanaan Sains, Teknologi, Kujuruteraan dan Matematik (STEM) dalam Pengajaran dan Pembelajaran. In *Bahagian Pembangunan Kurikulum* (Vol. 1).

MoE. (2024). *Malaysia Education Blueprint (2013-2025), Annual Report 2023*.

MOSTI. (2021). National Science, Technology and Innovation Policy 2021-2030. In *Ministry of Science, Technology and Innovation*. Putrajaya, Malaysia: Ministry Science, Technology and Innovation (MOSTI).

National Research Council. (2013). Next Generation Science Standards: For States, By States. In *Next Generation Science Standards: For States, By States* (Vol. 1–2). Washington, DC: The National Academies Press. https://doi.org/10.17226/18290

Nejla, G., & Kılıç, Z. (2021). The Effects of Scientific Argumentation on High School Students' Critical Thinking Skills. *International Journal of Progressive Education*, *17*(6), 183–200. https://doi.org/10.29329/ijpe.2021.382.13

OECD. (2013). *Teachers for the 21st Century: Using Evaluation to Improve Teaching*. OECD Publishing. Retrieved from http://dx.doi.org/10.1787/9789264193864-en

ÖZELMA, E., & Seyhan, H. G. (2022). Effect of Argumentation Based Learning on Science Achievement and Argumentation Willingness: The Topic of "Particulate Nature of Matter". *Bulletin of Education & Research*, *44*(2), 31–50. Retrieved from https://search.ebscohost.com/login.aspx?direct=true&db=ehh&AN=161124337&site=ehost-live

Ping, I. L. L., Halim, L., & Osman, K. (2020). Explicit teaching of scientific argumentation as an approach in developing argumentation skills, science process skills and biology understanding. *Journal of Baltic Science Education*, *19*(2), 276–288. https://doi.org/10.33225/jbse/20.19.276

Putri, T. S., Suyanta, & Rohaeti, E. (2025). Scientific Argumentation in Chemistry Education: A Literature Review of Practices. *Challenges And Solutions. Tarbiyah: Jurnal Ilmiah Kependidikan*, *14*(1), 127–142. Retrieved from https://creativecommons.org/licenses/by/4.0/

Rizqi Nurul Laily, T., & Rohaeti, E. (2024). Enhancing Scientific Argumentation Skills Through Electronic Worksheets Based on Research Oriented Collaborative Inquiry Learning. *KnE Social Sciences*, *2024*, 177–187. https://doi.org/10.18502/kss.v9i8.15505

Rusmini, R., & Suyono, R. A. (2021). Profile of Argumentation Ability of Undergraduate Students In Chemistry Education Based On Non-Routine Problems. *E3S Web of Conferences*, *328*. https://doi.org/10.1051/e3sconf/202132806007

Satriya, M. A., & Atun, S. (2024). The Effect of Argument Driven Inquiry Learning Models on Scientific Argumentation Skills and Higher Order Students on The Topics of Acid Base. *Jurnal Penelitian Pendidikan IPA*, *10*(5), 2663–2673.

https://doi.org/10.29303/jppipa.v10i5.6834

Shahali, E. H. M., Ismail, I., & Halim, L. (2020). Policy Trajectories and Initiatives in STEM Education STEM Education in Malaysia : Policy , Trajectories and Initiatives. *Educational Planning and Research Division, Ministry of Education, Malaysia*, 122–133.

Stavros, J. M. (2020). SOAR 2020 and Beyond: Strategy, Systems Innovation and Stakeholder Engagement. *AI Practitioner*, *22*(2), 70–91. https://doi.org/10.12781/978-1-907549-43-4-11

Stavros, J. M., & Cole, M. (2013). SOARing Towards Positive Transformation and Change. *Development Policy Review*, *1*(November 2013), 10–34. Retrieved from https://www.researchgate.net/publication/259975881_SOARing_towards_positive_transformation_and_change

Suyono, S., Harun, N., Bertha, Y., Anggita, I. K. D., Wardani, S., & Duhita. (2021). The Validity of the Internalized Argumentation Skills Test for Chemistry Students. *E3S Web of Conferences*, *328*. https://doi.org/10.1051/e3sconf/202132806008

Ula, F. R., & Suyono. (2023). Development of Argumentation Skills Assessment Instruments on Buffer Solution Material. *Jurnal Penelitian Pendidikan IPA*, *9*(12), 10792–10799. https://doi.org/10.29303/jppipa.v9i12.4760

UNICEF Malaysia. (2023). Education 2030 in Malaysia | UNICEF Malaysia. In *UNICEF Malaysia*. Retrieved from https://www.unicef.org/malaysia/reports/education-2030-malaysia

Wan Hussin, W. A. S., & Mohd Matore, M. E. E. (2023). Systematic Review: Factors Affecting Academic Procrastination in Mathematics among Students. *International Journal of Academic Research in Business and Social Sciences*, *13*(1), 1474–1493. https://doi.org/10.6007/ijarbss/v13-i1/15800

Yovita, Sonia, G., Vebrianto, R., Susanti, E., & Berlian, M. (2024). Development of Scientific Argumentation Test Instruments for Students on the Classification of Living Creatures in Junior High School. *Science Education and Application Journal*, *6*(2), 155–164. https://doi.org/10.30736/seaj.v6i2.1056

Al-Ajmi, B., & Ambusaidi, A. (2022). The Level of Scientific Argumentation Skills in Chemistry. *Science Education International*, *33*(1), 66–74.

Allchin, D., & Zemplén, G. (2020). Finding the place of argumentation in science education: Epistemics and Whole Science. *Science Education*, *104*(5), 907–933. https://doi.org/10.1002/sce.21589

Aziz, R. C., Hamzah, S., Hashim, N. A. A. N., Rahim, M. A., Zulkifli, W. F. W., & Ahmad, G. (2019). S.O.A.R Model: An Alternative Approach for 21th Century Education to Shift from “Classroom Management” to “Classroom Leadership.” *International Journal of Academic Research in Progressive Education and Development*, *8*(2), 485–493. https://doi.org/10.6007/ijarped/v8-i2/6142

Berlan, L. K., & McNeill, K. L. (2010). The “Results” dimension of the SOAR framework represents the culmination of aspiration and action—a reflection of how strategic intentions translate into measurable educational transformation. In the context of science education, applying SOAR to enhance. *International Journal Science Education*, *94*(5), 765–793. Retrieved from https://doi.org/10.1002/sce.20402

Cole, M. L., Stavros, J. M., Cox, J., & Stavros, A. (2022). Measuring Strengths, Opportunities, Aspirations and Results: Psychometric Properties of the 12-Item SOAR Scale. *Frontiers in Psychology*, *13*(April), 1–17. https://doi.org/10.3389/fpsyg.2022.854406

González-Howard, M., & McNeill, K. L. (2020). Acting with epistemic agency: Characterizing student critique during argumentation discussions. *Science Education*, *104*(6), 953–982.

https://doi.org/10.1002/sce.21592

Hasnunidah, N., Susilo, H., Irawati, M., & Suwono, H. (2020). The contribution of argumentation and critical thinking skills on students' concept understanding in different learning models. *Journal of University Teaching and Learning Practice*, *17*(1), 1–13. https://doi.org/10.53761/1.17.1.6

Hendratmoko, A. F., Madlazim, M., Widodo, W., Suyono, S., & Supardi, Z. A. I. (2024). Inquiry and Debate in Science Learning: Potential Strategy for Improving Students' Scientific Argumentation Skills. *International Journal of Education in Mathematics, Science and Technology*, *12*(1), 114–138. https://doi.org/10.46328/ijemst.3152

Jamaluddin, F., Razak, A. Z. A., & Rahim, S. S. A. (2025). Exploring self-leadership strategies and the successful transition of STEM students to higher education in Malaysia: Academic anxiety as a bridge. *STEM Education*, *5*(4), 643–685. https://doi.org/10.3934/steme.2025030

Kamran, M., Bano, A., & Sohni, K. (2025). *Optimising the teaching and learning process for children with special educational needs in an inclusive school : A SOAR analysis in Karachi , Pakistan*. *52*(1), 37–48. https://doi.org/10.1111/1467-8578.12569

Laliyo, L. A. R., Utina, R., Husain, R., Umar, M. K., Katili, M. R., & Panigoro, C. (2023). Evaluating students' ability in constructing scientific explanations on chemical phenomena. *Eurasia Journal of Mathematics, Science and Technology Education*, *19*(9). https://doi.org/10.29333/ejmste/13524

Ling Heng, L., & Surif, J. (2014). Sains Humanika Memahami Kesilapan Pelajar dalam Membentuk Penghujahan Saintifik. *Sains Humanika*, *2*(1), 23–33. Retrieved from www.sainshumanika.utm.my

MESTECC. (2020). *Sinergisme Ke Arah Kemampanan Negara dan Kesejahteraan Rakyat*. Putrajaya, Malaysia: Unit Komunikasi Korporat Kementerian Tenaga, Sains, Teknologi, Alam Sekitar dan Perubahan Iklim (MESTECC).

Ministry of Finance Malaysia. (2024). Economy Outlook 2024. *Creative Economy Outlook 2024*.

Ministry of Finance Malaysia. (2025). *Budget Speech*. Ministry of Finance Malaysia. Retrieved from https://belanjawan.mof.gov.my/pdf/belanjawan2025/ucapan/ub25-en.pdf

MoE. (2016). Panduan Pelaksanaan Sains, Teknologi, Kujuruteraan dan Matematik (STEM) dalam Pengajaran dan Pembelajaran. In *Bahagian Pembangunan Kurikulum* (Vol. 1).

MoE. (2024). *Malaysia Education Blueprint (2013-2025), Annual Report 2023*.

MOSTI. (2021). National Science, Technology and Innovation Policy 2021-2030. In *Ministry of Science, Technology and Innovation*. Putrajaya, Malaysia: Ministry Science, Technology and Innovation (MOSTI).

Muhammad, H., & Hromada, M. (2023). Evaluating an E-Government Stage Model by Using SOAR-AHP Process. Transportation Research Procedia, 74, 1538–1545. https://doi.org/10.1016/j.trpro.2023.11.131

National Research Council. (2013). Next Generation Science Standards: For States, By States. In *Next Generation Science Standards: For States, By States* (Vol. 1–2). Washington, DC: The National Academies Press. https://doi.org/10.17226/18290

Nejla, G., & Kılıç, Z. (2021). The Effects of Scientific Argumentation on High School Students' Critical Thinking Skills. *International Journal of Progressive Education*, *17*(6), 183–200. https://doi.org/10.29329/ijpe.2021.382.13

OECD. (2013). *Teachers for the 21st Century: Using Evaluation to Improve Teaching*. OECD Publishing. Retrieved from http://dx.doi.org/10.1787/9789264193864-en

Omran, F., Ahmed, K., & Al-magarbi, A. O. (2023). Strengthening Libyan Hospitality : A SOAR Analysis of Digital Marketing Strategies and Practices in the Tourism and Hospitality Sector. Journal of Economics, Management and Trade Volume, 29(12), 144–159. https://doi.org/10.9734/JEMT/2023/v29i121181

ÖZELMA, E., & Seyhan, H. G. (2022). Effect of Argumentation Based Learning on Science Achievement and Argumentation Willingness: The Topic of "Particulate Nature of Matter". *Bulletin of Education & Research*, *44*(2), 31–50. Retrieved from https://search.ebscohost.com/login.aspx?direct=true&db=ehh&AN=161124337&site=ehost-live

Ping, I. L. L., Halim, L., & Osman, K. (2020). Explicit teaching of scientific argumentation as an approach in developing argumentation skills, science process skills and biology understanding. *Journal of Baltic Science Education*, *19*(2), 276–288. https://doi.org/10.33225/jbse/20.19.276

Prabu, A., Id, K., Omprakash, A., Kumar, P., Mani, C., Id, M. K., Wael, D., & Sathiyasekaran, B. W. C. (2023). E-learning and E-modules in medical education — A SOAR analysis using perception of undergraduate students. PLoS ONE, 18(5), 1–14. https://doi.org/10.1371/journal.pone.0284882

Putri, A. I., & Pertiwi, V. I. (2025). Analisis SOAR Terhadap Strategi Keterbukaan Informasi Publik Melalui Pejabat Pengelola Informasi Dan Dokumentasi Provinsi Jawa Timur. Jurnal Tata SejutaSTIA MATARAM, 11(1), 87–102.

Putri, T. S., Suyanta, & Rohaeti, E. (2025). Scientific Argumentation in Chemistry Education: A Literature Review of Practices. *Challenges And Solutions. Tarbiyah: Jurnal Ilmiah Kependidikan*, *14*(1), 127–142. Retrieved from https://creativecommons.org/licenses/by/4.0/

Rizqi Nurul Laily, T., & Rohaeti, E. (2024). Enhancing Scientific Argumentation Skills Through Electronic Worksheets Based on Research Oriented Collaborative Inquiry Learning. *KnE Social Sciences*, *2024*, 177–187. https://doi.org/10.18502/kss.v9i8.15505

Rusmini, R., & Suyono, R. A. (2021). Profile of Argumentation Ability of Undergraduate Students In Chemistry Education Based On Non-Routine Problems. *E3S Web of Conferences*, *328*. https://doi.org/10.1051/e3sconf/202132806007

Satriya, M. A., & Atun, S. (2024). The Effect of Argument Driven Inquiry Learning Models on Scientific Argumentation Skills and Higher Order Students on The Topics of Acid Base. *Jurnal Penelitian Pendidikan IPA*, *10*(5), 2663–2673. https://doi.org/10.29303/jppipa.v10i5.6834

Shahali, E. H. M., Ismail, I., & Halim, L. (2020). Policy Trajectories and Initiatives in STEM Education STEM Education in Malaysia : Policy , Trajectories and Initiatives. *Educational Planning and Research Division, Ministry of Education, Malaysia*, 122–133.

Stavros, J. M. (2020). SOAR 2020 and Beyond: Strategy, Systems Innovation and Stakeholder Engagement. *AI Practitioner*, *22*(2), 70–91. https://doi.org/10.12781/978-1-907549-43-4-11

Stavros, J. M., & Cole, M. (2013). SOARing Towards Positive Transformation and Change. *Development Policy Review*, *1*(November 2013), 10–34. Retrieved from https://www.researchgate.net/publication/259975881_SOARing_towards_positive_transformation_and_change

Sugiarti, W. S., Pujangkoro, S. A., & Sembiring, M. T. (2023). Analisis SOAR (Strength, Opportunity, Aspiration & Result) Sebagai Upaya Peningkatan Penjualan Melalui Digital Market. Jurnal Ilmiah Manajemen Dan Kewirausahaan, 2(2), 25–34.

Suyono, S., Harun, N., Bertha, Y., Anggita, I. K. D., Wardani, S., & Duhita. (2021). The Validity of the Internalized Argumentation Skills Test for Chemistry Students. *E3S Web of Conferences*, *328*. https://doi.org/10.1051/e3sconf/202132806008

Ula, F. R., & Suyono. (2023). Development of Argumentation Skills Assessment Instruments on Buffer Solution Material. *Jurnal Penelitian Pendidikan IPA*, *9*(12), 10792–10799. https://doi.org/10.29303/jppipa.v9i12.4760

UNICEF Malaysia. (2023). Education 2030 in Malaysia | UNICEF Malaysia. In *UNICEF Malaysia*. Retrieved from https://www.unicef.org/malaysia/reports/education-2030-malaysia

Wan Hussin, W. A. S., & Mohd Matore, M. E. E. (2023). Systematic Review: Factors Affecting Academic Procrastination in Mathematics among Students. *International Journal of Academic Research in Business and Social Sciences*, *13*(1), 1474–1493. https://doi.org/10.6007/ijarbss/v13-i1/15800

Yovita, Sonia, G., Vebrianto, R., Susanti, E., & Berlian, M. (2024). Development of Scientific Argumentation Test Instruments for Students on the Classification of Living Creatures in Junior High School. *Science Education and Application Journal*, *6*(2), 155–164. https://doi.org/10.30736/seaj.v6i2.1056