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Promoting school-industry collaborations in STEM: Insights and implications from two case studies

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As STEM education evolves to address the complexity of real-world problems, collaboration between schools and industry is increasingly recognised as a powerful yet underutilised strategy. While school-industry partnerships offer rich opportunities for contextualised, authentic learning, their implementation remains limited due to logistical and pedagogical barriers. This paper presents a conceptual synthesis contributing to the field by offering a comparative analysis of how industry partnerships promoted through problem-based learning (PBL) can function as a complex adaptive system to STEM learning. Drawing on two case studies led by the authors, we provide valuable insights into three interrelated dimensions of school-industry partnerships: authenticity and industry relevance; feedback and iterative learning; and equity, agency, and pathways. We conclude by acknowledging the importance of boundary brokers, sustained teacher support, innovative feedback mechanisms, and alternative pedagogical models in fostering authentic, equitable, and future-focused STEM learning.

Keywords: experiential learning, problem-based learning, school-industry collaboration, STEM education

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Introduction

STEM education is evolving in response to global challenges, workforce shifts, and emerging technologies, requiring a move beyond traditional, discipline-specific models. There is a growing emphasis on transdisciplinary, human-centred approaches that foster critical capabilities. As outlined in the Australian Curriculum (ACARA, n.d.), integrated STEM is gaining traction as an effective strategy for student engagement, prompting the need to explore how it can be meaningfully implemented in classroom practice.

The incorporation of experiential learning through real-world projects, simulations, or hands-on activities (Kolb et al., 2014) provides an opportunity to develop skills needed in a world that is changing quickly due to technology and other global challenges. Experiential learning is not just engaging; it also enables students to apply knowledge in meaningful ways, leading to increased information retention, and to develop critical skills like problem-solving, adaptability, and teamwork (Chang et al., 2023; James et al., 2018). This learning approach can take many forms depending on the context, with problem-based learning (PBL) being an increasingly commonly used approach in school settings in South Australia (Gaardboe, 2025). PBL, a form of inquiry-based learning, engages students in solving real-world problems, fostering deep understanding while building practical skills (Cooper & Heaverlo, 2013; Gaardboe, 2024).

To implement meaningful PBL in the classroom, industry partnerships are essential (Gaardboe, 2024). These collaborations offer students real-world learning experiences that make curriculum content more relevant through contextualised and authentic applications. A key benefit is the ability to bridge the gap between theoretical knowledge and practical application, allowing students to see how STEM concepts are used to address real industry challenges. Fostering partnerships between the education sector and industry is therefore an effective method to offer students real-world challenges, making STEM learning more relevant and applicable to the real world (Australian Academy of Science, 2019; Lyons & Quinn, 2010).

PBL frequently requires students to work in small groups of two to three, fostering collaborative learning and enabling the development of peer-to-peer feedback loops. When industry partnerships are in place, these internal feedback mechanisms are often augmented by external feedback, resulting in a network of interconnected feedback processes. Collectively, these form multiple feedback loops, commonly referred to as feedback chains or cycles, where the output of one phase informs the next, thereby supporting a continuous and iterative learning process (Kolodner, 2002).

However, despite their transformative potential, school-industry collaborations are still the exception rather than the norm and can be difficult to establish and sustain (Hobbs & Kelly, 2020). These challenges stem less from a lack of interest or potential, and more from the absence of supportive systems, incentives, and infrastructure needed to make such partnerships feasible, sustainable, and equitable. This paper contributes to a growing body of knowledge by presenting two case studies that demonstrate the effective implementation of STEM industry partnerships to enrich the learning experiences of primary and secondary school students.

In line with pragmatic views of educational research (see Svabo et al., 2025), we aim to bridge the gap between abstract theory and applied interventions by presenting a conceptual synthesis with illustrative cases of two industry-based initiatives in South Australia, both led by the authors. One case study is situated in the primary school context, introducing younger students to foundational STEM concepts through industry-aligned activities. The other focuses on female secondary students, offering extracurricular and specialised engagement with real-world problems and workplace practices. Although utilising different lesson formats, theoretical processes, and implementation designs, together, these initiatives provide valuable insights into three interrelated dimensions of effective school-industry partnerships: authenticity and industry relevance; feedback and iterative learning; and equity, agency, and pathways. These dimensions serve as analytic lenses for examining the two case studies and for identifying broader implications for the design of sustainable STEM education initiatives. A summary of the two programs is provided in Table 1.

Table 1: Summary of the two school-industry programs discussed in this paper

	Problem-Based Learning in Schools	**STEM Girls Academy**
Leading institution	Government	University
Target year	Primary (Years 4 to 6), government schools	Secondary (Years 7 to 12), all school systems
PBL Framework	Engineering design process	Design thinking
Objective	Apply STEM-subject knowledge, develop critical and creative skills	Develop critical skills and change in attitudes
Curriculum Integration	Curriculum-aligned	Extra-curricular
Industry Partners	Problem posing, feedback loops and career modelling	Problem identification/posing and feedback loops
Teacher involvement	Ideating, delivery	Online PD
Duration	10-week school term, 1 to 3 weekly lessons	3 sessions of 5 hours each
Examples of problems developed with industry partners	How might we reduce the impact of fruit bats landing on power lines, causing blackouts and death of animals? How might we replace a water main situated on a bridge crossing the river – the bridge is heritage listed and in constant use. How might we provide a boat launching marina that doesn't fill up with sand.	How might we leverage an IP mesh network to enhance the quality of life for people living in rural and remote areas of Australia? How can we produce healthy high quality protein foods that can be used in foods that taste great? How might we improve crew wellbeing on board ships?

Program: Problem-Based Learning in Schools

The Problem-Based Learning in Schools program was developed in response to a perceived need to enhance primary school students' use and development of critical and creative thinking skills. Essential for success in STEM careers (Leopold et al., 2025), these skills have been shown to be effectively fostered through a combination of PBL pedagogy and exposure to authentic, unsolved, multifaceted problems presented by industry partners (Gaardboe, 2024).

Authenticity and industry relevance

The Problem-Based Learning in Schools program introduces primary students (Years 4–6) to authentic STEM problems sourced from a wide range of industry partners, including engineers, local councils, government departments, and research organisations. These problems are deliberately aligned with the Australian Curriculum to ensure subject relevance while extending learning into real-world contexts that often exceed the direct experience of classroom teachers. The program is structured around the eight-step engineering design process (define, ask, imagine, plan, prototype, test, improve, and evaluate), which mirrors professional practice and provides a systematic framework for weekly lessons over a 10-week school term.

Feedback and iterative learning

Industry partners engage at three stages. They begin by introducing the challenge as a genuine plea for help (e.g., "I have a problem – I'm hoping you can help me"), which captures student interest. Midway through the program, they provide formative feedback using the "two stars and a wish" model, offering encouragement while extending student thinking. Finally, they review completed solutions, affirming the validity of multiple approaches and reinforcing confidence in students' problem-solving abilities. Throughout, teachers scaffold the development of critical and creative thinking skills, including questioning, research, ideation, computational thinking, and presentation.

Equity, agency, and pathways

As part of a state-wide initiative in South Australian public schools, the program provides broad equity of access. Student agency is central, with learners directing their research and solution development while collaborating in teams. Industry partners also serve as role models, exposing students to possible STEM career pathways and showing the relevance of their classroom learning to future opportunities.

Program: STEM Girls Academy

The STEM Girls Academy Creative Challenge is a research-based, extracurricular outreach initiative from the University of South Australia. The initiative was designed to address persistent gender disparities in STEM participation. It situates learning within authentic, co-developed challenges that emphasise the altruistic and socially impactful nature of STEM.

Authenticity and industry relevance

The STEM Girls Academy situates learning within authentic, co-designed challenges developed in partnership with industry. Using the design thinking framework (empathise, define, ideate, prototype, test, evaluate), the program highlights the altruistic and socially impactful dimensions of STEM, an approach supported by research showing that young women are particularly motivated by careers with perceived social benefit (Almukhambetova et al., 2023; Lubinski et al., 2001; Tillberg & Cohoon, 2005; Weisgram & Bigler, 2006).

Design thinking facilitates partnerships with industry, while its empathy phase highlights the altruistic values of STEM (Kijima et al., 2021). It promotes optimism and reduces fear of failure, empowering young females to share ideas and believe in their creative abilities (Kijima & Sun, 2021; Kijima et al., 2021; Wingard et al., 2022). By focusing on developing students' creative confidence, the program aims to increase students' likelihood of persisting in STEM pathways (Vieira et al., 2024). Industry briefs frame complex, real-world issues, thereby reinforcing the value of STEM as a means to address pressing challenges.

Feedback and iterative learning

The program delivers three five-hour workshops at university campuses. Teams are deliberately mixed across schools and year levels to foster peer-to-peer collaboration and diverse perspectives. Industry partners co-develop problem briefs with facilitators, deliver challenges directly to students, and return to provide evaluative feedback. Iterative prototyping and feedback cycles increase students' critical thinking, tolerance for failure, and strengthen their creative confidence (Kijima & Sun, 2021; Kijima et al., 2021). An example of a prototype developed by students is illustrated in Figure 1. Teachers are not positioned as leaders but instead participate in an observational role, supported by online professional development on design thinking, which both shifts ownership of learning to students and contributes to building teacher capacity.

Figure 1: Example of a student-developed STEM prototype developed through design thinking to address a real-world industry challenge

Equity, agency, and pathways

The program has engaged over 600 female students from 61 schools across metropolitan and regional areas, drawing participants from Years 7 to 12 across all school systems. Its explicit focus on gender equity responds to the underrepresentation of women in STEM pathways. Student agency is central, as learners are encouraged to ideate, prototype, and test their own solutions while collaborating in diverse teams. Industry mentors, most of whom are women, play a particularly important role in providing both mastery and vicarious experiences, which Bandura (1977) identifies as key sources of self-efficacy. Developing self-efficacy, particularly in creativity, increases the likelihood that students will continue studying STEM subjects (Vieira et al., 2024).

Challenges and future directions

These two case studies offer valuable insights and practical guidance for strengthening school–industry partnerships in STEM education. Firstly, it is important to acknowledge that the responsibility for initiating and sustaining school-industry collaborations cannot rest solely on educators. Ongoing support structures are essential for educators to continuously refine and enhance their pedagogical practice (Education Council, 2018). A critical, yet often overlooked, enabler is the role of the boundary broker. This role is typically filled by an external individual, sometimes referred to as a boundary spanner, intermediary, or liaison, whose core function is to act as a conduit between the education system and industry (Akkerman et al., 2021). Their work involves interpreting the needs and expectations of industry partners and reframing them to align with curricular goals, thereby ensuring that tasks are both authentic and feasible within the constraints of school programs (Hobbs & Kelly, 2020). In liaising with educators, industry mentors, and facilitators, boundary brokers manage expectations, clarify objectives, and cultivate a shared understanding of purpose (Pattison, 2021). They play a key role in making STEM partnerships more equitable and effective by designing inclusive learning experiences and aligning the goals of education and industry. Outreach programs, in particular, are instrumental in training these boundary brokers and supporting their integration into educational settings.

While boundary brokers can assist educators in addressing the practical and logistical challenges of implementing industry partnerships, additional support from school leaders is also needed to strengthen the pedagogical approaches required for their effective integration. PBL requires a fundamental shift in the educator’s role from a transmitter of knowledge to a facilitator of learning (Lewrick et al., 2018). This role also extends to facilitating engagement with boundary brokers and industry partners, which involves balancing the freedom for professionals to contribute authentically with the support they need to interact meaningfully with students. Making this transition can be complex and requires deliberate, ongoing support for educators.

Professional development should equip educators to understand creativity within STEM education and foster it as a core capability alongside technical skills. Teachers may sometimes view highly creative behaviours as disruptive (Scott, 1999), making it essential to build a deeper understanding of how to recognise and nurture creativity in the classroom. Acknowledging the role of creativity in STEM subjects would establish creativity’s role beyond the arts. When educators see all students as capable of being creative, the conversation shifts from questioning creativity’s place in STEM to exploring how and when it can be most effectively encouraged (Beghetto & Kaufman, 2014).

Another important point to consider is the expansion of feedback mechanisms. While interactive feedback loops are a core strength of PBL, industry experts might not always be available to provide real-time, domain-specific feedback to students. To address this challenge, alternative methods such as Artificial Intelligence (AI)-based tools (see Cropley, 2025) can offer formative feedback throughout the project process. For example, AI can assist during the ideation and prototyping stages by suggesting alternative approaches, prompting reflection, or checking alignment with defined design criteria. To be effective, these tools must incorporate safeguards for reliability (e.g., validated feedback prompts), bias reduction (e.g., diverse training data), and privacy (e.g., secure handling of student work). These tools empower students to self-assess and iterate their solutions, balancing the scalability of classroom implementation with the pedagogical intent of authentic learning experiences (Marrone et al., 2024). Rather than restricting the use of AI, educators should broaden their perspective and encourage responsible human–AI collaboration (Clark, 2025).

It is worth mentioning that school-industry collaborations may sometimes raise concerns around intellectual property (IP) and potential financial gain. Based on the authors’ experience, ensuring transparency and fairness requires clear agreements that define the ownership of any resulting IP and outline how any benefits or rewards will be distributed, particularly for participating students.

Future research could explore alternative pedagogical models to broaden strategies for developing STEM competencies. For example, systems thinking (Fisher, 2023) supports students in tackling complex problems by understanding the interconnections within larger systems. Likewise, futures thinking (Laherto & Rasa, 2022) equips learners to anticipate and prepare for long-term challenges and opportunities. Similarly, life-centred design (Borthwick et al., 2022) extends the principles of human-centred design by incorporating global well-being into the design process. Exploring how these approaches can be delivered, either individually or in an integrated manner, may help make school-industry partnerships more inclusive, relevant, and future-focused.

In conclusion, school-industry collaborations function as a complex systems that rely on a range of STEM-related capabilities, such as communication, project management, problem-solving, and systems thinking, to operate effectively. While these partnerships can be challenging to establish and sustain, they are essential for advancing STEM education by providing students with authentic, real-world learning opportunities that bridge the gap between theory and practice.

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The authors used ChatGPT-4 for the purpose of improving clarity and grammar throughout the article. The authors take full responsibility for the content.

About the authors

Dr Maria F. Vieira holds a PhD in STEM and is a lecturer in Education Futures at the University of South Australia. Her work is grounded in a deep commitment to advancing educational equity through innovative, research-informed teaching practices that nurture creativity. In her current role, she leads key initiatives in course coordination, curriculum development, and outreach programs. She coordinates the research-based STEM Girls Academy program, establishing and nurturing partnerships with over 30 STEM industry collaborators in UniSA's metropolitan and regional areas. The program reaches over 200 schoolgirls annually across South Australia and Victoria, successfully contributing to a positive change in attitudes towards STEM through creative practices.

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Dr Sue Gaardboe began her professional journey with a successful STEM career in textile conservation before training as a primary school teacher. With a strong passion for science and education, she was recognised as *STEM Educator of the Year* in 2012. Her teaching practice evolved from working directly with students to supporting teachers in the implementation of problem-based learning (PBL). This work sparked a key research interest in understanding the role and effectiveness of industry partnerships in PBL. Dr Gaardboe is currently employed by the South Australian Department for Education, where she leads a program integrating industry partnerships into PBL in primary schools across the state. She also holds an Adjunct Researcher Fellowship at the University of South Australia.

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Nick Pattison is an educator and researcher passionate about creativity, STEM education, and the intersection of emerging technologies with authentic learning. With a background in teaching and curriculum design, Nick has led innovative projects that bring industry-relevant experiences into classrooms, empowering students through real-world problem solving and digital tools. He is particularly interested in project-based learning, generative AI, and fostering creativity across the curriculum. Nick collaborates with schools, universities, and industry partners to co-design learning environments that promote student agency, curiosity, and future-ready skills. He works to bridge the gap between education and industry by embedding real-world challenges into learning experiences and supporting teachers to adapt to evolving technologies.

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