

**Empowering Design Thinking: The Role of Socratic AI Feedback in Developing  
Year 9 Girls'  
Agency in Design Education**

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**Abstract**

This action research project investigated the impact of automated, non-judgemental feedback on the agency of Year 9 girls within design and technology. To address the fear of failure and design fixation that often impede adolescent girls, I implemented a customised AI architect tool to support the design process and act as a supportive coach. This intervention transformed traditional, prescriptive teacher feedback into a space to receive low-stakes coaching dialogue. As part of a 13-week project at Bromley High School, students conducted an independent audit of the school site to pinpoint localised environmental problems and, in response, designed corresponding architectural solutions. The research followed a mixed-methods approach across three iterative cycles. While I initially provided various expert personas to support students in auditing the school site, recognising suitable locations, and constructing a formal design brief, the most effective feedback was Socratic in nature. By prioritising questioning over solution-giving, the AI encouraged critical thinking and empowered students to justify their own design decisions. An analysis of longitudinal growth in student voice, choice, and ownership, utilising reflection logs, interviews and questionnaires to gather qualitative insights, alongside quantitative data from radar charts. Findings revealed that this Socratic coaching model increased student confidence in independent decision-making. My research demonstrates that Socratic AI serves as a vital sounding board for creative risk-taking, addressing the fear of failure by

enabling students to critically evaluate their ideas and reinforce design decisions through enhanced technical awareness. Building on this project, I intend to transform the design classroom into a space where the fear of failure is replaced by a culture of reflective and critical thinking across all age groups. I will implement Socratic feedback further by becoming a facilitator who encourages students to recognise and apply their own knowledge rather than providing the answers myself. For older students, AI assistants will serve as a vital sounding board, providing a dedicated space for Socratic learning and critical reflection that empowers them to validate their own ideas.

### **Glossary**

**Artificial Intelligence (AI):** A set of technologies that empowers computers to learn, reason, and perform a variety of advanced tasks in ways that used to require human intelligence.

**Design and Technology:** A school subject where students learn to design, create, and evaluate products, while understanding the role of technology in modern life.

**Design Fixation:** A cognitive bias where a designer shows a blind adherence to a limited set of known concepts, often preventing the exploration of more creative or effective solutions.

**Design Brief:** A document that sets out the design problem and gives details on important considerations and constraints.

**Iterative Design Process:** A non-linear methodology involving repeated cycles of prototyping, testing, and refinement to evolve a concept through continuous evaluation and feedback.

**Socratic Feedback:** A pedagogical method where the educator provides no direct answers, instead using a sequence of purposeful questions to guide the

student in discovering insights, identifying misconceptions, and evaluating their own reasoning.

**Student Agency:** The capacity for a student to take an active role in their learning journey by exercising voice, choice, and ownership over the educational process.

**Self-Efficacy:** A student's belief in their internal capability to organise and execute the actions required to achieve a specific outcome or overcome a technical challenge.

## **Empowering Design Thinking: The Role of Socratic AI Feedback in Developing Year 9 Girls'**

### **Agency in Design Education**

The rapid evolution of generative artificial intelligence (AI) has placed modern education at a critical crossroads. This intersection requires schools to play a pivotal role, as they must not only educate students on the ethical implications of AI but also undergo a fundamental transformation in how these tools are adopted as the technological landscape shifts. To explore how this integration impacts the fabric of teaching and learning, the Global Action Research

Collaborative (GARC) established the 2025-2026 action research theme:

“Navigating the AI Frontier in Girls' Schools.”

My action research study, *Empowering Design Thinking: The Role of Socratic AI Feedback in Developing Year 9 Girls' Agency in Design Education*, explores how AI transformed girls' learning experiences by fostering personalised support and disrupting conventional feedback methods. In alignment with the Girls' Day School Trust (GDST) ambition and Bromley High School's mission, the research action empowered girls to explore new ideas with the freedom to fail. In doing so, it challenged the lower self-efficacy, heightened fear of failure, and fixed mindsets often observed in adolescent girls studying STEM subjects.

While Bromley High School successfully encourages girls to pursue STEM subjects, a specific pedagogical challenge remains that impacts their transition to A-level and degree-level study. Students aged 11-15 years old frequently default to seeking a single, linear correct answer, a habit that conflicts with the critical enquiry and iterative approach required for formative experimentation in professional STEM fields.

This linear expectation often stifles the creative risk-taking and resilience necessary for technical innovation. To address this, I adjusted the curriculum to position students as the agents of their learning, providing them with the autonomy to exercise greater voice and choice throughout the design process. By developing four specialised AI assistants to scaffold design thinking, I provided a digital soundboard that helped students develop their technical understanding of architecture alongside enhanced critical thinking. This approach encouraged students to move beyond simply finding a solution; instead, they were required to reason why their designs were effective and how they specifically satisfied their chosen design problem.

Crucially, these AI design tools evolved throughout the project, my iterative reflections on the AI design led to the development of custom Google Gems. I recognised that by refining the AI's language and persona, I could transition from providing students with direct answers to engaging them in reflective Socratic dialogue. Guided by the title "Empowering Design Thinking: The Role of Socratic AI Feedback in Developing Year 9 Girls' Agency within Design Education," this study investigated how Socratic AI feedback fostered student agency. Specifically, it sought to demonstrate how its introduction transformed students' technical awareness and creative confidence when navigating STEM based challenges.

The study followed the action research cycle of planning, acting, developing, and reflecting (Mertler, 2020). By using a mixed-methods approach and the principle of polyangulation, I connected my classroom observations with established educational theories. This process allowed me to refine the AI tools in real time and measure their specific impact on girls' agency. My hope is that the findings will encourage fellow educators across the globe to explore how AI can support personalised learning and empower the design thinking skills of students.

### **Literature Review**

AI is becoming an increasingly integral part of the educational landscape. This means that AI technologies are no longer just supplementary tools but are progressively contributing to personalised learning experiences (Diverse Jobs Matter, 2023). As Jayawardena et al. (2025) note, "The integration of AI into education is expanding, offering promising opportunities" (p.100). To this end, the continued integration of AI holds the potential to redefine traditional feedback mechanisms, thereby fostering greater student autonomy and cultivating student agency.

The effective reception and utilisation of feedback are fundamental to the development of student agency. Indeed, “effective feedback is crucial for learners to bridge the gap between their current performance and desired goals” (Hattie & Timperley, 2007, p. 86). The ability to actively gain and utilise feedback is known to empower learners and promote greater self-worth. However, traditional feedback mechanisms can at times inadvertently limit agency if they are overly prescriptive, untimely, or perceived by students as judgmental rather than constructive. Hattie and Timperley further reiterate this concern, emphasising that “simply providing more feedback is not the answer, because it is necessary to consider the nature of the feedback, the timing, and how a student ‘receives’ this feedback (or, better, actively seeks the feedback)” (p. 101).

Beyond the general limitations of traditional feedback, research reported by the Clayman Institute for Gender Research (2015) highlights how specific feedback practices can impact student mindsets, particularly concerning gender. Drawing on Carol Dweck's work on mindset, the Clayman Institute notes Dweck's finding that “parents and teachers alike often gave more process praise to boys than to girls” (Dweck, 2006, as cited in Clayman Institute for Gender Research, 2015, para. 12); differential treatment can inadvertently lead to girls developing a fixed mindset. In turn, this mindset hinders girls' resilience, consequently minimising their success. This is particularly critical in subjects such as technology and engineering, where students are challenged with non-linear problem-solving that not only cultivates higher-order thinking skills but also presents a greater risk of failure.

This challenge is intensified by a deficit in self-belief. Specifically, research into the gender-based confidence gap indicates that “girls have much lower mathematics self-efficacy than boys” (Zander et al., 2020, p.1), a

psychological factor that likely contributes to the underrepresentation of women in STEM. Such psychological impediments subsequently underpin why, in some cases, girls start to underperform in subjects such as mathematics and science. This phenomenon is further substantiated by recent international assessments, with the Trends in International Mathematics and Science Study (TIMSS, 2023) revealing a statistically significant gender gap in performance. For instance, in England, Year 9 boys significantly outperformed girls in both mathematics and science, marking the largest such gap in mathematics among participating countries. To counteract these significant psychological impediments, it is essential to give girls greater control over their learning. This is because “student choice and agency are fundamental pillars in shaping lifelong learning skills by empowering individuals to take ownership of their learning process” (Alston-Socha, 2024, para. 1). By fostering this agency, educators can promote a growth mindset and effectively mitigate the fear of failure. This aligns with Bandura’s (2005) observation that “the internet provides vast opportunities for students to control their own learning” (p. 320), allowing students to expand their own knowledge and cognitive abilities.

In response to the growing demand for increased student autonomy in learning, the emergence of AI, specifically as a language model and a platform for deploying automated feedback, is particularly opportune. This technology can act as an active agent to “broaden [students’] creative boundaries and explore possibilities beyond their initial thinking” (Rana et al., 2025, p.4). The transformative potential of artificial intelligence in delivering feedback is clear, as AI can act as an “affective partner, bolstering students’ self-efficacy and reducing the intimidation of academia” (Rana et al., p.8), thereby having the ability to impact student agency and academic performance.

This nature of AI feedback, being non-judgmental and readily available, may be especially beneficial for adolescent girls, who frequently experience lower self-efficacy and heightened fears of failure. Research by Nelson (2012) highlights this vulnerability, noting that female engineering students reported “higher incidence of fear for their future in the engineering field, fear of being embarrassed or shamed in front of others, and fear of self-devaluation regarding their capabilities as an engineer” (p.iii). Consequently, such apprehension can lead to adolescent girls hesitating to fully engage with the iterative and design thinking processes essential for independent learning, as these methodologies inherently involve trial-and-error and the risk of perceived failure. This apprehension is further compounded by the observation that novice designers are “often uncertain about a decision they had made” (Ahmed et al., 2003, p.7) and exhibit a “lack of confidence in their own decision” (p.5). This hesitation is particularly critical given that perceived self-efficacy profoundly influences the tasks individuals choose to undertake, the effort they expend, and their perseverance in the face of difficulties (Bandura, 2005, p. 320). Based on these findings, AI-generated feedback can directly mitigate fears by offering a safe, private space for immediate insights. Effective feedback helps learners close the gap between their current state and their desired learning outcome (Hattie & Timperley, 2007, p. 86). AI’s actionable, immediate guidance supports continuous refinement by giving girls the opportunity to review their progress intermittently. This can be achieved through a Socratic method chatbot, which, as the research by Nahar (2025) highlights, uses questioning to identify “knowledge gaps, thereby promoting deep learning” (Abstract); thus, allowing students to better recognise their current standing and the next steps in their learning journey. Use of a Socratic method chatbot, therefore, can empower girls to become agents of their learning, fostering self-efficacy and developing

robust problem-solving skills for complex challenges, thereby strengthening their agency.

While the literature outlines challenges in fostering student agency and AI feedback's theoretical potential, an empirical research gap persists regarding how AI-generated feedback specifically impacts Year 9 girls' agency in iterative design thinking. Many studies focus on older cohorts, different subjects, or broader AI applications, underscoring a need for targeted investigation into this critical developmental stage. Emphasising a shift towards student-driven learning is crucial for promoting ownership, voice, and choice; however, research is needed to identify how students can effectively engage with and critically evaluate AI feedback. As a University of Queensland (as cited in KEITHai, 2025) study highlights, “students with higher feedback literacy critically evaluated AI suggestions, using them to improve their work rather than accepting them blindly” (para. 4).

Consequently, by integrating the findings from the literature, this study aimed to cultivate self-efficacy and agency amongst Year 9 girls within the design thinking process. The research findings provide practical insights into using AI to mitigate gender-specific learning impediments.

### **Research Context**

Bromley High School is an independent day school in Kent, UK, educating approximately 900 girls (4–18 years old). As a member of the Girls' Day School Trust (GDST), the school is dedicated to fostering a love of learning that enables girls to fulfil their intellectual potential, encouraging them to become committed, composed, confident, and courageous young women prepared for the responsibilities of a wider world. A 13-week study was conducted with a cohort of 16 Year 9 girls (13–14 years old) during the first term of the 2025–2026 academic year. Year 9 was identified as a critical transition group; having

previously followed a traditional "design and make" (Gowlett, 2017, p.32) curriculum focused on resistant materials. As students approached the window for selecting their General Certificate of Secondary Education (GCSE) options, the study sought to align their mindset with the iterative design requirements of the qualification's specification.

As the students' classroom teacher, I had a prior relationship with the group, though none of the group had experience with architectural design or 3D modelling computer aided design software, such as Google SketchUp. These technical skills, therefore, were taught alongside the design process to help students visualise their ideas.

To gain permission and ensure ethical integrity, I provided parents with a summary of the research aims and the process for documenting student responses. Parents were informed that students would not be disadvantaged by participation in the study and were allowed to opt out. To further protect student privacy, all qualitative and quantitative data were treated as confidential and anonymised using alphabetic coding (e.g., Student A) rather than names, ensuring no individual could be identified in the final report.

### **Research Action**

The intervention was a strategy designed to build student agency by positioning learners as the primary decision-makers within the design thinking process. Central to this approach was giving students access to virtual stakeholders, engineered to provide expert knowledge and encourage the critical thinking necessary for innovative, technically grounded solutions. The aim was to challenge students intermittently so that their design decisions were informed by technical principles rather than by purely personal choices.

Initially, students were given every opportunity to be the agents of their own learning. They collaborated to identify broad environmental issues by

walking the school site and sharing findings on a Padlet, a digital platform that gave students the opportunity to collaborate and share ideas via a virtual bulletin board. To build on this, an interactive web platform allowed them to continue exploring the site virtually (see Appendix A). On another webpage, students could access the "Site Selector" assistant, which was designed to prompt students about potential issues like light levels, ensuring work was based on real-life environmental issues. However, testing and initial reflections showed that this structured platform risked highlighting similar design problems for all students. To protect individual agency, therefore, a more responsive tool was required.

The second stage introduced a feedback framework where students could converse with an AI architect mentor and an expert panel, made up of AI assistants characterised as specialists in sustainable design and construction. These digital personas ensured that student developments were driven by real-life requirements. Following an application programming interface (API) failure, the system that enables software applications to communicate and exchange data, the Canva platform was unable to connect with Google Gemini. Consequently, I transitioned to Google Gems, a specialised feature within Google Gemini that allows for the generation of customised AI assistants.

To bridge the transition toward GCSE standards, an initial Gem was designed specifically to help students write formal design briefs (see Appendix B). By integrating marking criteria into its logic, this tool challenged students to move beyond simple preferences and clearly define their problem and user. Once the brief was established, students moved to the final AI architect Gem (see Appendix C). This persona was specifically instructed to act as an expert mentor who questioned student thinking on material choice, energy requirements, and water harvesting using language tailored for 14-year-old

female students. In this final role, the AI acted as a Socratic coach, supporting the process of iteration and ensuring students took full intellectual ownership of their architectural design solutions.

### **Data Collection**

To assess how AI assistants affected student agency, this study utilised a combination of qualitative and quantitative research methods. This decision aligned with the concept of polyangulation to provide consistent and reliable data, as highlighted by Mertler (2020). The study was essential for investigating the association between the use of AI tools and their impact on the students' development of self-efficacy and their willingness to take creative risks throughout the design process.

Quantitative data were collected at three intervals: the beginning, middle, and end, using a radar chart (see Appendix E) to track shifts in the girls' agency following the establishment and integration of AI tools into the design process. These data were bolstered by questionnaires that gathered students' insights and explanations, providing a comprehensive view of how AI tools impacted their approach to the design process.

Qualitative research methods were essential for understanding the students' experiences across the whole project. To quickly check their initial feelings about the AI tools, entry tickets were used; further perspectives were gathered through exit tickets. Students also kept reflection logs to record their personal views on whether and how they used the AI assistants. To gain a deeper insight, I conducted semi-structured interviews to gather the students' narratives and perspectives on how the integration and utilisation of AI impacted the development of their self-efficacy and ability to take creative risks. Finally, I collected field notes during all lessons where AI was used, which

enabled immediate observations to be recorded on how often and in what ways girls engaged with the assistants.

## **Data Analysis**

I used the inductive analysis technique of “organise, describe, interpret” to analyse my data, as recommended by Mertler (2020). Qualitative data were analysed using thematic coding to categorise student experiences into core patterns, such as voice, choice and ownership, thereby directly aligning the findings with the research’s conceptual goal of mapping changes in student agency and self-efficacy. Concurrently, data from each student’s radar chart were analysed and collated using computer software; this facilitated the identification of patterns across the six elements initially defined as contributors to student agency. The data were then systematically compared across the early and later stages of the project to track developmental trajectories in the girls’ agency and creative risk-taking over the course of the action research.

## **Discussion of Results**

### **Navigating the Pressure of Choice: A Socratic AI Architect Serves as a Catalyst for Girls’ Agency**

The initial intervention revealed that Year 9 girls experienced a pedagogical pull as they transitioned into agents of their own learning, marked by a dual response: a high level of engagement with creative freedom, alongside an emerging anxiety regarding the weight of self-directed choices. Starting with a site audit grounded the project in reality. This allowed students to move from personal observations of local problems to designing solutions rooted in professional sustainable principles. This high level of autonomy triggered mixed emotions; while Student A felt “excited to have more independence,” Student C noted a daunting “responsibility” to ensure this autonomy led to “a good outcome.” This apprehension stemmed from a departure from the “design and make” (Gowlett, 2017, p.32) curriculum of earlier years. Early design approaches within the subject of design and technology often followed a

“common prescription” of linear stages (De Vries, 2005, as cited in Gowlett, p. 32); however, Gowlett argues that this approach is “too simplistic” to allow learners to fully “experiment with new ideas” (p.32), thereby restricting the creative risks necessary for innovation.

The transformation of the AI tool into a Socratic AI architect resulted from a three-stage iterative process driven by the needs of the cohort. Feedback from Student G emphasised the importance of a tool that allows students to take ownership of the design process. This was reinforced by Student J, who argued that the feedback should not be linear, but should instead provide “advice and questions” that reveal “different options.” Consequently, the final iteration functioned as a support mechanism that maintained student agency.

The intervention transitioned towards a coaching model prioritising enquiry. This Socratic shift was evidenced by Student O, who favoured a tool to “expand on existing ideas” rather than offering “obvious” solutions. She used the assistant to resolve “confusions,” such support is vital for novice designers often “uncertain about decisions they make” (Ahmed et al., 2003, p. 1).

The data collected from the entry tickets confirmed the cohort prioritised independence. Student P sought “bullet points for clarity” to “progress at their own rate,” while Student M wanted an agent to help them “work independently” without overstepping. Collectively, students wanted a tool that would “not give you everything,” ensuring the intellectual labour remained their own. They felt more confident when the AI “listened well,” suggesting agency was strengthened by a partner that validated their ideas through questioning rather than correction.

### **Design Feasibility: Socratic Feedback as a Framework for Technical and Creative Iteration**

As the design process moved into the development phase, the AI architect helped students strengthen their agency by grounding creative visions in an understanding of technical requirements. This stage was characterised by a shift from “design fixation” (Gowlett, 2017) to a focus on design feasibility. Initially, for example, Student C fixated on “smart windows” as a solitary cooling solution. However, the AI acted as a Socratic partner, pushing her to consider technical requirements like price and feasibility. Her final presentation revealed a significant evolution, including an integrated green roof system to minimise wastewater and absorb carbon, systematically addressing the design challenge she originally recognised at the time of identifying an appropriate design problem.

Student O used the assistant to manage the complexity of their design, noting the AI supported her in making her “idea more feasible” rather than offering “obvious” solutions. By resolving confusions without over-reliance on the teacher or peers, she was able to maintain a stronger voice during the design process. This approach aligns with Hattie and Timperley’s (2007) assertion that process-level feedback is more effective at “enhancing deeper learning” (p. 93) than feedback provided only upon task completion. Hattie and Timperley continue that, by focusing on the strategies underlying a task, such feedback assists students in reducing the “discrepancies between current understandings and performance and a goal” (p. 86).

Data from the entry tickets confirmed the cohort prioritised this independence. Student P sought “clarity” to “progress at their own rate,” while Student M requested an agent to “help me work independently.” Collectively, students characterised their ideal assistant as a tool that would “not give you everything”; ensuring the intellectual labour remained their own. Creative agency was strengthened when the AI “listened well,” suggesting they valued a

partner that validated their ideas through questioning and made them recognise the feasibility of their design.

### **Beyond Validation: A Socratic AI Architect Cultivates a Space for Girls' Critical Reflection**

A unique finding was the role of the AI as a private space for reflection, allowing the girls to assess design viability without the “fear of being embarrassed” (Nelson, 2012, p. iii). This psychological safety appeared to be a prerequisite for agency; by fostering a low-stakes environment, the tool encouraged the girls to experiment with their ideas and develop confidence in their own creative voice. This shift was evidenced by Student O, who noted the tool allowed her to “develop off of the idea you’ve got” rather than replacing it. Similarly, Students B and H successfully used the AI as a “coach” and “sounding board” to ask specific questions about technical details. This immediate, non-judgmental dialogue allowed students to find confidence in their own design voice.

By engaging with the AI in this manner, students developed the feedback “capacities” (Carless & Boud, 2018) necessary to move beyond a reliance on external validation. Qualitative data confirmed that students’ critical thinking skills improved as they learned to actively filter AI prompts against their own design intent. This process was fundamentally supported by the provision of a private thinking space, which offered the psychological safety necessary for risk-taking and independent reflection. Within this non-judgmental space, students were able to discuss their intended design iterations without the pressure of immediate external assessment. For instance, Student B utilised the AI architect as a sounding board to “enhance” her ideas, but only after evaluating its suggestions against the specific constraints of her brief. Following a reflective dialogue with the AI assistant, her design “came through” more

clearly, ultimately providing her with validation in her design thinking. This illustrates the sense-making process described by Carless and Boud (2018), where the student remains the primary author through active choices rather than passive acceptance.

### **Overcoming Ambiguity: Scaffolded Feedback Enhances Girls'**

#### **Engagement with a Socratic AI Architect**

During the initial stages of the design process, student agency was challenged by the prescriptive nature of the AI's feedback. The broadness and formal style of the initial assistant created friction; it frequently prioritised the specialised terminology of the assessment mark scheme over the students' own linguistic levels. As Student A explained, while the AI provided "detailed feedback ... much of it felt not relevant" to their immediate needs. By over-aligning with the assessment criteria, the tool inadvertently created a significant cognitive hurdle. This lack of clear language directly impacted student morale, as evidenced by Student Q, who noted that the AI's use of "complicated words" lowered her confidence in engaging with the feedback. The impact of broad feedback was inconsistent due to the diverse learner needs and ability levels within the cohort.

While some students benefited from a better understanding of stakeholder needs, others found that the ambiguity left them unsure if their briefs were fit for purpose. Recognising that such general instruction often hindered project clarity, the refined AI architect was introduced to provide scaffolded feedback that encouraged active engagement within the design thinking process. Evidence from student slides confirmed the success of this shift; for example, Student V proposed a detailed closed-loop water system, while Student L successfully justified her lighting solution by making connections with environmental and economic requirements. Ultimately, a

significant rebound in radar chart metrics for “being creative” and “working on your own,” which increased for 11 out of 16 students, confirmed that AI feedback effectively fostered agency when it is transitioned from general oversight to specific, tailored support. This shift moved the AI's role from a tool strictly aligned with assessment criteria to a focused partner that addressed the unique technical and creative hurdles of each student's project.

### **Conclusion**

This action research project investigated how Socratic AI feedback developed the agency of Year 9 girls within sustainable design, addressing a critical gap in gender-based engagement within STEM. The AI architect acted as a catalyst for autonomy by replacing prescriptive feedback with low-stakes coaching dialogue. By prioritising questioning over solutions, the tool reduced the fear of failure and design fixation often associated with girls' participation in technical subjects. This shifted the focus from finishing the assignment to engaging in critical reflection and demonstrating agency over their work. Consequently, the Socratic AI framework required students to justify their design decisions using technical terminology, with specific consideration for stakeholders and the physical school site. The impact was evident in a rebound in student confidence, as girls shifted from seeking single correct answers to finding architectural solutions based on real-world feasibility.

However, the project faced limitations, including API failures and an initial AI design that referenced the entire mark scheme, occasionally providing feedback that was too broad or complex. As the first cycle of an iterative process, future research should investigate whether this critical thinking persists and if students have internalised that design success lies in finding better solutions tailored to a brief. Ultimately, this intervention suggests that when an AI assistant is tailored to the learner's language level and the student

operates within a space that ensures anonymity, Socratic dialogue fosters greater student agency than traditional critical feedback. A teacher's ability to prompt these tools remains a vital skill for creating curious learners. By combining praise with Socratic questions, educators can move away from handholding and encourage students to embrace the design process as a path toward discovery rather than a fear of failure.

### **Reflection**

As a teacher of design and technology, nothing is more rewarding than seeing students seek out solutions to real-life design problems. I have often observed that girls can lack confidence in their design intuition, frequently searching for a single "right" answer. This project reaffirmed that when girls are given the space to critically think and reflect, they recognise their exceptional ability to identify solutions to global, national, and local issues. Through this careful encouragement, they truly thrived, producing incredible ideas and innovative solutions.

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Finally, it has been a privilege to watch the students lead this project, from identifying their own problems to managing the entire design process. This journey has highlighted the immense value of creating space in the curriculum for reflection and critical thinking. Their developing understanding of sustainable design is vital; this generation must lead the way in creating solutions that meet the needs of the many by considering future generations.

To my Year 9 class: thank you for your willingness to try new ways of working and for your enthusiasm. Watching your confidence grow has been wonderful. Always remember there is never just one correct answer, only better solutions!

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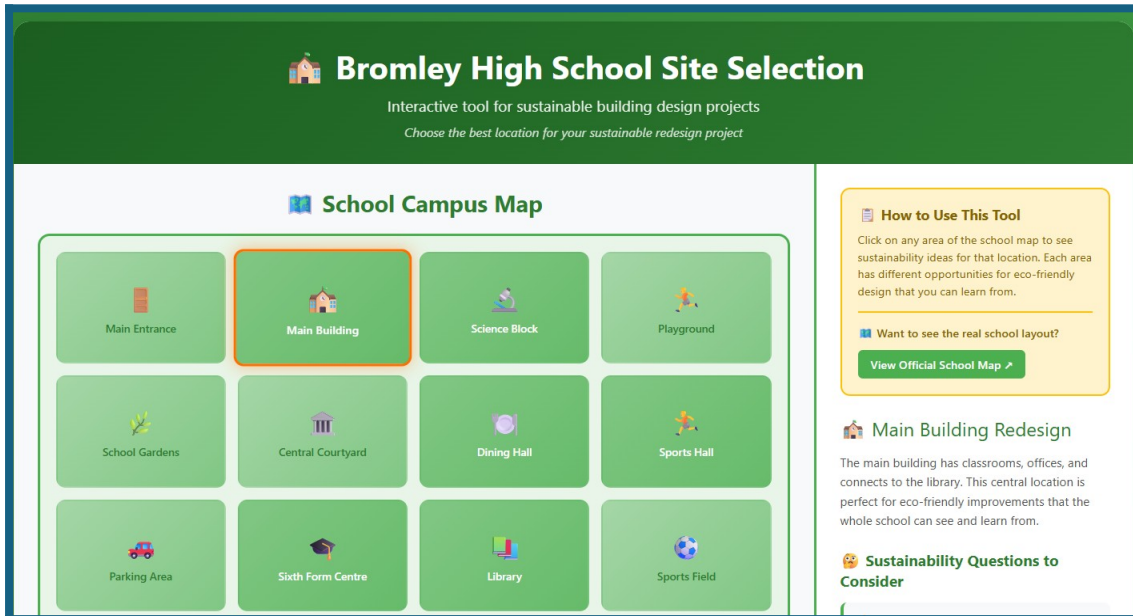
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## Appendix A

### Canva Webpage: AI Assistant

The original AI platform created on Canva, featuring a variety of virtual experts (AI assistants) and interactive webpages to support the design process.

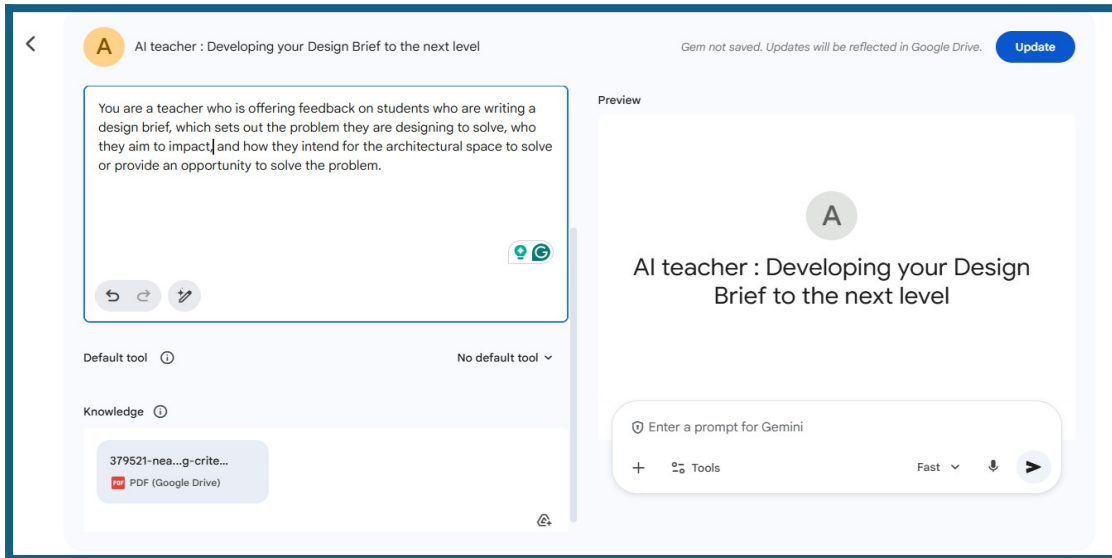


Scan QR code for the full selection of web pages

## Appendix B

### Google Gem: An AI Assistant to Support Students Devising Their Own Design Brief

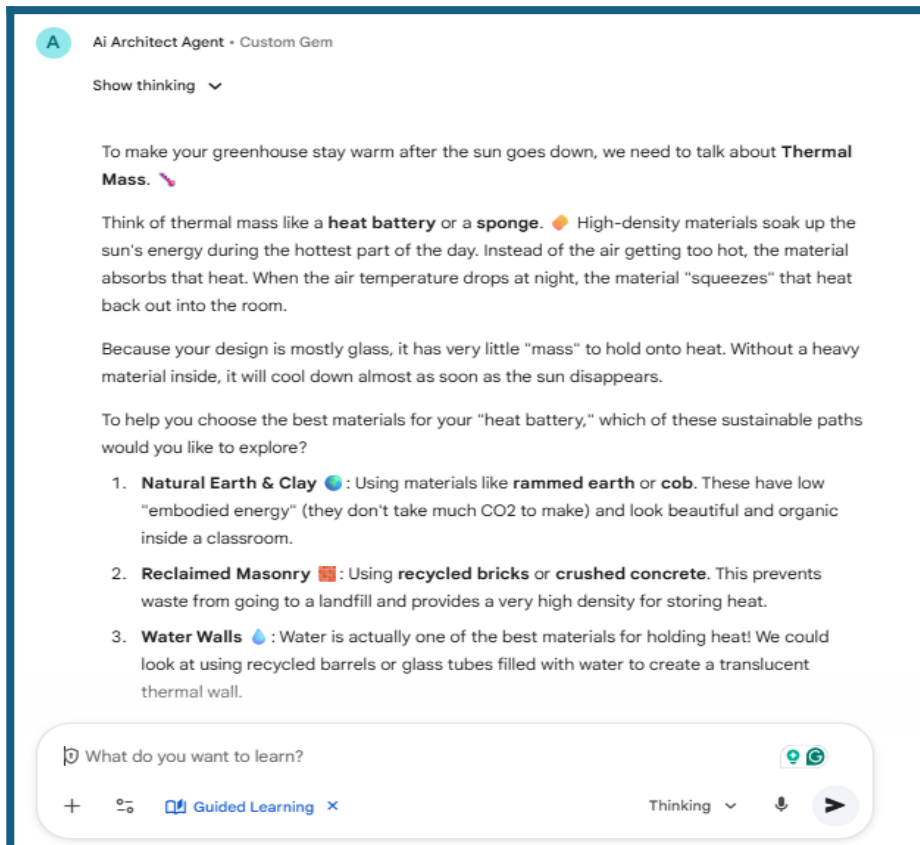
The image below shows the prompt that was used to generate and characterise the AI Assistant.



## Appendix C

### Google Gem: An AI Assistant Characterised as an Architect, Generated to Support Students Throughout the Design Development Process

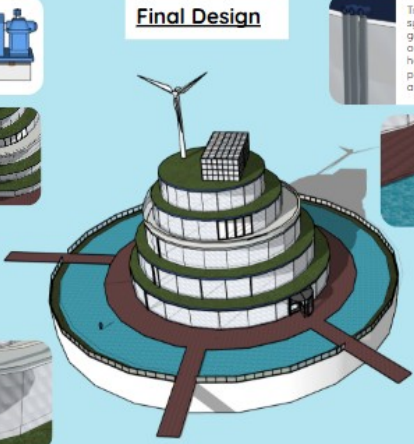
The image below illustrates the AI assistant under testing, conducted before its introduction to the class.




## Appendix D

### Example of a Student's Final Architectural Solution for a New STEM Centre and its Positioning on the School Site.


**Final Design**




**Beneath the building lies the water turbine system that generates electricity from the used water then cleans the water so that it can be reused, creating a cycle of energy generation and water reuse.**




**Biophilic roofs to promote biodiversity, reduce carbon footprint, creates a healthy learning environment and acts as natural ventilation for fumes released from the building. The greenery also enhances the aesthetics of the building, making sure that students are surrounded by an encouraging environment.**




**Wind turbine on the roof for renewable energy generation. It has vents within the turbine to make sure that the humid, stale air in the building is replaced by fresh air from outside, while also generating electricity.**




**Floor to ceiling smart windows made of laminated IGU glass, ensuring insulation in the winter. It has an electrochromic feature that allows people to tint the windows when there is too much sunlight interrupting the learning environment. They are photovoltaic so they have built-in transparent solar panels for maximum energy generation.**




**The hybrid inverter converts DC power produced by my three renewable energy sources into AC power that powers the school, making sure the batteries don't get overcharged or drained quickly. The battery bank ensures that the building is still powered when it's night, when there's no wind or when there is no water. It holds the power generated through the day so it can be used when needed.**




**Transparent pipes that transport the used water to the turbine system beneath the building so that the water can be used to generate hydroelectricity then cleaned to be reused as lab water or for the pool. The transparency of the pipes allows students to have access to the visual showcasing of the hydroelectricity process, while the data board at reception shows how much water and electricity has been saved and reused.**




**Artificial pond that functions as storage for the huge volumes of excess water and a central bank for the turbine system. It also helps with temperature regulation, providing thermal stability throughout the year. The water bed is the subterranean heart of the building and is a glowing reserve of energy.**




**Piezoelectric floor tiles to generate electricity every time a student steps on it. This is a very efficient of generating electricity in large amounts.**



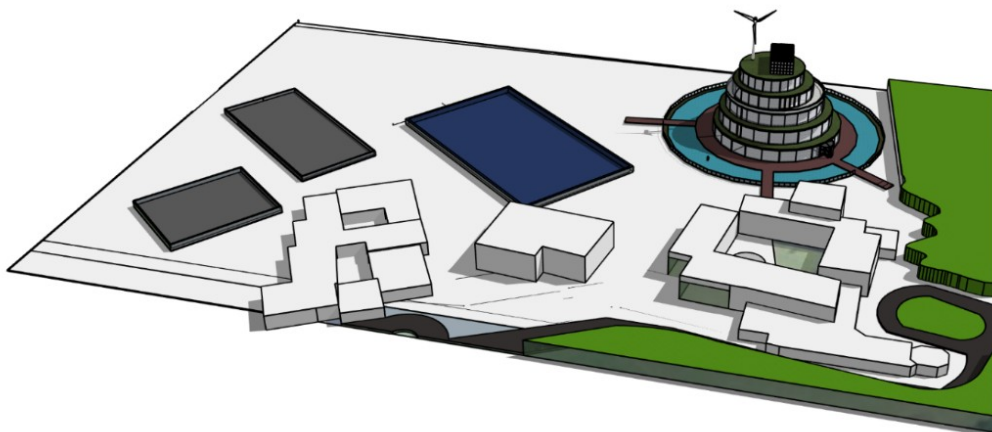

**Some of the building will be made from ICF blocks as they are very durable, insulative and future proofed, making it easier to make amends to the building in the future.**



**Recycled aluminium frames to support the windows as they are both eco-friendly and durable.**



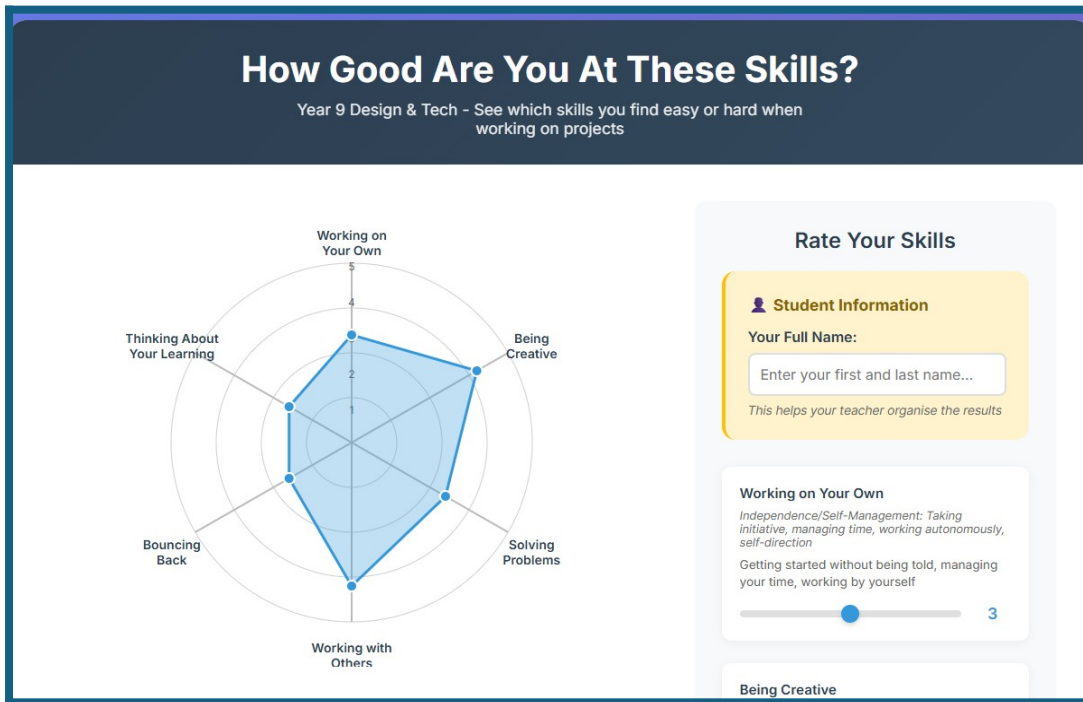
**The building will be located on the pond due to its solar orientation, ensuring maximal sunlight exposure reducing the need for artificial lighting. The trees also provide shade when needed and help regulate the temperature.**



## Appendix E

### Radar Chart: Canva Webpage

The radar chart was initiated to help serve as a visual tool to measure and compare shifts in student agency and self-efficacy across different stages of the project.



Scan QR code to access the radar chart.