OPEN STEM PROJECT

Engineering Design and Development (EDD)
Martin Luther King High School
Team Name: M.O.J.O.
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Element A

Presentation & Justification of the Problem

1 PROBLEM STATEMENT

The team has found that commercial offerings labeled as “girls’ STEM toys” often present narrower technical content, stereotyped themes, and uneven value relative to gender-neutral alternatives, which can dampen girls’ early interest in STEM.

2 STATEMENT OF PURPOSE

The team will design, build, and test a STEM construction kit that engages young learners using evidence-based principles from child development and the learning sciences, prioritizing authentic inquiry and identity-affirming materials without reliance on gendered colored cues or “pink” signaling.

3 PROBLEM BACKGROUND & STATISTICS

The team’s market research synthesizes findings from three currently marketed products and three relevant patents to characterize the market space for girls’ STEM toys. The reviewed products target learners roughly ages 3-12 and carried by mainstream retailers as well as educational suppliers, indicating ready discoverability and present market demand. Patent activity within the same space, explicitly including a patent targeted towards encouraging girls’ interest in STEM, corroborates that industry actors already recognize both the need and commercial potential of solutions focused on girls’ engagement. Together, these sources establish an actual baseline for the problem.

Quantitatively, the team’s research covered many price bands, with list prices ranging from $23 to $150 with sale prices listed near ~$13 for budget sets and ~$120 for premium kits. Such dispersion matters for equity of access and for parental value judgements at the time of purchase, particularly when ongoing consumables or unclear instructions dilute learning value over time. Qualitatively, two of the three products researched explicitly marketed themselves as “for girls”, while one positioned itself as “boys & girls”, revealing mixed norms in audience signaling that can shape

caregiver reception and children's expectations before play even begins. Content analyses further indicate uneven depth: while several products provide credible STEM affordances (e.g., microscopy or mechanical construction), others leaned heavily on themed aesthetics or consumable-heavy activities that offer limited pathways for sustainable inquiry without additional purchases. Figures A-B (prices and marketing languages) visualize these patterns and invigorate the team's emphasis on authentic inquiry, modular challenge progressions, and neutral, mechanics-first branding in the proposed design.

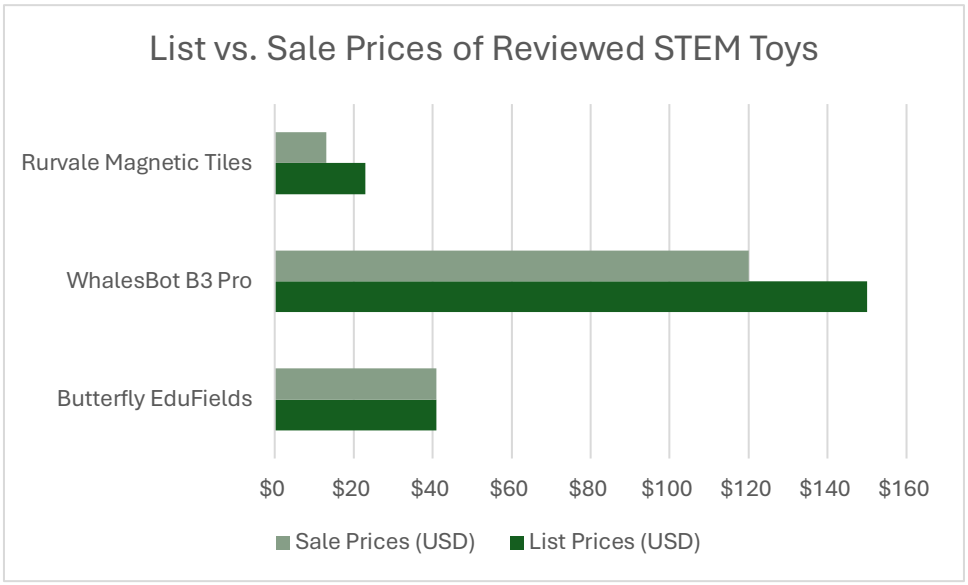

Figure A – List vs. Sale Prices of Reviewed STEM Toys

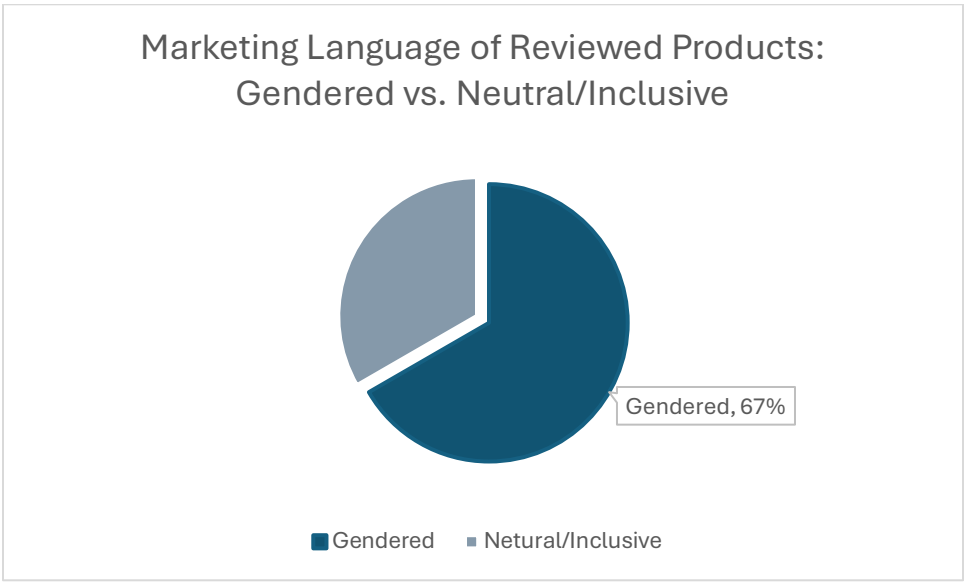

Figure B – Marketing Language of Reviewed Products: Gendered vs. Neutral/Inclusive (Note: Sample size is small.)

4 CONSUMER RELATED RESEARCH

The team's consumer-related research draws on both online product critiques directly by the team. Broader consumer perspectives have not yet been collected and will be incorporated through planned surveys and interviews. For example, the Butterfly EduFields Girls Mini Engineering Kit offered topical variety but was criticized for confusing instructions and stereotyped schematics such as hair dryers or vacuums. The WhalesBot B3 Pro introduced novel screen-free coding with pens and cards, though its premium price raised concerns especially with its perceived inadequacy in teaching core coding skills. One of coding's biggest strengths is persistence and the ability to build and save immutable logic over time, whereas this product required the child to manually perform one action at a time with the pen and cards for each run, offering no option to store or reuse logic. The Rurvale Magnetic Tiles set, marketed as "Toddler Girl Toys", was praised for affordability during sales but limited in piece count and depth of STEM content beyond early spatial play. Collectively, these cases illustrate how price, branding, and instructional clarity interact to shape parent and child experiences.

Parents remain the primary purchasers and decision-makers, and the team's consumer pool reflects this, including women in engineering, parents and guardians, and individuals with sisters who provide insight into both buyer behavior and user identity. Planned surveys and interviews will measure purchase frequency, the relative importance of features such as durability and learning outcomes, and reactions to packaging language.

5 VALIDATION OF PROBLEM

The validation of the problem rests on three dimensions: educational, technical, and economic. From an educational perspective, peer-reviewed commentary highlights that authentic inquiry requires prediction, data collection, and evidence-based conclusions, all of which are frequently absent from craft-style activities. The proposed kit therefore emphasizes NGSS-aligned practices, note booking, and repeatable experiments to encourage transferable skills. From a technical perspective, documented critiques involve unclear instructions, limited and shallow mechanics without progressive extensions. These issues demonstrate opportunities for clearer affordances, higher quality tolerances, and modular challenge paths that keep leaners engaged over time. Finally, from an economic perspective, the team noted that STEM toys in this category often vary by as much as six to seven times in price and sometimes impose additional consumable costs, producing uneven value propositions for families. A reusable, engaging, and transparently scaffolded kit could address these gaps by offering parents confidence in both learning outcomes and long-term value.

6 SCHOLARLY ARTICLES

Sack, J. D. (2022). *Yellow Scope Science Kits for Girls*. *The American Biology Teacher, 84(2),* 115.

Summary: Promotes kits that promote authentic inquiry (prediction, data collection, conclusions) versus craft-like activities. https://doi.org/10.1525/abt.2022.84.2.115

Critique: Strong construct alignment but limited longitudinal evidence for identity/persistence.
Design implications: Include inquiry notebooks, measurable outcomes, and repeatable experiment cycles.

Coyle, E. F., & Liben, L.S. (2018). *Gendered packaging of STEM toy influences children's play, mechanical learning, and mothers' play guidance. Child Development, 91(1),* 43-62.

Summary: With 61 mother-child dyads (mean age ~5), identical mechanical toys packaged "for girls" vs. "for boys" produced different learning and caregiver mediation patterns.
Critique: Excellent internal validity; generalization beyond the studied narrative/brand context requires caution.
Design implications: Use more gender-neutral, mechanics-forward packaging and concise build prompts to support exploration across diverse audiences.

Alexandre, S., Xu, Y. Washington-Nortey, M., & Chen, C. (2022) *Informal STEM Learning for Young Children: A Systematic Literature Review. International Journal of Environmental Research and Public Health, 19(14),* 8299.

Summary: PRISMA review (36 studies, ages ~3-14) identifies caregiver involvement and facilitation quality as consistent levers for engagement; notes gap for dual-language learners.
Critique: Heterogeneous instruments limit meta-analytic synthesis; early-childhood subgroup evidence is thinner.
Design implications: Provide co-play scaffolds (brief caregiver prompts, observation checklists, optional challenge cards) and language-inclusive materials; include low-cost take-home extensions.

7 EXPERTS, CONSULTANTS, AND CONSUMERS

The team's rationale for finding experts was to pair child-development researchers with a practicing elementary teacher to blend research-based guidance and pragmatic classroom constraints.

Please note that these are prospective experts; not all have yet confirmed support. The list represents a wish list of individuals the team intends to reach out to.)

- Catherine Lussier, Ph.D – Professor of Child Development, University of California, Riverside.
- Nancy Dayne, Ed.D – Professor of Child Development, California State University, Long Beach.
- Grace Paradis, Ph.D – Professor of Child Development, California State University, Stanislaus.
- Victoria Cortez, Ph.D – Professor of Child Development, California State University, Stanislaus.
- S. Pfeiffer – Elementary School Teacher, Riverside Unified School District.

For consumers, the pool is predominantly women in engineering, parents/guardians, and individuals with sisters, with parents as the primary purchasers. The team will reach out and

synthesize their feedback on price/value, durability, instructional clarity, and reactions to packaging/branding once interviews and surveys are conducted.

8 Conclusion

Evidence from market scans, patents, and scholarly literature converge on a solvable problem: many offerings labeled for girls underdeliver on authentic STEM engagement and return unequal value. The team's design response prioritizes NGSS-aligned inquiry, neutral and mechanics-forward packaging, modular challenge progressions, and caregiver co-play scaffolds to incentivize persistence. Expert consultation will bridge research and classroom practice, while parent-focused consumer feedback will align features with purchasing criteria. By addressing teaching methods, usability, and economics together, the proposed construction kit is positioned to close a documented engagement gap and deliver durable learning value.

9 Citations

Adafruit. (n.d.). GoldieBlox and the Movie Machine. https://www.adafruit.com/product/2408?srsltid=AfmBOop7L0GtYrN91J1gK0pzH_Vn40pmbQLOHsbpc06cXV4FHAYU2mak

Deng, S. (2019). Multi-dimensional building block toy component and set (U.S. Patent No. US11273386B2). U.S. Patent and Trademark Office.

Educational Insights. (n.d.). Nancy B's Science Club® Microscope & Activity Journal. https://www.educationalinsights.com/item-nancy-b-s-science-club-microscope-activity-journal

GoldieBlox. (n.d.). Official GoldieBlox site. https://goldieblox.com/?srsltid=AfmBOopyzI6KcFW9_X7XkMJZJOfY_560bxnu6o6whC1-sPdk-DQ0caPl

Jichi, H. (2016). Themed building toy (U.S. Patent Application No. US20170144081A1). U.S. Patent and Trademark Office.

Michaels Stores. (n.d.). Yellow Scope Foundation Chemistry Kit: Beakers & Bubbles. https://www.michaels.com/product/yellow-scope-foundation-chemistry-kit-for-kids-beakers-and-bubbles-stem-ki t-for-girls-and-boys-educational-fun-holiday-gift-for-ages-812-356730479353282578

Sack, J. D. (2022). Yellow Scope Science Kits for Girls. The American Biology Teacher, 84(2), 115. https://doi.org/10.1525/abt.2022.84.2.115

School Specialty. (n.d.). Nancy B's Microscope & Activity Journal. https://www.schoolspecialty.com/nancy-bs-educational-insights-nancy-bs-microscope-activity-journal-1490529?srsltid=AfmBOooEM1AYWjJRIFUv_zYbALP-IipyF-qObu84bMNto0hSNgw5Poel

Brinkley, C. (1989). Educational toy for teaching construction and recognition of predetermined forms (U.S. Patent No. US4998883A). U.S. Patent and Trademark Office.

Amazon product pages summarized in the team's critique sheet (Butterfly EduFields; WhalesBot B3 Pro; Rurvale Magnetic Tiles).

Coyle, E. F., & Liben, L. S. (2020). Gendered packaging of a STEM toy influences children's play, mechanical learning, and mothers' play guidance. Child Development, 91(1), 43–62. https://doi.org/10.1111/cdev.13139

Alexandre, S., Xu, Y., Washington-Nortey, M., & Chen, C. (2022). Informal STEM learning for young children: A systematic literature review. International Journal of Environmental Research and Public Health, 19(14), 8299. https://doi.org/10.3390/ijerph19148299