Using Tinkercad in Middle School Mathematics and Science Classrooms

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Abstract: Interdisciplinary STEM education is a pedagogical approach that allows students to understand the interconnectedness of the disciplines of STEM. The interdisciplinary approach introduces problem-based learning, cooperative learning, expands problem-solving skills, and introduces students to the use of engineering design. Tinkercad is a visual computing tool that models mathematical and scientific concepts and support interdisciplinary STEM learning and experiences. In this session, participants will explore Tinkercad in the context of middle school curriculum. Free, accessible lessons that highlight the use of Tinkercad in the middle school classroom will be shared from our project. Participants will explore the gravity feature and ways to use this feature to explore mathematical and scientific concepts.

Keywords: visual computing, middle school, STEM, interdisciplinary learning

Teaching Science, Technology, Engineering, and Mathematics (STEM) in middle school classrooms is a critical task that can shape students' academic and career trajectories. STEM education at this level provides opportunities for students to delve deeper into these subjects and explore STEM ideas (Kloser et al., 2018; Kurz et al., 2024). Hands-on learning activities that are engaging and designed to use tools can support STEM learning and interdisciplinary experiences (Kennedy & Odell, 2014).

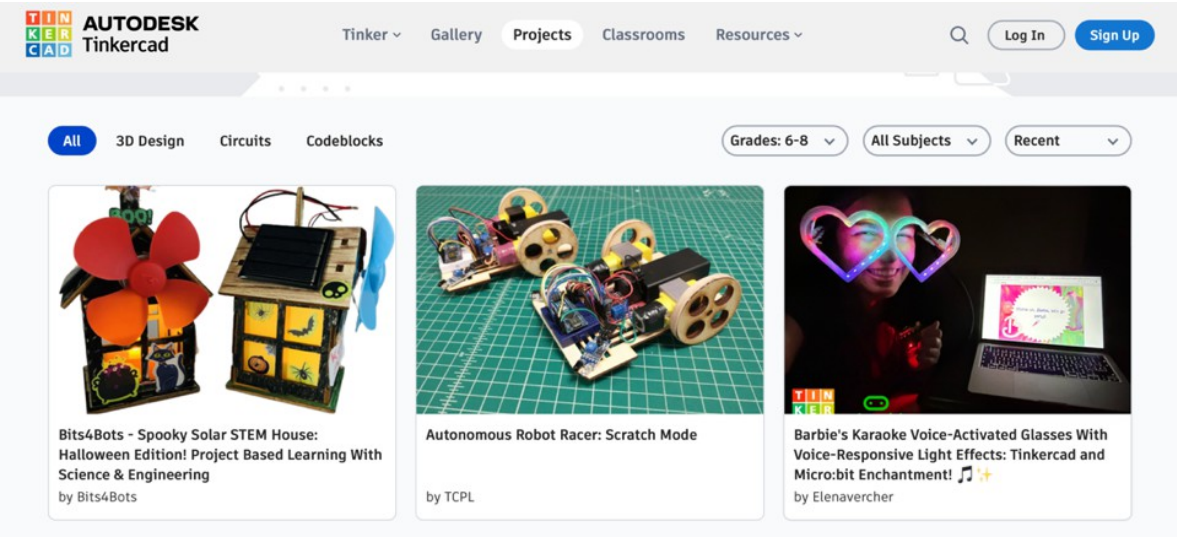
Interdisciplinary STEM education is a pedagogical approach that allows students to understand the interconnectedness of the disciplines of STEM (Daugherty & Carter, 2018) The interdisciplinary approach introduces problem-based learning, cooperative learning, expands problem-solving capabilities, and introduces students to the use of engineering design. Interdisciplinary learning changes the dynamic by placing students in a much more active role. It allows students to incorporate their unique subject-area strengths in multiple projects, places learning in a broad context that's relevant to students' lives, and encourages students to make connections across wide areas of learning. This can lead to more personal, relevant, and memorable learning experiences for both students and teachers (Gao et al., 2020).

Tinkercad Overview

Tinkercad (www.tinkercad.com) is a graphics interface that focuses on the use of three-dimensional shapes and simulations. Concepts of geometry, engineering, coding, mathematics and more can be easily explored using this free tool (Diaz et al., 2019). Mazes, dominos, roller coasters, circuits, code blocks and other features can be used to explore STEM concepts. Templates are provided, but students can also build their own creations, see Figure 1.

Figure 1

Tinkercad Lesson Features



A Tinkercad Lesson

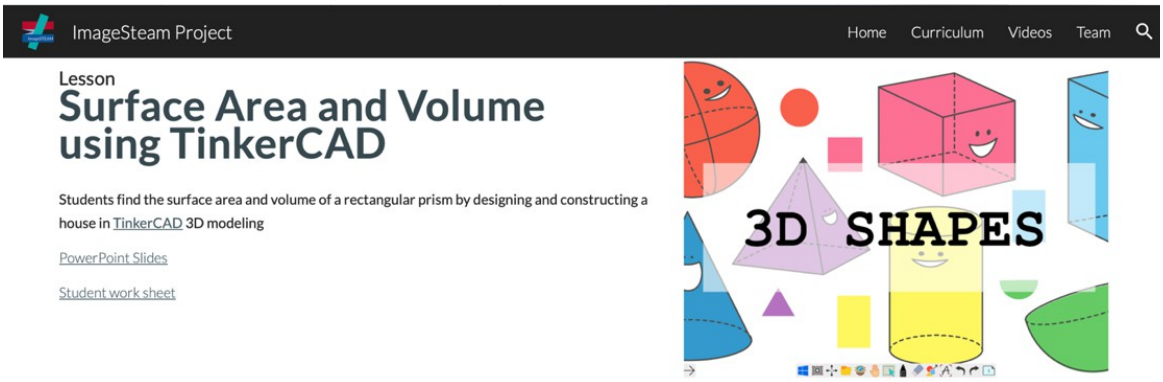
Using the three-dimensional modeling program Tinkercad, students can design a sturdy table with two tiers that is made from at least four different three-dimensional shapes (cylinder, cone, rectangular prism, hexagonal pyramid and so on). The table must be able to withstand a large metal sphere being dropped on it. After the table is built, using the "Gravity" feature in Tinkercad, drop the large metal sphere on the table, see Kurz et al., 2025. If your table did not survive the drop, iteratively redesign your table to produce a successful model. What shapes features are most advantageous for the table top? What shape features are most advantageous for the legs? What is the impact of the height of the legs? Are right or oblique three-dimensional

shapes better? Why? The tool can be used to support the engineering design process. Likely, multiple iterations of the table will need to be created or adjusted to withstand the drop of the large metal sphere. Students will work in small groups to problem-solve and to plan, construct, test, evaluate, and improve their visual computing model attending to the affordances and constraints of the three-dimensional shapes' features. This lesson aligns with standards: 7.G.B.6 Solve real-world and mathematical problems involving area, volume, and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms. MS-ETS1-3 Engineering Design: Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

Some of the lessons and supportive videos regarding the use of Tinkercad are available at the following address https://www.imagesteam.org as open-source curriculum for other teachers to utilize in their classrooms (Jayasuriya et al., 2024). There are lessons, guides and explanations that can be used to support teachers as they learn to use this tool. Figure 2 is a screenshot of one of the lessons on the website that uses Tinkercad.

Figure 2

Mathematics-based Tinkercad Lesson



Conclusion

Tinkercad can be used in the middle school STEM classroom in an extremely versatile computing tool that can support a plethora of lessons. In addition to the three-dimensional example provided here, it can also other STEM concepts. Students can use Tinkercad to create prototypes of their designs, such as simple machines, structures, or robotics. They can iterate and make modifications to their designs based on the feedback received, encouraging the engineering design process. Tinkercad also offers features like Arduino simulation, where students can learn and practice coding by controlling virtual electronic components (Juanda et al., 2021). They can create circuits and program them to perform specific tasks, such as turning on an LED or controlling a motor. Finally, Tinkercad can be integrated into various STEM projects. For example, students can create 3D-printable models of cells for a biology project, design and simulate electronic circuits for a physics experiment, or construct geometric shapes for a math exploration. Tinkercad can provide middle school students with a user-friendly platform to explore and apply various STEM concepts, fostering creativity, problem-solving skills, and a deeper understanding of science, technology, engineering, and mathematics.

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References

Daugherty, M. K., & Carter, V. (2018). The nature of interdisciplinary STEM education. *Handbook of technology education*, 159-171.

Díaz, L. M., Hernández, C. M., Ortiz, A. V., & Gaytán-Lugo, L. S. (2019, October). Tinkercad and Codeblocks in a summer course: An attempt to explain observed engagement and enthusiasm. In *2019 IEEE Blocks and Beyond Workshop (B&B)* (pp. 43-47). IEEE.

Gao, X., Li, P., Shen, J., & Sun, H. (2020). Reviewing assessment of student learning in interdisciplinary STEM education. *International Journal of STEM Education*, *7*(1), 1-14.

Jayasuriya, S., Swisher, K., Rego, J. D., Chandran, S., Mativo, J., Kurz, T., Collins, C. E., Robinson, D. T., & Pidaparti, R. (2024). ImageSTEAM: Teacher Professional Development for Integrating Visual Computing into Middle School Lessons. *Proceedings of the AAAI Conference on Artificial Intelligence*, *38*(21), 23101-23109. https://doi.org/10.1609/aaai.v38i21.30355

Juanda, E. A., & Khairullah, F. (2021, February). Tinkercad Application Software to Optimize Teaching and Learning Process in Electronics and Microprocessors Subject. In *6th UPI International Conference on TVET 2020 (TVET 2020)* (pp. 124-128). Atlantis Press.

Kennedy, T. J., & Odell, M. R. (2014). Engaging students in STEM education. *Science education international*, *25*(3), 246-258.

Kloser, M., Wilsey, M., Twohy, K. E., Immonen, A. D., & Navotas, A. C. (2018). "We do STEM": Unsettled conceptions of STEM education in middle school STEM classrooms. *School Science and* Mathematics, 118(8), 335-347.

Kurz, T., Jayasuriya, S., Swisher, K., Mativo, J., Pidaparti, R. & Robinson, D.T. (2024). The impact of teachable machine on middle school teachers' perceptions of science lessons after professional development. *Education Sciences 14,* (417), 1-17. Available: https://www.mdpi.com/2227-7102/14/4/417

Kurz, T.L., Kurban, F., Jayasuriya, S. & Swisher, K. (2025). Exploring the Intersection of Engineering and Technology: Tinkercad in the Middle School Classroom. *Technology and Engineering Education, 2*(3), 25-29.