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Designing a children's recreation room

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Project-based learning (PBL) is an effective approach to STEM education because it allows students to experience scientific inquiry by using their knowledge and skills in science, technology, engineering, and mathematics to solve realistic problems (Krajcik and Blumenfeld 2006; Lee 2014). PBL consists of four components:

1. Posing and comprehending a driving question
2. Exploring the driving question to suggest a solution
3. Creating final products
4. Presenting these products to class or community members and evaluating them

This article follows the sequence of these four components to describe the major elements of a project-based unit designed to support STEM education in upper elementary school (grades 5 and 6). These include ways of posing a driving question at the beginning stage of the project, strategies for facilitating students' problem solving during the project, and guidelines for helping them create and share their final products at the end of the project.

Posing and comprehending a driving question

To motivate children, create a convincing problem-solving situation in which they can feel involved. To present a driving question realistically, a community partner or someone playing this role can be enlisted to act as a client asking for help with an authentic problem (Markham, Larmer, and Ravitz 2003). An alternative would be to show a video of a client asking for such help. If neither option is possible, the teacher can create the scenario and present it in the role of a client. In the scenario described here, the client is consulting a team of interior designers to develop plans for a children's recreation room with certain specifications. At the end of the presentation, the following problem was explicitly stated:

> How can you, as interior designers, provide suggestions for designing a children's recreation room which is soundproofed, includes facilities that children like, and does not exceed a budget of $7,000?

Students were grouped into design teams of three to five members, and each team was

required to provide three final products:

1. A written document describing how to design, furnish, and decorate the room
2. A three-dimensional online design sketch of the room, incorporating the client's specifications using an app such as Planner 5D on the iPad®
3. A poster to show their inquiry process

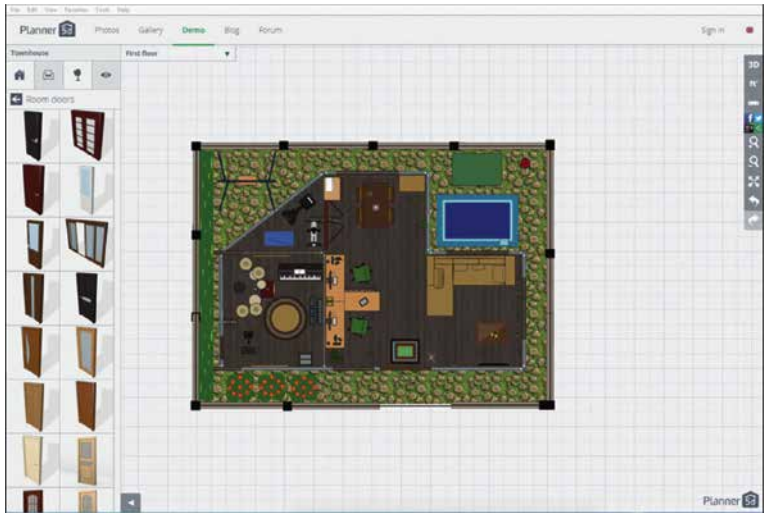
The Planner 5D is a browser-based tool for creating floor plans and interior design. It can be downloaded from https://planner5d.com/. Most of the basic functions are free, but some premium functions may be purchased. The basic Planner 5D is divided into three sections:

1. Rooms
2. Interior, including furniture and electronics
3. Exterior, including garage, plants, and a pool

Using this tool, students can easily map out their floor plan; assign labels to rooms; and fill spaces with furniture, color, and different materials.

FIGURE 1

This example of a student-designed, furnished children's recreation room was done collaboratively with the Planner 5D online tool.



Exploring the driving question with STEM knowledge

To address the driving question, students in each group first cooperated to assign responsibility for various tasks, including conducting an online survey among students at their school to determine the most popular facilities for a children's recreation room and using the Internet to research appropriate materials and costs for selected items and materials. Then group members designed a room using Planner 5D (see **fig. 1**), resulting in a product showing the room and how they would furnish it.

While solving the given problem, students measured the width and height of the walls to determine the amount of paint or wallpaper needed to decorate the walls, calculated the floor area for accommodation of furniture and equipment, used addition and multiplication to calculate costs, and analyzed the online survey data. Through these activities, they dealt with content standards covered in the Common Core State Standards for Mathematics (CCSSM) (CCSSI 2010), in particular, 5.MD.1,

TABLE 1

After deciding on choices to include, students created survey items using a five-option Likert scale.

Electronic drum	Extremely dislike	Dislike	Undecided	Like	Extremely like
PlayStation	Extremely dislike	Dislike	Undecided	Like	Extremely like
Online games	Extremely dislike	Dislike	Undecided	Like	Extremely like
Children's books	Extremely dislike	Dislike	Undecided	Like	Extremely like

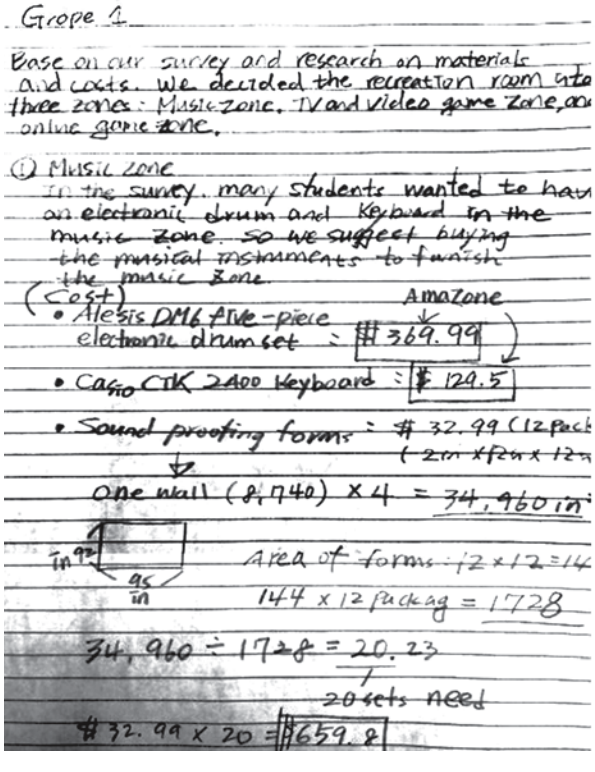
6.G.1, and 6.SP.5. Students also explored science and engineering to investigate appropriate materials for soundproofing and to apply principles of design. For further information on room design, some students contacted experts, such as architects and interior designers.

Moreover, in the process of finding a solution to the problem, students used technology to collect information, analyze data, and display final products. According to CCSSM, using appropriate technological tools strategically to achieve their goals, such as finding appropriate Internet sources or using software, is important for students. In this project, technology is used in three ways, depending on students' strategic needs. First, to survey children's preferences for furniture, materials, and equipment, students used an online survey tool, such as Survey Monkey (https://www.surveymonkey.com/). To create their survey instrument, group members first brainstormed possible items for the recreation room and developed a set of several items they believed would excite the most interest. Here it was important to encourage students to consider not only their own opinions but also the preferences of other students. After deciding on choices to include, students then created survey items using a five-option Likert scale ranging from *extremely dislike* to *extremely like* (see **table 1**). This part of the project provides opportunities for teaching statistical operations, particularly sampling and surveying. For example, teachers can first allow students to consult online survey tools

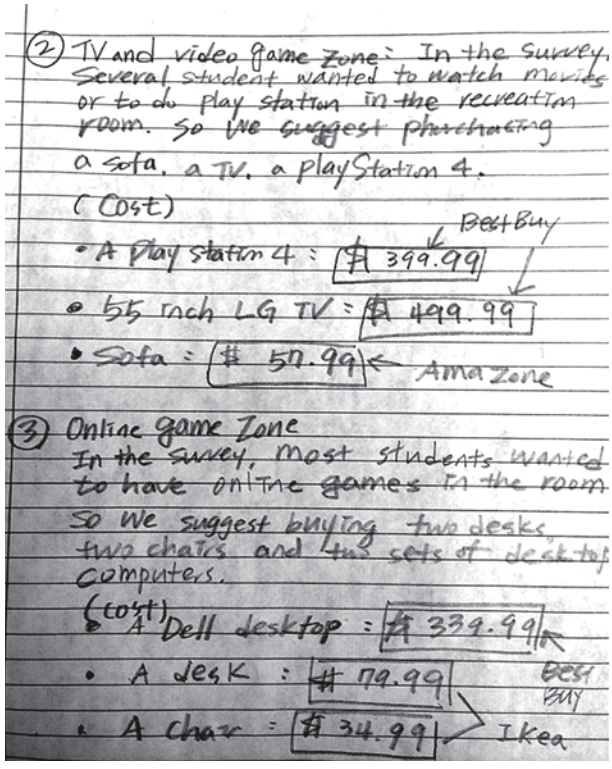
FIGURE 2

Students in each group used the app to create a room design, then wrote a document explaining how to design and furnish a children's recreation room, including the cost estimate.

(a) To report findings, each group prepared a poster, which members presented to the class, teachers, and the community members who had posed the driving question.



(b) After their presentation, students received feedback from the audience in terms of the five PBL criteria.



to select types of questions—such as multiple choice, comment box, ranking, or individual rating scale—and then encourage them to discuss the strengths and weaknesses of the different types of survey items (Francis et al. 2014). The following example shows a survey instrument for which the selected objects are an electronic drum, a PlayStation, online games, and children's books (see **table 1**). When they have administered the survey, they can discuss rate of return and whether the sample they have obtained is representative of the whole population.

Second, to design the room, students used the online design tool to click, drag, and drop, and they easily created professional-looking, detailed floor plans as well as vivid interior designs without needing exceptional skills. Using simple settings with many options, they also could experiment with materials, colors, and arrangements of furniture and other items selected from catalogs to determine their final design. In 3D mode, they were able to get a view of the room from any angle.

Third, they used the Microsoft Excel® program to organize and display their data, which enabled them to easily calculate the money they spent for different components. Also through the program, students were able to explore the most appropriate display options, such as tables and graphs, to effectively show how funds were allocated for different components of the recreation room. In this way, they could manage a finite budget.

TABLE 2

Below is a suggested timeframe for implementing the unit.

PBL phase	Relevant activities	Expected time
1. Posing and comprehending a driving question	A. Provide a driving question by enlisting a community partner, showing a video, or creating the scenario and presenting it.	Day 1 (15 min.)
2. Exploring the driving question	B. Form design teams of 3–5 members. C. Let groups create lists of what they need to do and assign responsibility for various tasks to specific members. D. Explain how to use Survey Monkey. E. Let students work on their assigned responsibilities. • Create and conduct an online survey. • Research appropriate remodeling materials. • Using the Internet or print catalogs, research costs for items selected on the basis of the survey. F. Explain how to use the Planner 5D and let students explore it. G. Let students design a children's recreation room using the Planner 5D based on the collected information.	Day 1 (10 min.) Day 1 (15 min.) Day 2 (40 min.) Days 3–5 (120 min.) Day 6 (40 min.) Days 7–8 (80 min.)
3. Creating final products	H. Ask students to prepare three final products: • A 3D online design sketch of the room • A written document describing their design • A poster to show their inquiry process	Day 9 (40 min.)
4. Presenting final products and evaluating them	I. Let students present their final work and obtain feedback from the audience using five PBL criteria.	Day 10 (40 min.)

Creating, presenting, and evaluating final products

On the basis of their survey results, research, and a group journal they had kept to document the progress of their explorations, students in each group created a room design using the app and a written document (see **fig. 2**). To report their findings, each group prepared a poster, and together, the members presented what they found to the class, teachers, and the community members who had posed the driving question. In the presentation, students described their inquiry process and the supporting rationale for their design and budgetary decisions. The goal of the presentation was for students to assume the role of an interior design team presenting its design proposal to a prospective client, thus emulating a real-world situation. After their presentation, students received audience feedback in terms of the five PBL criteria (compare Markham, Larmer, and Ravitz 2003):

1. Impact of performance
2. Work quality and craftsmanship
3. Adequacy of methods and behaviors
4. Validity of content
5. Sophistication of knowledge employed

Timeframe

Because of the complexity of the project, allow a period of at least two weeks (assuming a math class schedule of about 40 minutes for five days) to implement this unit (see **table 2**).

Authentic project-based learning

To summarize, through this project-based unit, students engaged in all STEM fields by doing research and finding solutions to a real-world problem as an interior designer team. That is, students had opportunities to employ technology tools to conduct a survey, gather needed information, and design a recreation room, which aligns with the CCSSM emphasis on using appropriate technology tools according to their needs and goals. In this process, they also learned about the scientific characteristics of materials. In addition, students had the learning experience of applying design principles to planning the layout and décor of the room and the arrangements of items within it. Finally, they used mathematical knowledge to measure area and perimeter, analyze the collected data by summarizing numerical data sets in relation to their context, calculate materials needed, and budget funds. In particular, this mathematical knowledge about measurement of area and perimeter (content standards 5.MD.1 and 6.G.1) and statistics (6.SP.5) are directly related to CCSSM goals for mathematics learning (CCSSI 2010). Such hands-on involvement in authentic project-based learning can integrate students' STEM experience and help them develop a conceptual understanding of how the components are interrelated.

REFERENCES

Common Core State Standards Initiative (CCSSI). 2010. Common Core State Standards for Mathematics (CCSSM). Washington, DC: National Governors Association Center for Best Practices and the Council of Chief State School Officers. http://www.corestandards.org/wp-content/uploads/Math_Standards.pdf

Francis, Dionne Cross, Rick Hudson, Mi Yeon Lee, Lauren Rapacki, and Crystal Vesperman. 2014. "Motivating Play Using Statistical Reasoning." *Teaching Children Mathematics* 21 (November): 229–37.

Krajcik, Joe, and Phyllis Blumenfeld. "Project-Based Learning." 2006. In *The Cambridge Handbook of the Learning Sciences*, edited by R. K. Sawyer, pp. 317–34. New York: Cambridge University Press.

Lee, Mi Yeon. 2014. "Tinkering with Buoyancy." *Teaching Children Mathematics* 20 (May): 574–78.

Markham, Thom, John Larmer, and Jason Ravitz. 2003. *Project-Based Learning Handbook: A Guide to Standards-Focused Project-Based Learning*. 2nd ed. Novato, CA: Buck Institute for Education.

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