Figure 1: https://www.cbc.ca/news/canada/hamilton/playgrounds-covid-kids-1.5644817

Healthy Kids Primary School
COVID-safe Playground

Group #9
Engineering 1030
Section 003
Dr Suzanne Hurley
Memorial University of Newfoundland
October 30, 2020

Aabir Basu 202021630
Anna Behm 202005872
Claudia Matchem 201944121

Summary

Nearly every playground worldwide was forced to shut down due to the outbreak of the COVID-19 pandemic simply because it would be impossible to maintain governmental and medical guidelines on existing play structures. After what must have been a very boring hiatus from playing outdoors, schools have finally begun looking for options to allow their students to engage in much-needed exercise during these unprecedented times. The designs in the following report are the design group's attempt at a completely socially distanced, easy to clean, pandemic-safe playground.

Thorough analyses of how existing playground structures are not feasible to use today were essential in generating questions about features that a new play structure would require. Answers to these questions called for some out of the box, unorthodox thinking, which led to a very fitting novel answer to a novel question.

It was decided that hand sanitizing stations, signage outlining the dangers of the virus, socially distanced waiting and post-play areas, and regular staff cleaning would be the best course of action. Apart from these provisions, the group has also made every effort to ensure that the play equipment is not only safe to use and easy to maintain but also cost-competitive with other equipment on the market.

Through analysis of existing designs and the creation and examination of a morphological chart and evaluation matrices, a conceivable design concept was created. In the end, a play structure with two components was agreed upon: a miniature soccer golf course and a game where students must jump between rubber-surfaced mushrooms to get

across the path. A survey was also created to gauge an understanding of how the clientele might react.

The team's goal along every step of the design process was to come up with a safe set of materials to use in the play structure that could also be acquired at reasonable rates, to end up with a reasonable expense report. The total cost of the play structure's materials was estimated to be around $6000 (CAD), which is valued reasonably closely with any pre-pandemic structures and will undoubtedly be amongst the best values for socially distanced play structures.

Overall, refinement should be made near the end of the design process in order to adhere to feedback and ensure the client's satisfaction. Analyzing specific feedback from the open blank survey questions would help the team to satisfy specific suggestions and to refine the design accordingly. Physical testing would begin once feedback has been utilized and the design is fit for the clients. Testing the structure may be achieved using multiple sample groups in order to gather accurate feedback. After this stage is completed, the design will be ready for construction.

Table of Contents

List of Figures

List of Tables

1 Introduction and Problem Definition

At Healthy Kids Primary School (HKPS) parents and teachers have a philosophy that exercise is the best practice for encouraging healthy habits and optimum learning in the classroom. However, COVID-19 has really thrown them a curve ball; right now all HKPS play structures must be closed as there is no way teachers can enforce safety guidelines for COVID-19. The principal of HKPS needs help in the implementation of this new playground equipment.

Despite current playground structures being equipped to provide kids with exercise while having fun, staying safe from physical injury, building social skills, maintaining mental health, and developing a connection with nature early on in life, current equipment does not allow for social distancing to be maintained and school staff would struggle to keep all contact surfaces sanitised. As per the World Health Organization's (WHO) recommendations, social distancing guidelines are essential in reducing the spread of COVID-19. The same must be implemented throughout playgrounds in order to ensure the safety of children and their families.

All current outdoor play structures are closed due to the inability to enforce COVID-19 restrictions, which leads to inadequate physical activity for students. A new outdoor play structure that will meet current health regulations must be designed. It should allow for only one child to use at a time, enforce social distancing without staff intervention, and be easy for staff to disinfect. The play structure should, at a minimum, meet the COVID-19 regulations for playgrounds and schools outlined by the Government of Newfoundland and Labrador as well as the WHO.

2 Background Research

Where can the structure be built?

In order for HKPS to legally construct a playground structure, it must be located on pre-existing land owned by them. If this is unavailable, the school must acquire new open-to-air land with flat topography to be in accordance with provincial rules.

What health guidelines must the structure adhere to?

Current research on the possibility of socially distanced play equipment has advanced well. Some essential features for such equipment that have been agreed upon by the vast majority of those familiar with the situation, include the minimization of contact surfaces and socially distanced pre and post play areas. Hand sanitizing stations, as well as signage outlining the risks of COVID-19, are essential to ensure that the students are aware of the situation and take the utmost caution to the best of their ability.

What other conditions must be considered?

It must be remembered that students with physical disabilities will also use the playground facility. In order to accommodate them, it is necessary to provide entry-ways and exits suitable for as many of these students as possible. A school-wide survey of the extent and specifications of mobility challenges faced by these students will be helpful in determining the best form of provisions on the equipment. In addition, seeing as the target user for this equipment is children 6-7 years of age, sharp surfaces or unreasonably high ledges will be unacceptable.

Previous designs

Current playground structures on the market have an unideal area of contact surface. A new concept for playground equipment must be generated such that contact surface is at a minimum while providing an equal amount of enjoyment. However, it must be noted that the HKPS authorities will not consider an equipment that costs significantly more than others of the same provisions already on the market.

Figure 2: Caroline Elementary School Playground, used simultaneously by a surplus of children with a great deal of contact surface. https://www.pinterest.ca/pin/357051076684031529/

3 Requirements

Functions: what the structure must do in order to work.

- Provide a continuous form of fun exercise, taking between 40 seconds and one minute to complete.
- Enforce social distancing without any school staff intervention, both while waiting to play on the structure and while exiting the structure.

Objectives: the structure should be…

- Easy to use
    - Allow for one child to use at any one time.
    - Appropriate for children aged 6-7 years.
    - Safe to use, lacking in high ledges (greater than one foot) and sharp edges.
- Cost competitive
    - Impose minimal cost for HKPS authorities.
    - Priced competitively with similar playground structures on the market, less than $10 000.
- Durable
    - Ideal design and material for resisting harsh winter conditions.
    - Withstand an average low of -10℃, an average rainfall of 119 cm per year, and an average snowfall of 322 cm per year.
- Easy to maintain
    - Standard structure aspects, no custom-ordered parts.
    - Simple cleaning procedure easily kept by school staff.

Constraints: the structure must…

- Contain minimal contact surface which can be cleaned easily and quickly by school staff.
- At a minimum, meet NL governmental COVID-19 regulations for playgrounds and schools.

4 Ideation

4.1 Concept Generation

Though the idea of a one-person, almost contactless, fun structure for children sounds very difficult to imagine, there are plenty of ideas that meet all of these criteria. However one must first think like the clients, in this case like children, to achieve the idea that would be most popular among the users. Such popular ideas include an obstacle course, a maze, and a miniature soccer course. All of these activities could be run as a relay race to ensure only one child goes at a time, and to create an aspect of friendly competition which makes it more enjoyable for the students. While students are waiting for their turn to try the fun activity, other short games could be played, including hopscotch, walking across low to the ground balance beams, or jumping from 'mushroom' to 'mushroom', to quickly cross the 'poisonous' ground. These games can be used to keep distance between the students before and after the main attraction. Furthermore, 'Zorb balls' (a transparent plastic orb worn by a person) could be worn by the students to ensure the mandatory 6 feet distance is kept at all times. A depiction of a potential obstacle course would include activities that would not need the use of the childrens' hands, as seen in Figure 3.

Figure 3: https://kiddo.edu.au/activities/obstacle-course-striking

A maze would be an enjoyable way to expand on the child's awareness of their surroundings,

and it can be made quickly with simple materials. A math maze would also give the children the opportunity to practice the topics learned in the classroom in an enjoyable, hands-on way. A soccer mini-golf course would bring the best of both worlds. It would aid the expansion of the child's kinesthetic senses, as well as be able to construct quickly and cost-efficiently. Since each child would be playing in their own section, they cannot progress on to the next until the student in front of them has finished. This allows them to stay in their bubbles and not come into contact with each other. Hopscotch would also allow the children to practice counting, and be a quick game to get the children started in the obstacle course. Furthermore, the rubber mushrooms would be another effective method that keeps the six-feet distance between the students, while exercising their imagination and their muscles. In addition, a balance beam would be similar to the rubber mushrooms, as it would aid the development of balance and creativity. Lastly, 'Zorb balls' used to ensure distance could also be used, however, it would involve much more cleaning than other options and more potential for children to fall and harm themselves. In circumstances such as COVID-19, many conventional ideas must be disregarded so that innovative, creative ideas may be thought of and researched to the fullest extent. While it is imperative that the least amount of areas are touched, this does not mean that it will contain the least amount of fun for its users. This is why one must reach their inner child to understand the problem, and how to be able to bring out happiness in their users.

4.2 Brainstorming

Despite the fact that brainstorming as a team has been made unusually difficult by the fact that members are unable to physically meet each other to communicate and discuss their ideas with one another, the design group found alternative ways to alleviate the problems of the anchoring effect and unbalanced conversations. Some of these included:

Rapid ideation: In this technique, a set amount of time- often 2 minutes- was provided to all three group members, within which they would have to come up with as many solutions as possible to the problem being tackled. This method eliminated the possibility of members talking themselves out of sharing their ideas with the group.

Figure Storming: Since all three group members have close contact with someone in the family who is a practiced engineer, it was useful to look at problems from this person's perspective: as these are people known by group members for a very long time, it was easy for the members to ask "What would they do?" and come up with ideas that way.

Brain netting: A separate google doc file was created where any and every idea that came across the minds of group members was recorded whenever inspiration struck. After this, in consequent discussions, these ideas were followed up on to decide which ones to pursue and which ones to abandon. This method helped compensate for the remote nature of the brainstorming session and arguably turned out to be the best method of brainstorming for the group.

Starbursting: This brainstorming technique proved especially useful during the two rounds of screening. In this method, each idea is examined from six different angles: who, what, when, where, why, and how. Since this is a very vigorous method of assessing an idea's feasibility, it

helped in giving out standardized scores to the design variations.

4.3 Morph Chart

Below is a Morphological Chart created as a way of analyzing various options for the structure's features. Along the left-most column are design functions that must be determined in order to design the structure. Horizontally along rows are varying means aimed to satisfy the corresponding function. A line drawn from the top to the bottom passes through one mean per function, representing a possible design combination. This allows a decision to be made regarding the design's effectiveness in satisfying the criteria.

Table 1: **Feasibility Analysis Morphological Chart**

Morphological Chart

HKPS COVID-safe playground

FUNCTION	MEANS					
Social Distancing Perameters	Placement stickers on the ground 2m apart	Posted signage encouraging social distancing	Staggered lunches to minimize population	Zorb balls for each child to wear	-	-
Surface Material	*Pour in Place* Rubber Surfacing	Artificial Grass/Turf	Play Sand / Pea Gravel	Engineered Wood Fiber	Tiles	Concrete
Structure Material	Pressure-treated wood	Galvanized steel	Aluminum	Plastic	-	-
Number of Play Structures	1	2	3	4	5	6

2 of the many possibilites

Feasible	Staggered lunches - Rubber surfacing - Galvanized steal - 3 structures
Non-feasible	Zorb balls - Concrete - Plastic - 6 structires

4.4 Concept Sketches

Below are sketches of each of the six design concepts outlined by the team during the

concept creation process. The goal of this process was to create many feasible design options to be considered during the evaluation process, during which possible design options will be compared and examined, eliminated, and possibly combined in order to determine the greatest design. The following design sketches (Figures 4-9) were chosen to move into the evaluation phase. Fully explained concepts for all designs can be found in Appendix B.

Figure 4: This sketch was designed by group member Claudia Matchem to show each of the structures considered as part Designs A and B, which includes hopscotch, a mushroom top jumping, a math skills maze, and a miniature soccer course. Design A would include rubber flooring, while Design B would use gravel.

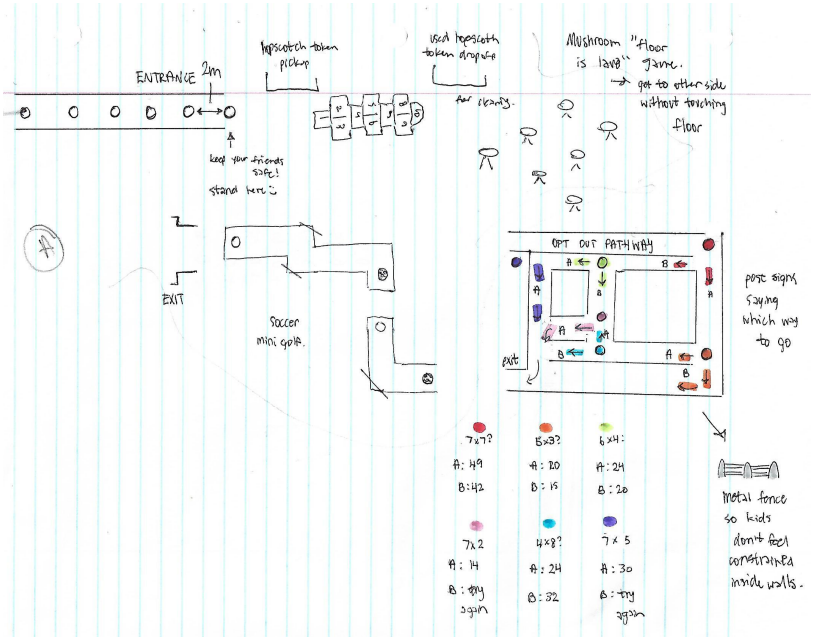


Figure 5: This sketch was designed by group member Anna Behm depicting the structures considered in concept Design C, including hopscotch and a math skills maze.

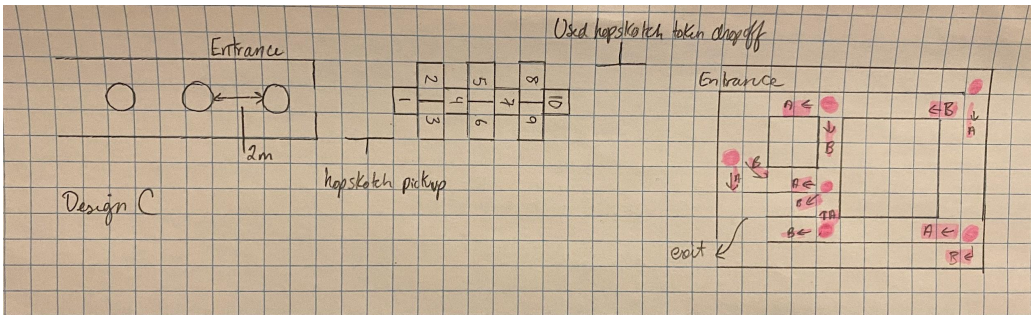


Figure 6: This sketch was designed by group member Anna Behm depicting the structures considered in concept Design C, including hopscotch and a math skills maze.

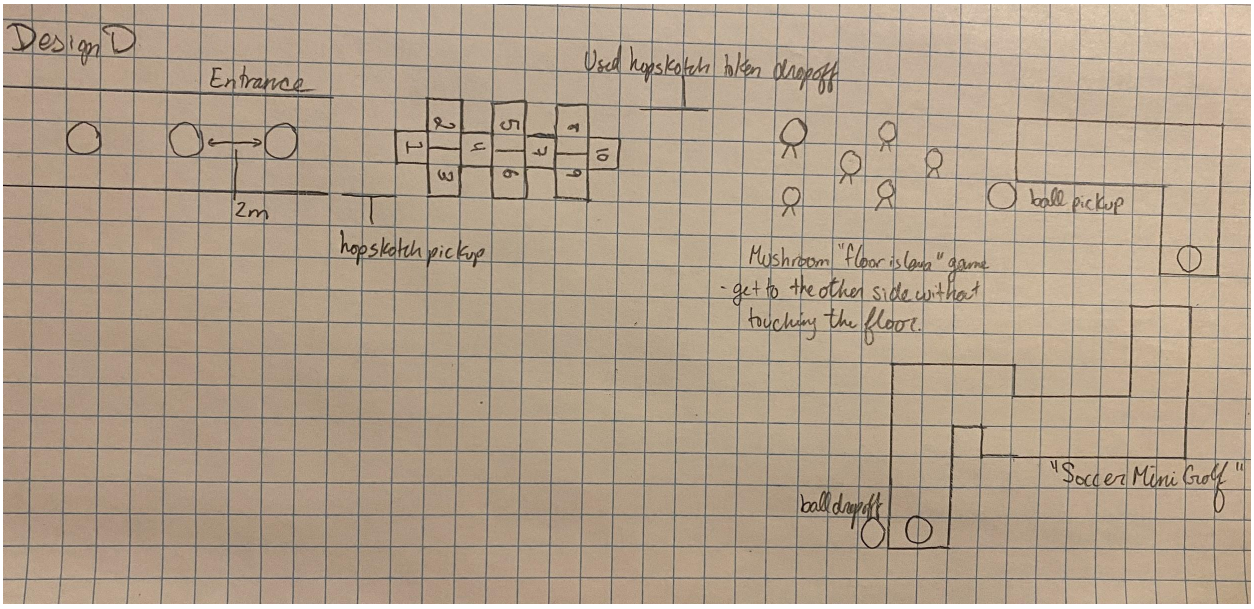


Figure 7: This sketch was designed by group member Anna Behm representing the structures as part of Design E, including hopscotch and a mushroom top jumping game.

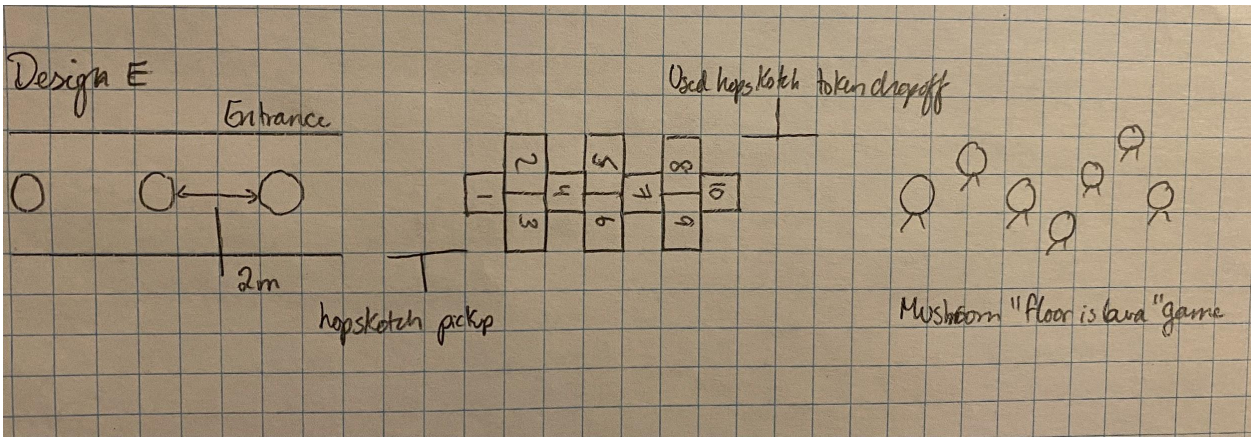


Figure 8: This sketch was designed by group member Claudia Matchem to show the structures as part of Design F, which includes a mushroom top jumping game and a miniature soccer course on a rubber flooring.

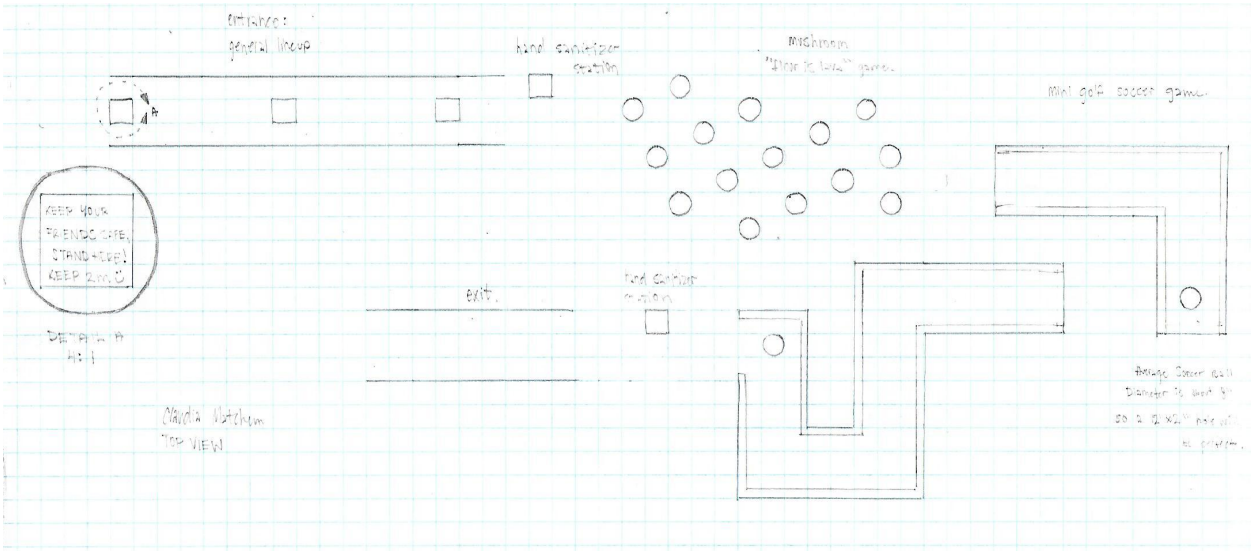
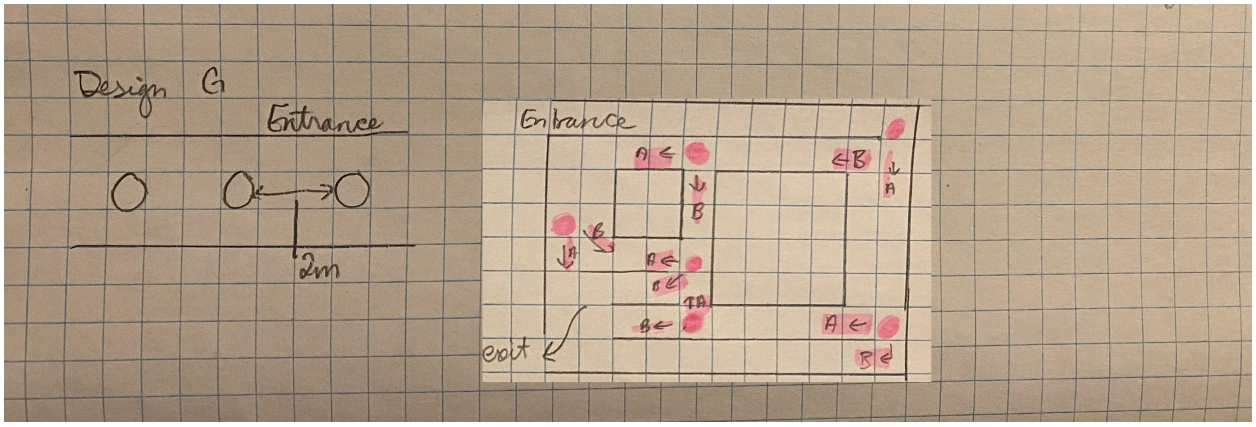


Figure 9: This sketch was designed by group member Anna Behm depicting the design concept for Design G, which consists of only the math skills maze.



5 Selection of the Best Solution

5.1 Screening Matrix

In this first matrix, the feasibility of variants of the designs were evaluated by the group using a fixed reference. This yardstick design was taken as design D. The two other designs that made it into the next stage of evaluation through the screening matrix were F and E. The designs that did not make it through the first screening were A, B, C, and G. Designs A and B were rejected in the first round since they were not easy to maintain as a result of an excess of inaccessible parts. Additionally, design A would consume a far longer period of time than 40-60 seconds to complete, as was required by the client. Design B lost out almost immediately due to the fact that the gravel flooring may not have been safest for children to use, and did not make it to the next stage of evaluation. Design C nearly made it into the next round on account of it being very similar to the reference design, but lost out as the math maze would require more work to maintain than the mushrooms and soccer golf. Design E surprisingly finished with an identical score as the reference after the first screening, since it was more cost effective as both the hopscotch and mushroom games required relatively lesser setup, but lost points as would take the youth less than 40-60 seconds to finish both the games. Design F, just like C, was evaluated very closely to the reference, and made it through to the next round as it was more cost effective simply because of a reduced number of games to be set up and designed.

Note: For a detailed description of the components of each design variation being evaluated here, please refer to Appendix B.

Table 2: **Screening Matrix**

SELECTION CRITERIA	**A**	**B**	**C**	**D (REF)**	**E**	**F**	**G**
Allows one child at a time	0	0	0	0	0	0	0
Safe to use	0	-	0	0	0	0	0
Cost effective	+	+	0	0	+	0	-
40-60 seconds	-	0	0	0	-	0	0
Durable	0	-	0	0	0	0	0
Easy to maintain	-	-	0	0	0	0	-
Easy to clean	0	-	-	0	0	+	-
Sum of +'s	1	1	0	0	1	1	0
Sum of 0's	4	2	6	7	5	6	4
Sum of -'s	2	4	1	0	1	0	3
Net Score	-1	-3	-1	0	0	1	-3
Rank	4	7	4	2	2	1	7
Continue?	No	No	No	Yes	Yes	Yes	No

Scale	
Relative Performance	*Rating*
Better than Reference	+
Same as Reference	0
Worse than Reference	-

5.2 Scoring Matrix

In the second and final round of screening, the reference design was changed from D to F, as F was the top scorer from the first matrix. Selection criteria were assigned a weight based on the importance that the feature be a part of the design. Each design was once again evaluated

by the group members and assigned a score out of 5 in each criteria. Design F was once again the top scorer by a large margin, since it did exceedingly well in nearly all of the criteria. It was the very clear winner and all members were happy to proceed with this design.

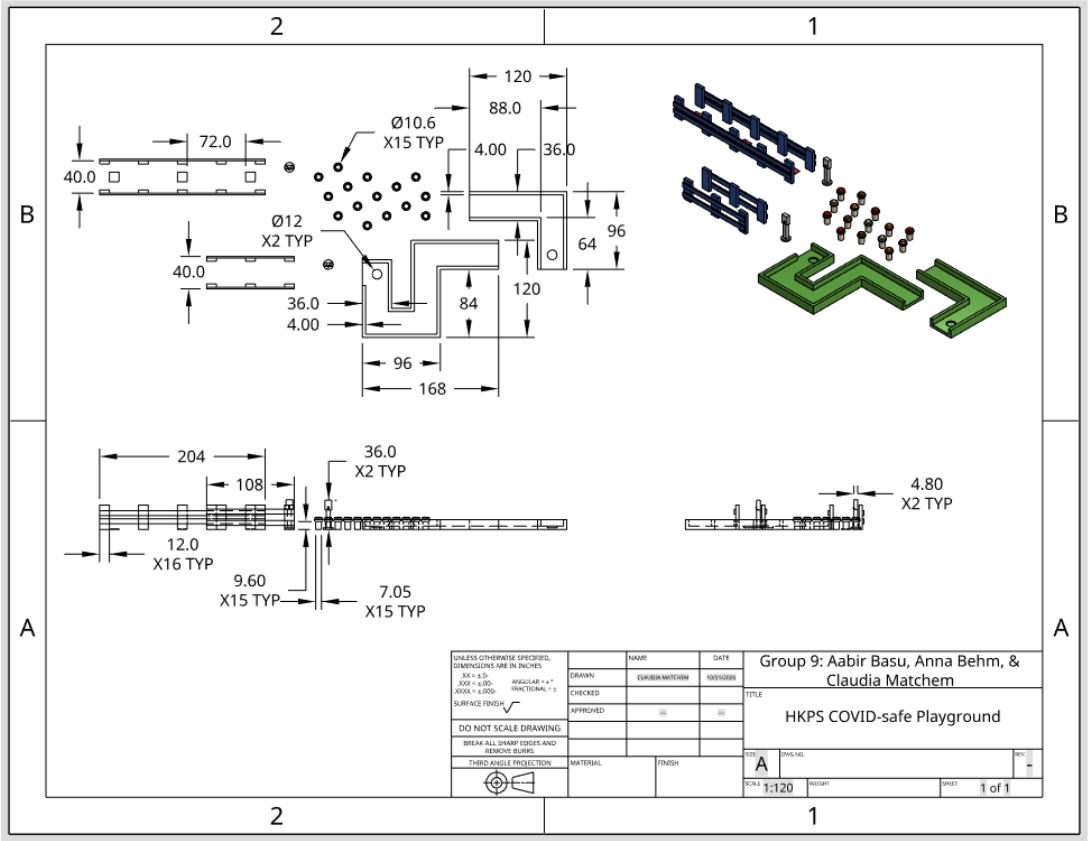
Table 3: **Scoring Matrix**

		F (REF)	**F (REF)**	**D**	**D**	**E**	**E**
Selection Criteria	Weight	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
Allows one child at a time	20%	4	0.20	4	0.20	4	0.20
Safe to use	15%	4	0.15	3	0.15	3	0.15
Cost effective	5%	3	0.05	2	0.05	4	0.05
40-60 seconds	20%	4	0.20	3	0.20	2	0.20
Durable	15%	4	0.15	2	0.15	3	0.15
Easy to maintain	5%	5	0.05	3	0.05	3	0.05
Easy to clean	20%	4	0.20	3	0.20	3	0.20
	Total Score Rank	4.60 1		3.00 3		3.05 2	
	Continue?	Yes		No		No	

Scale	
Performance Relative to Reference	Rating
Doesn’t meet Objective at all	0
Weakly meets Objective	1
Somewhat meets Objective	2
Mostly meets the Objective	3
Strongly meets the Objective	4
Outstanding with respect to the Objective	5

6 Solution Investigation and Iteration

Figure 10: Note that the exit and entrance would be extended and the sketch demonstrates the general concept for the gateway



A jumping mushroom top game and a miniature soccer course was selected for the play structure as an innovative way of decreasing contact surface while still providing a fun form of exercise and an exciting challenge for the students who use it. The mushroom tops are made from rubber surfacing to ensure safety by creating a factor of shock resistance in case of falling or missing the structure when jumping. The stems, however, are built from galvanized steel to ensure proper structural integrity and weather resistance. The mushroom structures are relatively close together so it will not be too difficult for the children to jump across, but far enough that the jumping aspect remains enjoyable.

The frame of the miniature soccer course will be built from galvanized steel to achieve strength and weather resistance, but the course pathway will be built using rubber surfacing in order to provide safety in the form of shock resistance and slip prevention. The target hole for the soccer ball is 12” in diameter and 2” inches deep. Given that the average diameter of a soccer ball is 8” in diameter, this hole size is ideal for landing the ball inside and easily retrieving it. The course walls are tall enough to ensure the ball is not easily lost and the shape of the pathway is challenging enough, but not too complex, in order to provide enjoyment for students.

The entrance and exit gateways will be built from galvanized steel to ensure durability and the social distancing placement mats will be implemented as part of the structure’s flooring area built from rubber surfacing. These placement mats should be different in colour to the main floor area and should display a message explaining social distancing perimeters (Figure 4). The hand sanitizer dispensers will be built from plastic and bolted to the ground, one near the entrance and the other near the exit, and it should be implemented as a janitorial duty to refill the dispensers regularly. Ideally the students would have staggered outdoor periods during lunchtime and the teachers responsible for lunchtime duty would supervise the entrance and exit to ensure social distancing is being upholded, as well as to instruct students when it is their turn on the structure and encourage use of the hand sanitizer dispensers.

The mushroom top jumping game and the miniature soccer course were decidedly the best way to implement the most fun with the least amount of contact surface. While playing with these structures there is little to no contact with the surface required to use them. Hopscotch was ruled out due to contact involved in the throwing stone, and the maze game was decided against in order to adhere to time constraints. During this process, galvanized steel was considered to be

used for the entirety of the structures, but it was decided that rubber would be a safer alternative for the surfaces the children will interact with.

Remaining details to be evaluated include the exact measurements for structures such as the mushrooms; during a test run it may be deduced that their top diameter is too small or their stems are too tall. Details such as these are to be fully assessed at a later date, at a time where the structure is being physically prepared and it is possible to physically test the legitimacy of these measurements. Another includes the length of the entrance and exit gateways. This will depend on the amount of children in each time slot, as well as the size of the land provided by the school for the structure.

Figure 11: https://www.vectorstock.com/royalty-free-vector/social-distancing-signage-or-floor-sticker-vector-30414672

Table 4: **Quantities & Approximate Cost**

Material	**Unit Cost (CAD)**	**Required Quantity**	**Total Cost (CAD)**
Galvanized Steel	$9.00–$12.00 / ft²	430.9995 ft²	$3879–$5172
Rubber Surfacing	$4.00–$7.50 / ft²	282.0980 ft²	$1128–$2116
PET	$0.234 / ft²	15.43972 ft²	$3.61

Overall cost of structure materials: $5110.61–$7291.61

7 Solution Testing and Evaluation

One way to test the chosen playground design would be to conduct a survey on the clients, which in this case would be the students and the teachers. The purpose of this survey would be to test the popularity of potential playground choices to see if the design is worthy of further development and refinement. It is imperative that feedback is gained before the final design is set in stone, as to be cost and time effective. The best design should be chosen ahead of building to ensure no losses. This survey could be conducted in a school classroom, with at least 10 students and 10 teachers. By having a larger population take the survey, it will be possible to see the average responses more accurately and determine the next steps with more knowledge on the feedback. To show the users the design, a 3D printed model could be used, or if this is unavailable at the time, the model in Onshape that was built could be presented. The survey would be divided into two parts - one for the students and one for the teachers. This would allow views on both the amount of fun for the children, and how easy the teachers would find it to maintain, clean, and keep distance between students. A potential survey for the children and teachers are included to the right.

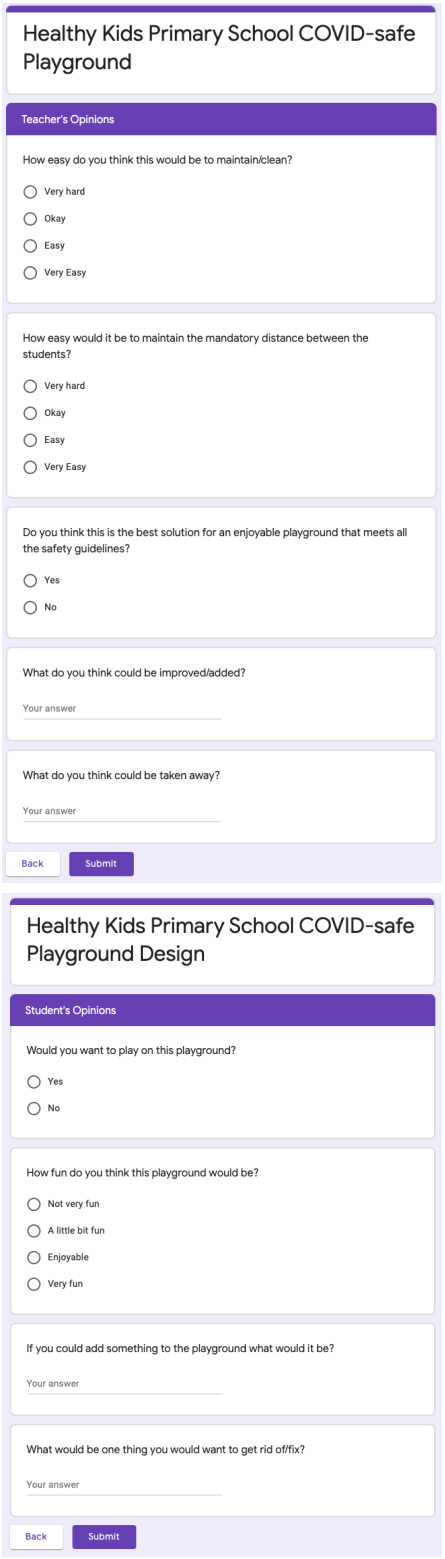


Figure 12: Surveys conducted through Google Forms in order to gather design feedback from staff and students

Based on the responses to these questions, the design would be considered a success if an average of 70% or higher of answers chosen were “Yes”, and “Enjoyable” or “Very fun” for the student’s survey. The design would also be a success if “Easy” or “Very easy”, “Easy” or “Very easy”, and “Yes” were the predominant choices for the teacher’s survey. For the non multiple choice questions, these answers will be taken into consideration when finalizing the plans & ensuring that the most enjoyable & safest playground is implemented.

8 Conclusions

In conclusion, design F, as depicted in Figure 4, is best suited to satisfy the needs of HKPS authorities and students. Remaining details dependent on fabrication, as outlined in the report, are the final details to be decided with the client. This design contains minimal contact surface and is easy to maintain while also being cost effective and providing timely fun for the clients.

This design's structures utilize jumping and kicking, allowing the students to engage in physical exercise while maintaining the fun of a pre-existing structure. Using this design, structures will rarely require sanitary intervention and may be maintained within the janitorial duties carried out at the end of the school day. This design is also fairly priced in comparison to similar structures on the market, which is important when designing such a project. The cost of materials for the structure is roughly between five and seven thousand dollars, as opposed to play equipment on the market suitable for an elementary school, which may cost upwards of ten thousand dollars.

In the end, the design created and chosen by the team is believed to be functional while adhering to the needs of the client, and to provide the greatest fun while staying the most safe given the constraints. As expected there are always improvements that can be made. Given more research, resources, and the opportunity to test the structure's practicality, a near-perfect design could be achieved. The design, as outlined, is believed to fit all criteria given by the client successfully.

9 Recommendations

Based on the analysis and conclusions in this report, it is recommended that the design be approved by the client before proceeding with further testing and development. Upon receiving feedback from the HKPS staff and students the next step would be to refine the design accordingly and proceed with testing of the structure in action. It is recommended that refinements adhere to the feedback specifically and accurately to ensure maximum satisfaction. If the children are unhappy with the enjoyment of the structure, the team should analyze the specific feedback from the last question to incorporate change as suggested by the students. If the teachers are unhappy with the ease of maintenance, the team should inquire specific suggestions from the staff to improve the design to their recommendations. Physical testing should not begin until feedback has been considered and the clients are satisfied with the design.

Moving into the design testing stage it is recommended that a scale model of the structure be built using recycled materials in order to minimize cost while providing a realistic sample to be tested. Young adults should test the structure first in order to verify any safety concerns and structural integrity, followed by a test done by the target audience, children ages 6-7, to receive active feedback regarding the structure's enjoyment level and time efficiency. After considering these few recommendations the design should be fully developed and ready to be constructed.

References

Google Forms: Free Online Surveys for Personal Use. [Online]. Available: https://www.google.ca/forms/about/.

"Caroline Elementary School - School Playground: School playground, Elementary school playground, Elementary schools," *Pinterest*, 25-Jul-2020. [Online]. Available: https://www.pinterest.ca/pin/357051076684031529/.

C. Caron, "As Playgrounds Start to Reopen, Here's How to Keep Kids Safe," *The New York Times*, 11-Jun-2020. [Online]. Available: https://www.nytimes.com/2020/06/11/parenting/playgrounds-reopen-safety-coronavirus.html.

"Coronavirus disease (COVID-19): Cleaning and disinfecting surfaces in non-health care settings," *World Health Organization*. [Online]. Available: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/question-and-answers-hub/q-a-detail/q-a-considerations-for-the-cleaning-and-disinfection-of-environmental-surfaces-in-the-context-of-covid-19-in-non-health-care-settings#.

"F.A.Q," *resilientrubbersurfacingca*. [Online]. Available: http://resilientrubbersurfacing.ca/faq/#:~:text=Q: How much does Rubber,square foot for Virgin rubber.

"Guidance for Parks," *COVID-19*, 24-Jun-2020. [Online]. Available: https://www.gov.nl.ca/covid-19/information-sheets-for-businesses-and-workplaces/guidance-for-parks/.

posted by: C. King, Written by Candice KingCandice King is a metal roofing advocate with over a decade of experience in communications for the roofing industry.Metalsmithing Associate of The Ontario College of Art and Design, W. by C. King, and Candice King is a metal roofing advocate with over a decade of experience in communications for the roofing industry.Metalsmithing Associate of The

Ontario College of Art and Design, “Metal Roof Cost in Ontario $ The Ultimate 2020 Guide $,” *MWI Metal Roofing and Siding*, 27-Jul-2020. [Online]. Available: https://mwimetalroofing.ca/metal-roofing-cost-ontario/.

“Metal Playground Sets and Wooden Play Equipment: AAA State of Play,” *Metal Playground Sets and Wooden Play Equipment | AAA State of Play*. [Online]. Available: https://www.aaastateofplay.com/wood-vs-metal-playground-equipment/.

“Obstacle Course (striking),” *Kiddo*. [Online]. Available: https://kiddo.edu.au/activities/obstacle-course-striking.

Onshape. [Online]. Available: https://cad.onshape.com/.

“Playground Surfacing for Schools and Parks,” *Play & Park Structures*. [Online]. Available: https://www.playandpark.com/products/surfacing.

“Playground structures are closed, but families and kids are using them anyway | CBC News,” *CBCnews*, 11-Jul-2020. [Online]. Available: https://www.cbc.ca/news/canada/hamilton/playgrounds-covid-kids-1.5644817.

O.-time payment, Download images on-demand (1 credit = $1). Minimum purchase of 30., Choose a monthly plan. Unused downloads automatically roll into following month., no signup needed. One-off payment, and Download images on-demand (1 credit = $1)., “Social distancing signage or floor sticker vector image on VectorStock,” *VectorStock*. [Online]. Available: https://www.vectorstock.com/royalty-free-vector/social-distancing-signage-or-floor-sticker-vector-30414672.

Appendix A: Meeting Minutes

Meeting #1 September 15 2020, 3:00-4:50PM

Meeting Participants: Aabir Basu, Anna Behm, Claudia Matchem

Meeting Notes: Meeting number one was to determine the choice of research project & begin researching the appropriate background information. The idea chosen was the "Healthy Kids Primary School Playground". The objectives were defined and research was done on the different aspects of the project; including the target users, constraints, potential budgets, desired goal state, and obstacles. It was planned to have finished the research by the next meeting (September 22 2020) and to look over the objectives of the next task: requirements and ideation.

Meeting #2 September 22 2020, 3:00-4:50PM

Meeting Participants: Aabir Basu, Anna Behm, Claudia Matchem

Meeting Notes: During the second meeting, the researching was summarized and the most important finds were highlighted. From the information found, the functions, objectives and constraints of the playground were discussed and the brainstorming of a potential model started. Multiple brainstorming tactics were utilized during this meeting, and great progress was made on the designs, while keeping in mind the objectives of the project. Over the next week it was planned to continue brainstorming and narrowing down the objectives, in order to obtain the best possible design.

Meeting #3 September 29 2020, 3:00-4:50PM

Meeting Participants: Aabir Basu, Anna Behm, Claudia Matchem

Meeting Notes: For the third meeting, the brainstorming continued and the best ideas were chosen from the objectives, functions, and constraints created in the last meeting. Models were drawn out both on paper and in the program Onshape to more clearly depict the models that were designed. A morph chart was also created in order to more clearly see the best options out of the presented ideas. The choice of the final model was not to be rushed, so appropriate methods of selection were researched to determine the winning design. Group members agreed to refresh their knowledge of evaluation tactics for the next meeting (October 6 2020) in order to finalize the playground model.

Meeting #4 October 6 2020, 3:00-4:50PM

Meeting Participants: Aabir Basu, Anna Behm, Claudia Matchem

Meeting Notes: The fourth meeting was used to select and iterate the final design. Screening and scoring matrices were found to be the best way to determine the ideal design. They were used to narrow down the ideas based on important aspects, including how durable the playground would be, the time that it would take for one child to use the equipment, how easy it would be to clean the structure after use, and the prices of the different materials. This concept screening allowed

for the optimal model to be chosen, and for the refinement of this selected design to begin. Over the week following, more specific information about prices was to be gathered & plans for a multiview drawing were started.

Meeting #5 October 13 2020, 3:00-4:50PM

Meeting Participants: Aabir Basu, Anna Behm, Claudia Matchem

Meeting Notes: Since the final design for the playground had been selected, meeting five was designated to create specifications to understand and fabricate the design. An Onshape model of the playground was created by Claudia Matchem for both the multi-view and isometric angles. The budget of the materials was created with more detail and accuracy, and group members started finalizing the design report over the following week.

Meeting #6 October 20 2020, 3:00-4:50PM

Meeting Participants: Aabir Basu, Anna Behm, Claudia Matchem

Meeting Notes: In order to see if the finalized design would be enjoyed by the clients, a survey was created, and a review of how the results would be analyzed was also written. The purpose of this survey would be to test the popularity of potential playground choices to see if the design is worthy of further development and refinement. The type of model to be used was determined, as was the target test group, and targets and explanations for the responses gathered. Furthermore,

the design report was edited and formatted to the project rubric during this time.

Meeting #7 October 27 2020, 3:00-4:50PM

Meeting Participants: Aabir Basu, Anna Behm, Claudia Matchem

Meeting Notes: This final meeting was used to conclude the research process and focus on editing the design report. For each part of the report, a person was appointed to edit and explain more thoroughly, the given ideas. Any changes in the design report were discussed and the missing elements were highlighted and given to each group member to finish before the deadline.

Appendix B: Original Designs and Descriptions

Design A

This design variation included hopscotch, the mushroom jumping game, the soccer golf course and a math maze with a rubber flooring. Design A did not make it through the first round of screening due to the possibility of the time needed to complete one round of using all of the equipment exceeding 40-60 seconds, which was the threshold provided by the client. Furthermore, the design included far too many inaccessible, difficult to clean spaces. This would be unacceptable on a play structure in today's pandemic-struck world.

Design B

This design variation included hopscotch, the mushroom jumping game, the soccer golf course and a math maze with a gravel flooring. Design B did not make it through the first round of screening due to the safety hazard that may have been posed by the usage of a gravel flooring for the math maze. Obviously, a play structure intended for children aged 6-7 years would have to be as safe as possible. Furthermore, the design included far too many inaccessible, difficult to clean spaces. This would be unacceptable on a play structure in today's pandemic-struck world, causing it to be tied for the lowest rank after the first round of screening.

Design C

This design variation included hopscotch and the math maze with a rubber flooring. Design C did not make it through the first round of screening due to the higher effort needed to maintain

the math maze when compared to other designs that included structures such as the mushroom jumping game and the soccer golf course.

Design D

This design variation included hopscotch, the mushroom jumping game and the soccer golf course. Design D automatically made it through the first round of screening since it was taken as the reference design for this round. In the second round, the decision was made to not continue with this design largely on account of the fact that this design would incur greater maintenance costs and also be far less durable than the other two designs simply due to the larger number of play structures involved in the design.

Design E

This design variation included hopscotch and the mushroom jumping game. Design E made it through the first round of screening due to the fact that it would be more cost effective than other designs on account of its lesser number of play structures involved. However, the decision was made to not continue with this design due to the fact that it would take far less time than 40-60 seconds to complete one round of playing on the two play structures. Since this time requirement was an explicit requirement from the client, it had a joint tied highest weighted score in the second round of screening. This caused Design E to finish second best at the end.

Design F

This design variation included the mushroom jumping game and the soccer golf course. Design F made it past the first round of screening mostly because it was more cost effective than other

designs simply because it involved a lower number of play structures. It was also the top scorer in the next round of screening and is the variation that the final design has. This can be accredited to the fact that this design did very well in all of the criteria that had the highest weighted scores, i.e, being cost effective, taking around 40-60 seconds to complete, and being easy to clean. It was evaluated as the perfect post-pandemic play structure by the group.

Design G

This design variation included the math maze alone. Design G did not make it past the first round of screening since it would take far less time than the required amount of 40-60 seconds. Furthermore, it would take more effort to clean and maintain the maze when compared to other designs. These exigent caveats led to this design being tied for the lowest rank after the first round of screening.