



Save the Penguins Project: Stages of the Engineering Design Process linked to Global Competencies

The following Table is designed to help educators organize their Problem-Based project using the necessary tools through the Design Engineering Process. Specific Global Competencies have also been identified to supplement the overall learning process using the “Penguin Problem” as the main context/example. Educators are encouraged to replicate this table to suit the needs of their students based on age, ability, familiarity with technology and backgrounds.

Stage of Design Process as it relates to the Penguin Population Problem	Penguin Project	Checklist for any Problem-Based project	Technology Resource Utilised (as applicable)	Modifications for Grade level (as needed)	Global Competencies
Stage 1: Defining the Design Problem Timeframe: 1 period	The Penguin population is declining due to Climate change.	The problem should be concise. Provide context to support the problem and encourage students to brainstorm and identify the main problem. At this stage, students should be provided with clear Learning Goals.	Google Keep - Notes from Keep App in G-Suite when article is open (shared setting with students)	K-3: Have students share ideas using a Smartboard App. 9-12: Padlet (alternative to Google Keep) or Kaizena (Conversation App)	Global Citizenship Communication Collaboration
Stage 2: Defining Potential Solutions. Timeframe: 1 period (can be completed with Stage 1)	Given a specific context and with reference to the following the “Save the Penguins” article; the class had an open discussion about the article and identified the following solution to	Solutions to the problem will emerge after students continue their discussion about the problem. Not all solutions need to be hands-on building projects; consider Reflection pieces,	*same as above	*same as above	Global Citizenship Critical Thinking Communication Collaboration

	the problem: To help penguins survive we are going to build a safe enclosure to protect them from the effects of global warming. This was then defined as their Engineering Design Challenge.	Action Plans, Artistic Interpretations, Social Media Engagement, Informatics etc. as an assessment piece emerging from the co-created Success Criteria.			
Stage 3: Asking Questions Timeframe: 1-2 periods	At this stage, students are organized into groups based on mixed abilities/qualities. They work together to identify at least 10 questions they may need to ask as means to solve the problem. They must also use this stage to identify any potential constraints to solving the problem.	Encourage students to ask questions that are relevant and will help them complete the task successfully. Students will need to communicate with one another and utilize their critical thinking skills to assess if a question posed will be helpful in the building of their final penguin structure prototype.	Google Doc (shared)		Learning to Learn/Self-Awareness & Self-Directed Learning Collaboration Communication
Stage 4: Researching Questions Timeframe: 2 periods	Students selected the top 10 questions and assessed them for relevance as they related to offering viable information for the final solution to the problem (e.g. choice of materials to build a suitable structure (knowledge of radiating, conducting and insulating materials	Encourage students to use a variety of resources (hi-tech and low-tech) to seek out different perspectives on a question and to fill in any gaps.	Google Docs (shared) Google Search Engine Library Search (online) and offline	K-3: Google Slides (to capture images and share ideas and knowledge of the problem) 9-12: Advanced use of Google Search and other referencing materials online and offline	Learning to Learn/Self-Awareness & Self-Directed Learning Collaboration Communication

	was needed)				
<p>Stage 5: Co-created Checklist (Anecdotal) and Diagnostic</p> <p>Timeframe: 1-2 periods</p>	<p>Using a shared Doc through Google, students developed a checklist with 10-15 items that they would use as a self-assessment tools at the end of the project determining success.</p>	<p>At this stage, encourage students to develop their own plan of action on how they will complete this task ensuring all members are actively participating. Members will need to edit their list before adding it to their Google Team Drive and prior to conferencing with their teacher.</p>	<p>Google Doc (shared)</p>	<p>K-3: Shorter Checklist, co-created with educator</p> <p>9-12: Google Doc (Shared)</p>	<p>Communication</p> <p>Collaboration</p> <p>Critical Thinking</p>
<p>Stage 6: Whiteboard drawings</p> <p>Timeframe: 2 periods</p>	<p>Given access to a materials list, dimension constraints and a budget sheet itemizing the “cost” of the building products, students then sketched two rough drafts of their potential penguin structures and then captured pictures of them then adding them to their Team Drive for later reference.</p>	<p>This is when students get to be really creative. Provide students with enough information to develop their ideas. Given a set of constraints you will be amazed at how creative students can get with their design ideas. Encourage “scouts” to check out what other ideas are emerging in different groups.</p>		<p>K-3: Whiteboard and markers/paper to sketch or brainstorm ideas</p> <p>9-12: Whiteboard sketch App (online) through personal device</p>	<p>Innovation, Creativity</p> <p>Communication</p> <p>Collaboration</p> <p>Problem Solving</p>
<p>Stage 7: 3D Design of Model</p> <p>Timeframe: 2 periods</p>	<p>Students selected through a process of elimination and viability the best of their two designs</p>	<p>A tutorial on how to use the relevant 3D software will need to be provided beforehand. Offer</p>	<p>Google 3D Sketchup Maker (licensed software)</p>	<p>K-3: This software can be somewhat complex for the younger audience, however, an</p>	<p>Innovation, Creativity</p> <p>Communication</p> <p>Collaboration</p>

	creating a 3D model of their design complete with accurate mathematical dimensions.	students some time to fiddle around with the software App. Encourage students to create different perspectives of their 3D model with accurate measurements.		alternative solution could be using a platform such as minecraft or Roblox which allows students to acquire knowledge of 3D building and shapes. 9-12: Google 3D Sketchup Maker	
Stage 8: Building Timeframe: 4 periods	With all items in their Team Drive (Q&A, checklist, whiteboard drawings, 3D models) at this stage students are given at least 2-4 classes to build their model as a group. Given a budget sheet and select materials, students had fund at this stage to “purchase” materials, manage their budget, time and work effectively with their group members to complete the build on time and with care. A few examples of the final products can be found here (add link)	The building stage should be the most fun part of this project. Remind students that this stage would not have been possible without the completion of all other necessary stages of the Design Engineering process. Provide students with a variety of building materials, building tools and be sure to review safety rules and expectations.			Innovation, Creativity Critical Thinking/Problem Solving Communication Collaboration
Stage 9: Testing/Modifications Timeframe: 2 periods	At this stage students tested the viability of their penguin structure studying it for increases in temperatures within	The testing phase is an essential component of the Engineering Design process. It is at this stage that students	Pasco Heat Probe Sensors SparkVue App (Ipad or Android)	K-12: Students at all grade levels would benefit from the use of these technologies. The analysis of the data	Critical Thinking/Problem Solving Communication

	the structure. Specific tools were used to gather this data and a thorough analysis of this data was also provided telling a “story” of what happened inside the structure after prolonged exposure to heat.	are able to gather any relevant data, accesses the data and provide real or hypothetical modifications to their design for further improvements.		may vary depending on the complexity of the solution and age level.	Collaboration
Stage 10: Conclusions/ Presentation Timeframe: 3 periods	The last stage was composed of several items including: 1) A self-assessment piece allowing student to share their feelings about the learning journey throughout the design process (e.g. challenges/successes); 2) Marketing Poster presentation of their Penguin Structure to potential investors/consumers of this product and 3) Group analysis of the final project using their original checklist leading to an open group discussion.		For Self-Assessment: Google Form For Marketing Poster Presentation: Google Slides For Group Analysis: Google Doc	*G-Suite Apps can be adapted based on level of complexity and mode of delivery to any age group.	Entrepreneurship Learning to Learn/Self-Aware and Self-Directed Learning Communication Collaboration

References:

Save the Penguins Article (see References list on Classroom Catalyst for this project)

21st Century Competencies: Foundation Document for Discussion, Winter 2016 Edition

http://www.edugains.ca/resources21CL/About21stCentury/21CL_21stCenturyCompetencies.pdf

Save the Penguins: TDSB STEM Website (May 2017)
<https://sites.google.com/a/tdsb.on.ca/stem-centres/resources>