Element K: Reflection on the design project

This entry would be likely to receive a score of 2, based on the EDPPSR.

The entry provides a project narrative that recounts the basis for the formulation by the project designers of the problem they wished to address, and then follows with an account of key steps in the project. While the entry is a clear and somewhat developed narrative, it lacks detail about "lessons learned"—and those should be at the heart of any reflection. One engineering expert who recently reviewed this entry commented, "it seems like an executive summary." This entry cannot be regarded as particularly "insightful" since there is little included in it to convey value judgments about steps in the project. Furthermore, information that would be useful to others attempting the same or similar project is not set forth explicitly for that purpose, but must be extracted by those reading the entry.

The distinctions between narrative and reflection may not yet be widely understood—either by students or teachers. A narrative is an account of a series of events or actions (steps in a process)—basically, a description of what happened. It typically includes detail about who, what, when, where, and how. A reflection, on the other hand, focuses primarily on what was learned as a result of an experience or activity—in this case, as a result of the conduct of a design project. Typically, in STEM-related contexts, reflection involves identifying and examining misconceptions and documenting changes in understanding

Engineering Design Process Portfolio Scoring Rubric
Component and Element Titles

Component I: Presenting and Justifying a Problem and Solution Requirements

- Element A: Presentation and justification of the problem
- Element B. Documentation and analysis of prior solution attempts
- Element C. Presentation and justification of solution design requirements

Component II: Generating and Defending an Original Solution

- Element D: Design concept generation, analysis, and selection
- Element E: Application of STEM principles and practices
- Element F: Consideration of design viability

Component III: Constructing and Testing a Prototype

- Element G: Construction of a testable prototype
- Element H: Prototype testing and data collection plan
- Element I: Testing, data collection and analysis

Component IV: Evaluation, Reflection, and Recommendations

- Element J: Documentation of external evaluation
- ***Element K: Reflection on the design project***
- Element L: Presentation of designer's recommendations

Component V: Documenting and Presenting the Project

- Element M: Presentation of the project portfolio
- Element N: Writing like an Engineer

Please Note: Elements M and N require no submission from the portfolio author(s) and are intended to be scored based on the portfolio work as a whole from what has been submitted from Elements A through L

Element K: Reflection on the design project

5 The project designer provides a consistently clear, insightful, and comprehensive reflection on, and value judgment of, each major step in the project; the reflection includes a substantive summary of lessons learned that would be clearly useful to others attempting the same or similar project.

4 The project designer provides a clear, insightful and well-developed reflection on, and value judgment of, each major step in the project; the reflection includes a summary of lessons learned that would be clearly useful to others attempting the same or similar project.

3 The project designer provides a generally clear and insightful, adequately-developed reflection on, and value judgment of, major steps in the project, although one or two steps may be addressed in a more cursory manner; the reflection includes a summary of lessons learned, at least most of which would be useful to others attempting the same or similar project.

2 The project designer provides a generally clear, at least somewhat insightful, and partially developed reflection on, and value judgment of, most if not all of the major steps in the project; the reflection includes some lessons learned which would be useful to others attempting the same or similar project.

1 The project designer provides a reflection on, and value judgment of, at least some of the major steps in the project, although the reflection may be partial, overly-general and/or superficial; the reflection includes a few lessons learned of which at least one would be useful to others attempting the same or similar project.

0 The project designer attempts a reflection on, and value judgment of, at least one or two of the major steps in the project, although the reflection may be minimal, unclear, and/or extremely superficial; any lessons learned are unclear and/or of no likely use to others attempting the same or similar project; OR there is no evidence of a reflection and/or lessons learned.

Reflective Questions for Element K;

- ***If I/we were going to do this project over, what should be done differently during the design process to improve the project and how would those recommendations make the project better overall?***

Dry Erase material storage is recognized to be a problem in the classroom and was verified by a survey of over 20 professional educators of varying professional experience. Existing Dry Erase storage in classrooms keeps markers and erasers in a tray below the board, collecting debris from erasing the board. The mixture of debris with markers and erasers leaves a greasy residue on hands and clothing. The low height of the tray allows access by small children. Research of MSDS on markers and marker chemicals revealed that Butanol is present in markers, and can cause severe side effects if ingested. This was verified by an Industrial Hygienist from OSHA. These facts led to a decision to design and build a product to store Dry Erase markers and erasers cleanly and safely. Our problem statement distilled to "Toxic Dry Erase materials are in millions of classrooms today and are accessible to children. This creates an unclean and unsafe learning environment."

Existing project research revealed that no existing products met our desired requirements. MSDS requires markers to be stored horizontally, which disqualified many products. Few products prevented erasers from being stored with markers, allowing possible contamination of the outside of the marker. A provided tray with Expo markers featuring separate storage of markers and erasers was rated the best available commercial solution based on developed criteria. The tray could be mounted at any angle via included tape and was of poor quality; our purchased sample was found to be cracked when removed from the box. The research pointed towards a solution that would physically prevent makers from being stored with erasers, and prevent erasers from being stored with markers. A method to clean erasers and capture any cleaning debris was also desirable. Wall mounting in a fixed orientation was desired to ensure horizontal storage and give a sufficient height to prevent marker access by unsupervised children.

Our design matured into a central angled cleaning screen to hold erasers from frictional force, yet allow markers to roll off. The angle of the cleaning screen was tested to be functional between 0 and 70 degrees. The cleaning screen was dimensioned to hold two erasers side by side. Four marker trays were added to the sides to hold markers yet prevent eraser storage. A removable tray was added below the cleaning screen, and the entire assembly was mounted to a back plate for wall storage. Hardware cloth covered by fine expanded metal from a range hood grease filter was selected to be the material for the cleaning screen. This would provide friction and a scraping surface and provide support for normal force when cleaning, yet allow debris to fall through into the tray. The concepts were turned into a set of drawings in Inventor and then built in the lab using thin plywood, glue, screws, hardware cloth and a repurposed range hood grease filter. The prototype was tested then painted.

The efficacy of the cleaning screen was tested and showed visual evidence of removing material from the eraser. Measured mass of material removed was inconclusive based on the limitations of the measuring equipment. Normal force was measured vs. screen deflection to show mechanical robustness. Deflection appeared to be roughly linear as expected; difficulties in consistently applying force limited the measurement results. A flammability test was performed by holding a new marker to an open flame. The marker was found to hold an open flame for over 30 seconds after the initial flame was removed.

The design met its objectives. Feedback will be solicited from the initial survey pool to verify our design will meet their perceived requirements. The design could be improved by reorienting the finer expanded metal to give greater friction in the expected removal direction of the eraser, which is forward and down when facing the unit. The final production design should be made from plastic for cost savings. Additional support should be provided in the center under the screen. The bottom tray can be made shallower based on the amount of material gathered during testing, and the tray can be mounted via grooves in the side pieces. This would allow removing the bottom piece and save weight and material.

Reflection

Toxic Dry Erase materials are in millions of classrooms today and are accessible to children. This creates an unclean and unsafe learning environment. Most schools in the U.S have dry erase boards in their classrooms. Teachers use the dry erase board to demonstrate a process in a lesson.

In most classrooms, teachers store the dry erase markers on the sill below the dry erase board. The dry erase markers leave a greasy residue which causes staining on clothing. Dry erasers collect residue that stays on the eraser and are dirty.

Most dry erase markers contain toxic chemical, tert-Butanol. Tert-Butanol causes eye irritation which can cause blurred vision and photosensitivity. According to the MSDS sheet, tert-Butanol if ingested can cause liver and kidney damage, central nervous system depression, headaches, dizziness, drowsiness and nausea. Advances stages may create the person to collapse, unconsciousness, coma and possible death due to respiratory failure.

If the teacher or student touches the marker ink, Tert-Butanol can cause skin irritation, defatting of the skin and dermatitis. The MSDS requires that the chemical be used in a well ventilated to avoid inhalation risks. In high concentrations the chemical may cause central nervous system effects caused by headaches, dizziness, unconsciousness and coma. Also, it causes respiratory tract irritation, liver and kidney damage, lung damage and may cause blood changes.

The current storage areas in most classrooms are accessible to children. All the tert-Butanol effects are increased to a small child. Our team was concerned with the exposure of the chemical to the children and adult. Teachers should follow the MSDS sheet if they use the dry erase markers in the classroom. They need to store the chemical at a safe height from children.

Our team developed a product that would store the Dry erase markers in a convenient, clean and safe manner. The SafeCleanStore is made of wood and is painted with high gloss paint for easy cleaning. It has four holes so that it can be mounted to the wall. According to the MSDS sheet the markers must be stored horizontally. Our SafeCleanStore has four horizontal holders for safe storage of the dry erase markers.

The top area of the SafeCleanStore has a grated screen that allows for the instructor to clean the eraser to help avoid build up. Also, the expanded metal, cleaning screen, is used as the means of storage for the erasers. The SafeCleanStore should be mounted at a 4 to 5 foot height to avoid access to children.

Our teams SafeCleanStore product could be created from plastic to allow for easy mass production and a cheaper cost. We would recommend the expanded metal, cleaning screen, orientation be placed to allow for the most resistance. Also, the instructor needs to consider using water based dry erase markers that do not contain tert-Butanol. MSDS sheets should be stored in the classroom on any chemical used in the classroom including dry erase markers.