GIFTS: Marching LEGO Ducks towards Critical Ideation

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Introduction

Generating a wide range of solutions proves challenging for First-year engineering students. Their experience with open-ended design problems is limited, and the ambiguity involved can cause them discomfort [1]. One of the more ambiguous elements can be broadening their exploration of the available solution space. Conceptually, it isn't something they likely ever thought critically about before [2]. Without guidance on how to push those boundaries, they tend to focus on a few paradigms and then create variations to meet arbitrarily set project minimums rather than explore a wider variety of concepts. When provided with means to expand their explored solution space, they tend to take that opportunity to do so [3]. The following curricular activity functions to engage them with the concepts of measuring novelty and variety to evaluate their solution generation, providing a broadly applicable method for understanding and, by extension, exploring the solution space. The methods used come from the works of Shah et al. in creating ideation metrics for quantifying those elements [2].

Curricular Activity

The activity starts by providing students with a LEGO set consisting of 6 pieces and giving the singular instruction, "Make a duck." The instructor then introduces the concepts of novelty as a measure of how unusual or unexpected an idea is among a population of ideas and variety as the measure of the explored solution space, the extent of fundamental differences among that population of ideas, and methods for quantifying these measures. Next, they discuss their ducks with these measures in mind, seeing how much of the possible solution space for a "making a LEGO duck" they explored. As they do, they receive a second, identical LEGO set and are told to "Make a very different duck." Once completed, they input the attributes of their ducks into a provided online form. A spreadsheet connected to that form is then shown, displaying the calculated novelty score for each duck, where they can see both their ducks' scores and those of their peers. The author may be contacted to request copies of this curricular activity and its associated materials.

Results

This lesson and activity has been implemented in 8 first-year design courses over the last two years. The reactions have been primarily positive, even being noted in some student evaluations as a favorite. The use of the metrics has not been a requirement in their design projects, but they are introduced at the time of solution generation for their second project, which requires a presentation of a range of their design ideas. Several design teams have utilized it for those presentations as it gives them the language to describe their engagement with this aspect of the engineering design process as well as the values by which they select their exemplar concepts. Some even include the novelty scores as ratings for a creativity objective within their decision analyses.

[1] E. P. Douglas, D. J. Therriault, M. B. Berry, and J. A. Waisome, "Comparing Engineering Students' and Professionals' Conceptions of Ambiguity," in *2022 IEEE Frontiers in Education Conference (FIE)*, 2022: IEEE, pp. 1-4.

[2] J. J. Shah, N. Vargas-Hernandez, and S. M. Smith, "Metrics for measuring ideation effectiveness," *Design Studies,* vol. 24, pp. 111-134, 2003, doi: 10.1016/S0142-694X(02)00034-0.

[3] L. R. Murphy, S. R. Daly, and C. M. Seifert, "Idea characteristics arising from individual brainstorming and design heuristics ideation methods," *International Journal of Technology and Design Education,* vol. 33, no. 2, pp. 337-378, 2023/04/01 2023, doi: 10.1007/s10798-021-09723-0.