

Conceptualisation and quantitative study of aesthetic and affective Perception of Pictures in Physics Education

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Abstract. Visualizations in physics education attract attention, fascinate viewers, and motivate engagement with the content. Research has linked visualization attributes to influence learning, but questions persist about how aesthetic visuals affect learning. Understanding student perceptions of picture aesthetics is essential, before investigating this further. Delving into theory of art and design, we selected criteria to choose eight pictures; four considered aesthetic. We assessed the perception of the pictures using a newly developed questionnaire. Results showed the chosen aesthetic pictures were more appealing. A short interview confirmed these findings, confirming that the selected criteria are effective for choosing aesthetic pictures.

Pictures in STEM education

Visualizations in physics education serve many functions by attracting attention, fascinating viewers, and motivating engagement with the depicted physical content [1]. However, they are sometimes not explicitly referred to in the text or in the exercises [2]. Then, they are merely decorative pictures, and decorative pictures were shown to be neither beneficial nor detrimental to most types of learners in testing [3]. Hence, we intend to use attractive pictures with instructions. In Linder's and similar studies (for example [4]), pictures are described as being attractive or aesthetically pleasing, indicating the potential for robust criteria to select and identify aesthetic pictures. In art, aesthetics is a widely discussed and applied concept that encompasses the aesthetics of music, natural elements and painting. Leder's model presents an aesthetics-based evaluation of pictures, and includes criteria applicable to select pictures that are perceived more aesthetic [5]. Included are features like the colours of a picture, visual complexity, and contrast. For physics education, picture content and topic are also important: the picture should be relevant for learning, and as such show physical phenomena in an easily perceptible way. Additionally, context is crucial when selecting pictures for teaching physics in class.

Research question

Our main question was if students would perceive the selected aesthetic pictures as more aesthetic than less aesthetic photographs with a classroom experiment context. Here aesthetic picture refers to pictures that are selected according to the specified list of criteria.

Picture selection and study design

We selected four aesthetic photographs based on theoretical and educational criteria. Pictures show different geometrical optics phenomena that are discussed in 7th and 8th-grade in German high schools. Phenomena depicted aspects of the four themes light propagation, spectrum, reflection, refraction. We contrasted these aesthetic pictures with four self-created, less aesthetic classroom experiment photographs showing the same phenomena. Our main study involved 118 students, average age 13.5, in a 90-minute session with a 30-minute intervention in a crossover design. Students rated two pictures from both categories (aesthetic picture and

classroom experiment picture) after the intervention. The main instrument consisted of an 11-item, 6-point Likert scale that measures the aesthetic and affective perception of pictures. It is based on instruments that assessed the perceived visual aesthetics of websites as well as instruments assessing the emotions about pictures.

An additional interview study (N = 18) was conducted to substantiate and confirm the use of the developed selection of criteria for aesthetic pictures, and the perception of the latter by learners.

Results of the picture assessment

Shapiro-Wilks test confirmed normal distribution of the perceived visual aesthetics ratings for half of the pictures. Residuals were normally distributed, and Levene's test confirmed homogeneity of variances between aesthetic pictures and classroom experiment pictures for every theme. We continued analysing data with a robust two-way mixed ANOVA for the impact of the picture category on the perceived visual aesthetics rating. The test showed significant main effects of the picture category with $F(1, 108) = 75.02$ and $p < 0.05$. Also, the differences in the theme were significant with $F(3, 324) = 4.62$. Post-hoc analysis with the Tukey test revealed high effect values for the picture category for all themes but spectrum. In general, aesthetic pictures had higher ratings than the classroom experiment pictures. Comparing different themes, only comparisons with the theme spectrum showed high effect values. With this we can conclude, that students perceived the selected aesthetic pictures for every phenomenon but rainbows as more appealing than the classroom experiment pictures.

As a last step, the interview study provides an additional insight into the reasoning of the students. The results of the interviews support the main findings. They highlight decisive criteria for the increased perceived aesthetics are colour and contrast as well as the context of the picture. This is in accordance with Leder's model and previous studies.

Conclusions

Our research demonstrated that it is possible to choose pictures that are perceived aesthetic based on defined criteria. The criteria for picture selection offer a foundation for selecting pictures with quantifiable aesthetic value in future studies. Further research may explore other physics topics and age groups to validate the impact of perceived visual aesthetics. In addition, it remains to validate the impact of perceived visual aesthetics on students' learning.

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