

# Comparison of Visualization Skills after Courses with Graphics and Solid Modeling Content

## Abstract

*This paper presents a comparison made between students that take a course with mainly visualization topics based on 2D concepts, and students that take a course where 3D solid modeling concepts are the main topics. The objective is to find out any possible benefit, or lack of, when covering specific 2D and 3D topics. The visualization aptitudes of the students was measured by administering the standard PSVT:R test before and after the respective topics were covered. This evaluation was done at two different academic institutions, and information regarding the academic status, 2D/3D experience, and gender was collected as well. The final evaluation will be administered in early December. Results from this study are relevant to define course content in light of the current trend of having 2D and 3D topics in one single course.*

## Introduction

Visualization has received significant attention from practitioners and researchers in fields such as education, psychology, and engineering. Visualization skills have been often linked to mental capabilities that indicate likeliness or aptitude to perform certain tasks or professions. Similarly, there are numerous reports on exercises that focus on developing, evaluating, and improving visualization skills, both, for development of imagination and creativity, as well as development of competencies directly related to technical fields such as engineering graphics and design.

In this field of graphics and design, more linked to STEM education, there has been reports about the development, improvement and expansion of tests for spatial visualization and spatial orientation. There are test such as the Purdue Spatial Visualization Test - Rotations PSVT:R, the Mental Cutting Test (MCT) (Sorby, 1999) and Shepard-Metzler Rotation (S-M) Test (Shepard, 1971) and its modification (Vandenberg, 1978). The PSVT:R is perhaps the most widely used test, and it is the one utilized in this study – mainly due to its availability. After its initial development (Guay, 1977) has been many reports for improvement, like the use of trimetric representation (Branoff 2000), or the use of realistic 3D views (Yue, 2008), or the use of pictorials (Ernst, 2015).

There are as well reports on several techniques being utilized in the classrooms in order to develop such visualization skills. Just as there are reports on the applicability and usefulness of those various techniques.

## Methodology

This study was designed to find out any benefit to the spatial visualization skill of students that have additional 3D solid modeling concepts offered to them. In most engineering and technology degrees students are required to have a course in technical graphics. There is great variety of offerings out there, with the most typical offering being a first-

year course where students are offered spatial visualization topics using 2D concepts, such as orthogonal views and multi-views. In the past couple of decades it has been common to have first-year courses that cover the similar visualization topics but in the context of 3D solid modeling. Nowadays, there is another trend where academic institutions have a hybrid course, where approximately half the course is in 2D concepts, and the second half cover 3D concepts. This study at two different academic institutions attempts to have some objective assessment of the benefits on spatial visualization by students having 3D concepts in addition to 2D concepts in their curriculum.

One of the participating institutions offers a one-semester course where 2D is the main topic. A second course in 3D solid modeling is offered and is taken only by a subset of students. In the first course Autodesk's AutoCad is used in the offering, in the second course the offering is based on Siemens' NX and Dassault Systemes' Catia. At the other academic institution, there is now a hybrid course where half of the course is done using as well Autodesk's AutoCad, and the other half of the semester is done utilizing Autodesk's Inventor.

The surveys (PVST:R) were administered to both groups of students at the following intervals, before the 2D segment/semester starts, after the 2D is covered and the 3D segment/semester starts, and at the end of the 3D segment/semester. In addition to the spatial visualization survey there was information collected for each one of the participants, basically data regarding their academic status/interest, experience with 2D/3D, and gender.

In the 2D segment/semester of the course, concepts, information and exercises are provided on drafting, with some creation of 3D representations based on 2D drafting. On the 3D segment/section there is exposure to the (semi-) integrated softwares used in industry nowadays, covering topics related to part modeling (including sketching), drafting and assembly.

## **Results**

The surveys were administered to the students, and their participation was completely optional. At the first academic institution there is a group of 42 students, and at the second institution there is a group of 20 students. The first survey (pre-2D) on the first institution was done during Spring'15 semester, when the students started their required first course in technical graphics. This first evaluation took place at the second institution during Fall'15 (current semester). The second evaluation (post-2D/pre-3D) at the first institution was administered at the start of Fall'15, and at the second institution was done in the second week of October. The third survey (post-3D) will take place at both institutions at the end of the Fall'15 semester (first week in December).

Participation in the survey was without any incentive offered, besides the explanation indicating that this will be used to possible redefinition of course content. The test was administered during lecture time, at the end of session in the last 25 minutes, and there has been a high level of participation.

Initial results regarding spatial visualization (at first institution) after 2D offerings reflect expected results for this type of activity. There are no final objective results at this point, some initial anecdotal results indicate some benefit of the 3D concepts being offered. Final results are expected at the end of the current semester, with a higher degree

of validity to any conclusion(s). The objective of comparing the effect of 3D concepts will be based on the comparison of average scores pre-3D and post-3D. Those results will be compared as well to the pre-2D and post-2D scores in order to define the magnitude of the impact of 3D concepts. Additional possible correlations will be established based on academic status/interest, previous experience, and gender. Standard deviations will be used to evaluate the validity of any conclusions drawn from the data in this pilot study. One interesting comparison that is expected to be reported is between having a second course or half a course with 3D concepts.

## **Conclusions**

This study is expected to provide information on the possible improvement of spatial visualization skills when 3D concepts are covered in the curriculum. The expectation is that students will have a positive outcome from such additional 3D materials. Similarly, it is expected that the level of visualization skills will be more homogeneous at the end of the 3D segment/semester. Final outcomes will be done in six weeks. Based on the results after administering the survey in two groups, some decisions are possible in terms on the content in the course that needs to be emphasized in order to fulfill the expected improvement and homogenization of the visualization skills of the students. Such knowledge will help in a more efficient design process, thus increasing productivity in any academic or industry endeavor.

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