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Confidence - A Path to Mastering Challenge, Exploring strategies to strengthen students' confidence in graphical expression through transformative experiences

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Confidence - A Path to Mastering Challenge
Exploring strategies to strengthen students' confidence in graphical expression through transformative experiences

Abstract

This study is an exploration into strategies designed to strengthen students' awareness of the relationship between their perceived and actual skills and abilities. Early engineering graphics courses are often students' first exposure to professional standards, expecting them to apply concepts, to choose critically, to qualitatively evaluate and to work harmoniously with their hands and minds. Classroom experience shows that students are increasingly unable to gauge their level of preparedness and to participate effectively in classroom activities. Students are struggling to visualize and sketch objects and processes, they are overwhelmed to employ descriptive geometry and to interpret two-dimensional representations of objects. The early and often exclusive use of digital tools, as well as an emphasis on standardized testing, seems to leave students unprepared for the challenges they encounter in engineering graphics courses. The strategy chosen for this study is a comparison of students' initial perception of their preparedness at the beginning of the semester with their confidence level based on accomplishments at the end of the semester. The outcome of this study hopes to illustrate that the chosen methods can support instructors of early engineering graphics courses in sustaining a quality educational outcome as well as offering tools and experiences to students to encourage them in taking ownership of their education. Figure 1 depicts the strategy for this study.

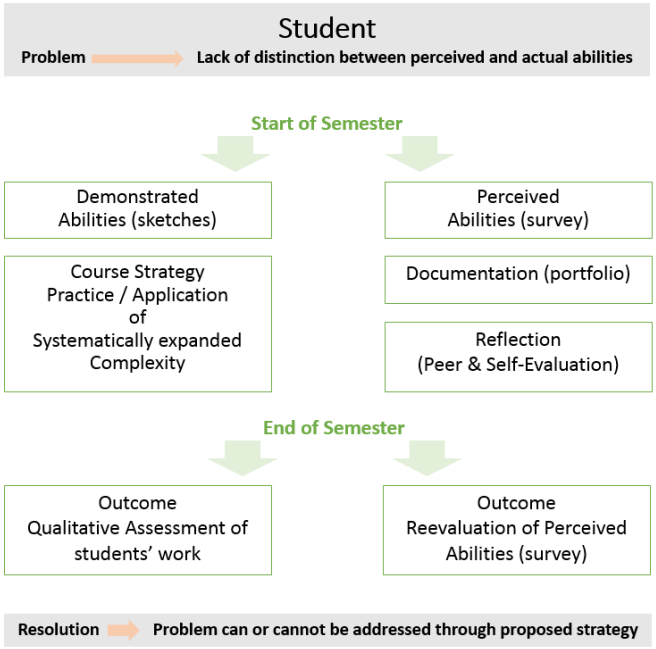


Figure 1. Strategy of Study

Introduction

"I am more of a visual learner" is a statement often heard from students enrolled in an introductory engineering graphics class when asked to study their textbooks. Equally frequent is the statement "I'm not an artist" when asked to sketch isometric views of objects. "I am a hands-on learner", is often paired with little curiosity in experimenting with drafting tools. There seems to be an interesting conundrum concerning students' interpretation of popular terminology and how those frameworks relate to their actual abilities. Early engineering graphics courses are often the first exposure to professional standards that asked students to apply concepts, to choose critically, to qualitatively evaluate and to work harmoniously with their hands and minds. Classroom experience shows that students increasingly struggle to gauge their level of preparedness and to participate effectively in classroom activities. When is the time to seek out support or to utilize resources; how much time should be spent with course material outside of scheduled class time; how much practice is needed to refine skills? These questions are essential for students in order to mature and take ownership of the education they pursue.

The current generation of freshman college students – born around 1995 - was raised in a world that depends on internet access and the use of digital tools to accommodate learning, as well as to demonstrate their knowledge, primarily through standardized multiple choice tests. Even though this process has happened incrementally over time - at this point college educators have to acknowledge that freshmen, educated in public schools, have spent much of their school career focused on achievement test results. In their article "No Child Left Behind: Implications for College Student Learning", Trolian and Fouts (2011) share their concern that students might become passive learners and task-oriented do-ers . . . expecting answers to be handed to them, rather than learning the methods to discover answers for themselves[1], attitudes that certainly can be observed in college classrooms. In the introduction to his book "Taking Aim at Testing" Richard Rothstein (2009) writes, accountability based exclusively on test score gains has corrupted American education. To spend more time raising reading and math scores, schools pay less attention to non-tested academic subjects[2]. As Diane Ravitch (2010) points out in her book "The Death and Life of the Great American School System" even the National Academy of Education worries we are apt to measure what we can, and eventually come to value what is measured over what is left unmeasured (p.167)[3]. In response to an educational background that informs the study habits of many students, this study is exploring teaching methods that focus on developing students' confidence in their actual abilities of visualization and graphic expression through classroom experience and reflection. The experience in the classroom can either confirm students' perception or broaden their framework. As Mezirow (1991) pointed out in his theory of transformative learning, we do not make transformative changes in the way we learn as long as what we learn fits comfortably in our existing frames of reference (p.7)[4]. Classroom observations suggest that students who feel comfortable and confident about their ability to graphically communicate and to critically reflect on their work are more willing to engage in further challenges and more likely succeed in their goals. The statement made in the Grinter Report (1955) that graphical expression is both a form of communication and a means for analysis and synthesis. The extent to which it is successful for these purposes is a measure of its professional usefulness. Its value as a skill alone does not justify its inclusion in a curriculum. The emphasis should focus on spatial visualization, experience in creative thinking, and the ability to convey ideas, especially by free-hand sketching, which is the normal mode of expression in the initial stages of creative work (p.16)[5]. Even though quite dated, the statement still holds truth. Contemporary digital tools add another layer of necessary competencies. Graphic

communication is a continuously evolving subject. Students need to be prepared for present demands in their fields as well as develop the aptitude to strive for quality and effectiveness in the dialogue with technology. Students do not only have to adapt to, but also drive, the changing needs and possibilities of graphic communication in their respective fields.

Purpose

This exploratory inquiry addresses the following research questions. Can the correlation between a preconceived notion of ability and the actual experience of performance be illuminated for students? Does anticipated failure or success - the framework that defines what can or cannot be achieved - hinder students' to engage in concepts of visualization?

Methodology

The student group chosen to participate in this study is enrolled in an introductory engineering graphics course. These students are primarily freshmen and for many of them this is the first course reflecting practical aspects of their chosen major. This course is offered to all engineering programs and therefore is comprised of a diverse audience – future manufacturing, mechanical, and packaging, plastics and supply chain engineers as much as technology educators.
Figure 2 illustrates the learning process as it might be experienced by a freshman student, including possible areas of intervention. The objectives of this course include freehand sketching, drafting standards and descriptive geometry, dimensioning and tolerances, working drawings, and CAD principles. The number of participating students is about 175.
An initial survey administered at the beginning of the semester is documenting students' perception of their graphic abilities, their learning styles and achievement goals. A similar survey at the end of the semester will clarify whether or not a broadening of the initial perception has occurred. The survey is conducted anonymously but pre and post survey can be associated through the use of random codes. The project was determined to be exempt from review by the Institutional Review Board for the Protection of Human Subjects in Research (IRB).
Some survey questions are listed in Figure 3.

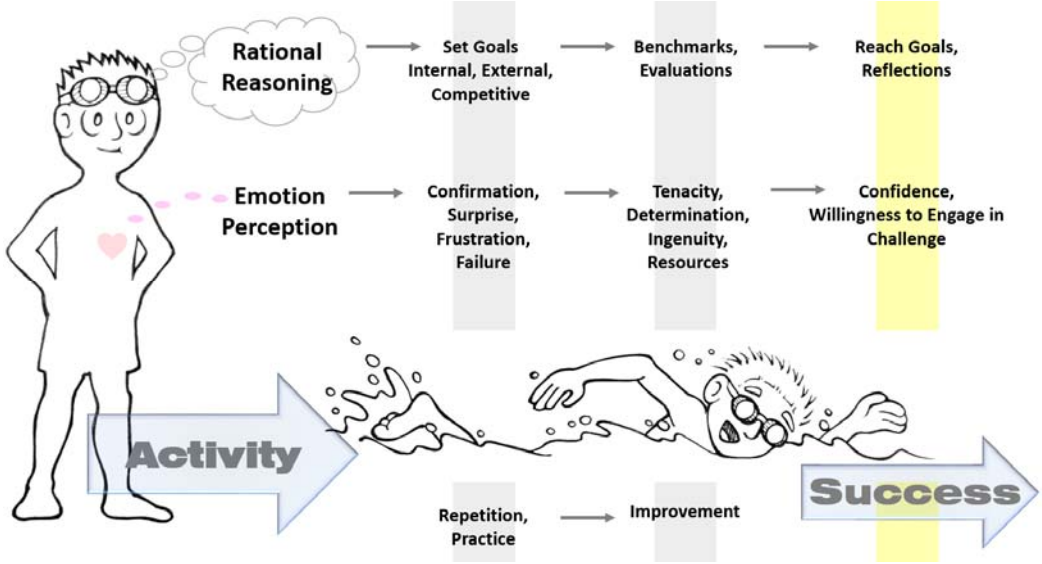
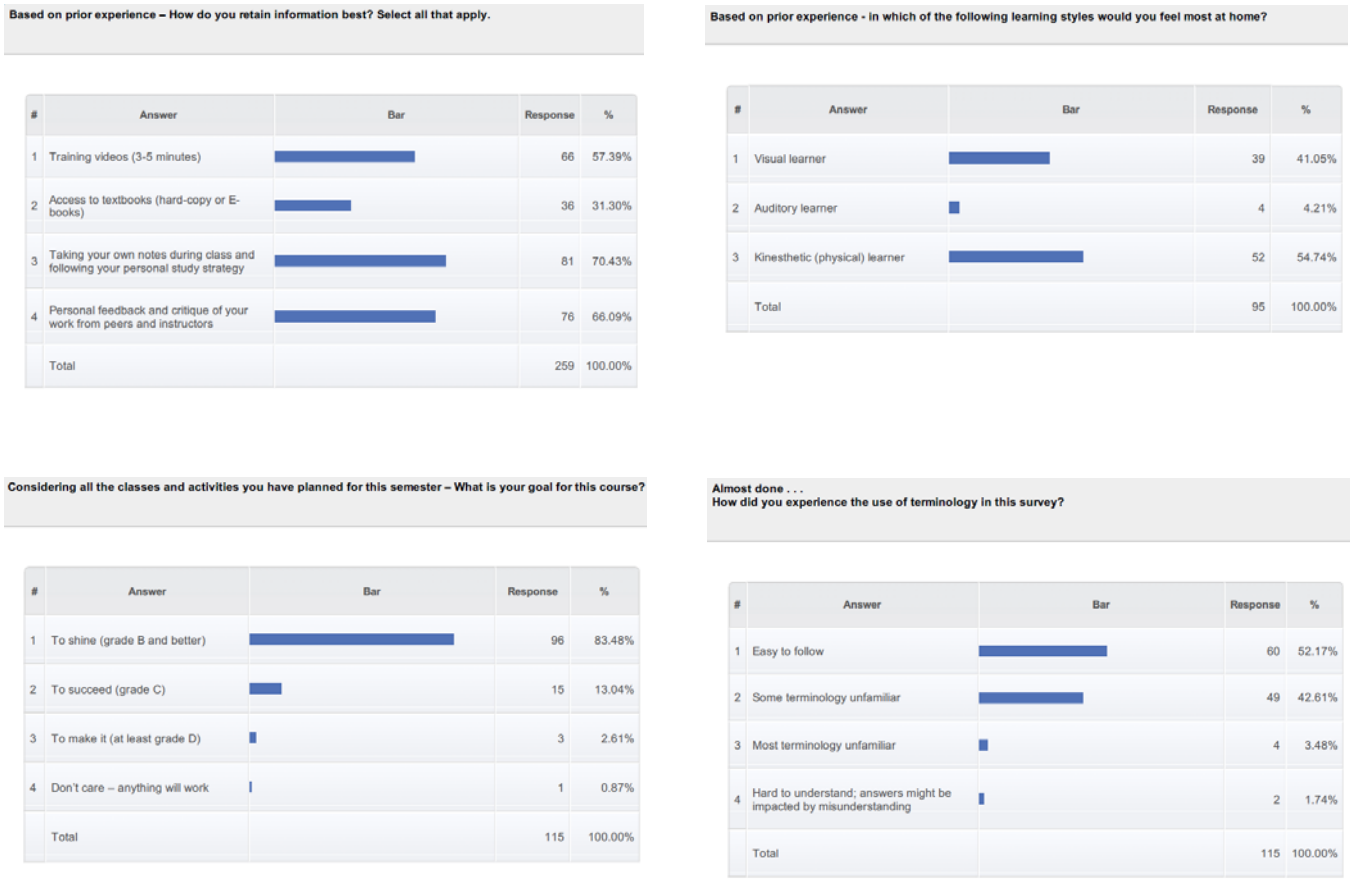


Figure 2 - Learning process diagram



Based on prior experience – How do you retain information best? Select all that apply.

#	Answer	Bar	Response	%
1	Training videos (3-5 minutes)		66	57.39%
2	Access to textbooks (hard-copy or E-books)		36	31.30%
3	Taking your own notes during class and following your personal study strategy		81	70.43%
4	Personal feedback and critique of your work from peers and instructors		76	66.09%
	Total		259	100.00%

Based on prior experience - in which of the following learning styles would you feel most at home?

#	Answer	Bar	Response	%
1	Visual learner		39	41.05%
2	Auditory learner		4	4.21%
3	Kinesthetic (physical) learner		52	54.74%
	Total		95	100.00%

Considering all the classes and activities you have planned for this semester – What is your goal for this course?

#	Answer	Bar	Response	%
1	To shine (grade B and better)		96	83.48%
2	To succeed (grade C)		15	13.04%
3	To make it (at least grade D)		3	2.61%
4	Don't care – anything will work		1	0.87%
	Total		115	100.00%

Almost done . . .
How did you experience the use of terminology in this survey?

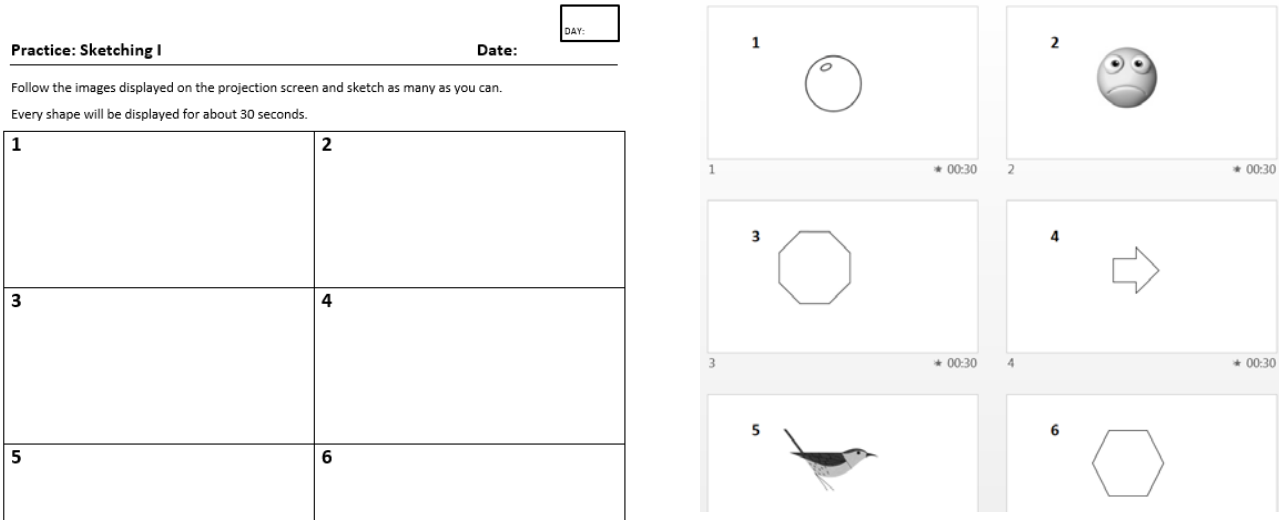
#	Answer	Bar	Response	%
1	Easy to follow		60	52.17%
2	Some terminology unfamiliar		49	42.61%
3	Most terminology unfamiliar		4	3.48%
4	Hard to understand; answers might be impacted by misunderstanding		2	1.74%
	Total		115	100.00%

Figure 3 – excerpt of introductory survey

In this initial study, the research team decided to focus on sketching, spatial visualization and visual expression as an essential preparation for the introduction of CAD and modeling tools. The intent is to expand this study in the future to areas of object dimensioning and tolerancing. In addition to research conducted by Norman (1994), where he found that a person's spatial skill level was the most significant predictor of success in their ability to interact with and take advantage of the computer interface[6], Sorby (1999) concluded in response to a study conducted at MTU that in order to develop 3-D spatial skills, the answer is sketching, sketching, sketching[7]. Parallel to analytical introductions of projection methods, students are asked to complete in-class sketching exercises of progressing complexity. Images are projected on the classroom screen and changed in quick paced intervals. Each sketching sequence contains 12 to 20 images. This type of practice is implemented throughout the semester. Figure 4 & 5 show examples of exercises with two and three dimensional geometries and pictorial images. Exercises are not graded or evaluated for accuracy, but completion is expected and students collect classroom material in a mandatory portfolio.

Exercises are intentionally paced by pre-set time intervals to avoid distraction and to focus students' attention. Students and instructor discuss the outcome of the activity, suggestions are

made for effective approaches or improvements and, if desired, the image sequence is replayed to allow for corrections.



DAY:

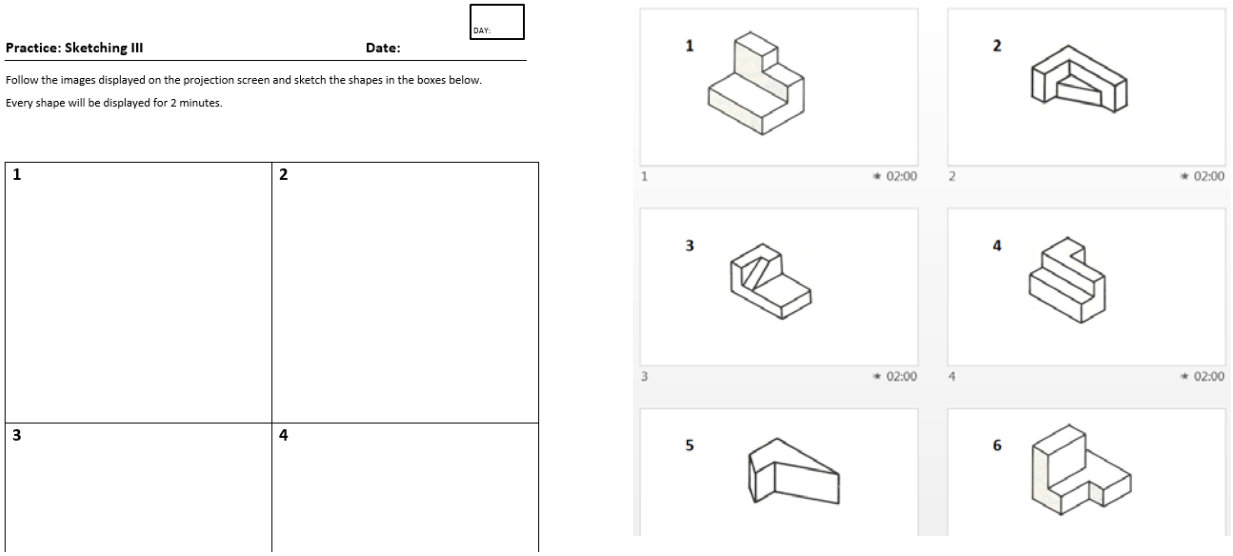
Practice: Sketching I **Date:**

Follow the images displayed on the projection screen and sketch as many as you can.

Every shape will be displayed for about 30 seconds.

1	**2**
3	**4**
5	**6**

Figure 4 – Sketching Practice 2D, excerpt of worksheet and projected images



DAY:

Practice: Sketching III **Date:**

Follow the images displayed on the projection screen and sketch the shapes in the boxes below.

Every shape will be displayed for 2 minutes.

1	**2**
3	**4**

Figure 5 – Sketching Practice 3D, excerpt of worksheet and projected images

Diamond (2005) highlighted that elevated levels of stress (or glucocorticoids) may also enhance attention and memory, depending on whether the information is a part of, or outside of, the stress context, as well as whether the stress occurs at the time of acquisition versus the retrieval phase of memory[8]. His publication took into account much earlier work on this topic as he emphasized that it has been almost a century since the first paper describing a non-linear relationship between arousal and behavioral performance was published (Yerkes and Dodson 1908)[8].
Figure 6 illustrates the linear and non-linear components of the Yerkes-Dodson Law based on task difficulty.

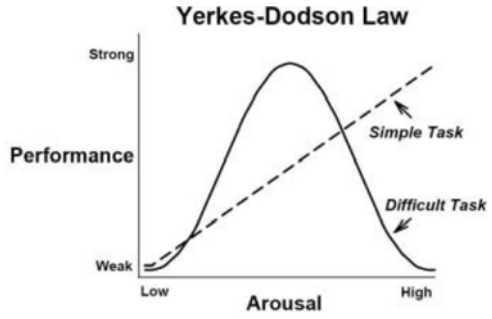


Figure 6 – Yerkes-Dodson Law, Diamond D. (2005)[5]

In addition to practical applications of visualization concepts, students also engage in guided peer evaluation and self-assessment. These critical reflections are essential, with the purpose of pointing out paths and resources that can lead to improvement. Students have the opportunity to witness how their feedback impacts the work of others. Instructors assign new partners or teams for each evaluation task to allow for fresh input and vital dynamic throughout the process.
Students are required to document their work in a portfolio. This task is given relevance through active use of the portfolio in the classroom. Lowenfeld (1945) pointed out that individuals who are haptic learners often prefer to orient themselves to the world of experience through touch, bodily feelings, muscular sensations and kinesthetic fusions[9].
The portfolios are reviewed in class and used by students as a study guide and resource. Additionally, these portfolios are tangible reminders for each student - documenting their process of accomplishment. They reflect a starting point, steps of improvement and the current status of proficiency.

Study Outcome

The pre and post survey data allow a comparison of students' perception of their abilities - before they start the course and after having experienced and documented their own performance throughout the semester. Sketches created by students throughout the semester will be collected, categorized and evaluated. The assessment of the compilation can show the level of quality achieved by a representative number of students and it can illustrate inasmuch the level of confidence expressed in the survey data is justified by the factual quality of work documented.
Figure 7 shows examples of the assessment strategy utilized to document the quality of students' sketches. Data collection for this initial phase of the study is still in progress and is anticipated to be concluded in early spring.

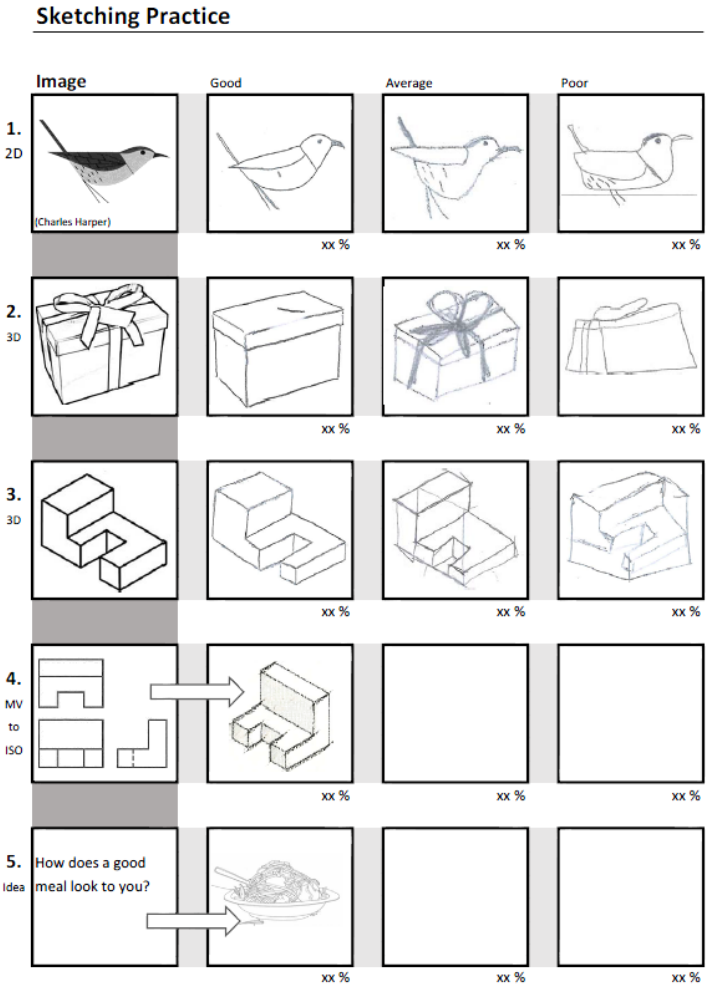


Figure 7 – quality assessment tool

Conclusion

At this point no concluding remarks can be shared. The expectation is that the quantitative data collection allows comparative insight into students' perception of their abilities and skills prior to starting the course and after completion of the course. Data derived from the quality assessment of sketch exercises will reflect students' actual performance. The conclusion will demonstrate if students' perception of their abilities and their actual performance are in correlation.

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Additional Resources

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