AC 2007-2261: ASSESSMENT OF LEARNING AND ITS RETENTION IN THE ENGINEERING DESIGN CLASSROOM

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Assessment of Learning and its Retention in the Engineering Design Classroom Part A: Instrument Development

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Abstract
This paper describes the development of an engineering design knowledge assessment instrument. While, our ultimate goal is to prepare the environment and conditions that are most conducive for our students in teaching engineering design concepts, we often are unable to determine whether or not changes to the classroom environment have any impact on student learning due to a lack of validated instruments. Therefore, the overall purpose of this project is the development of a stable instrument designed to measure the impact of pedagogic changes and supporting classroom materials on student learning. This paper documents the rationale for developing a new instrument and describes its development process.

Introduction
Assessment of students' engineering design knowledge at various points during their engineering curriculum is very critical. This assessment might have many purposes including gaining an understanding on: 1) are most students able to meet the intended objectives for the course? 2) is the information retained after a period of time has elapsed? 3) what are the areas that students have the most difficulty learning? With similar purposes in mind our team has evaluated the literature to determine what instruments exist that are intended to measure engineering design knowledge and how these instruments have been used in other engineering schools. After our extensive review, we concluded that available instruments were not as comprehensive as we had hoped. Accordingly, we have teamed up with learning specialists and embarked on the development of a new instrument. This paper documents this effort.

In the paper, first we provide a summary of our investigation on the availability of knowledge assessment tools on design, and then provide details on the development of the new instrument, which we have named as CADEK: Comprehensive Assessment of Design Engineering Knowledge instrument.

Literature Review
For continuous improvement of the engineering design education, both formative and summative assessments are needed[6]. Formative assessments provide feedback in the early stages of student's design knowledge experience which helps to ensure the development of their capabilities. Summative assessments, on the other hand, provide a measure of the program impact on the student achievement, necessary for evaluating the full scope of engineering degree program.

There have been several engineering design knowledge assessment tools in the past, which have aided the engineering design educators, engineering educators and learning assessment specialists. In general, assessment tools should be designed in such a way that they are capable of capturing the whole learning process which the individual students go through within the team. According to Bailey et al. [2], most of the previous assessments relied on 1) team grades on design reports, 2) performance of teams' built design artifact, and on 3) student's ability to answer design questions on tests. Wendy C. Newstetter and Sabir Khan[1] of Georgia Institute of Technology have developed three design assessment tools, which include Portfolio Assessment, Concept Maps and Freewriting. In the portfolio assessment, students were given portfolio assignments to include all iterations of the design specifications in reverse engineering a computer disk and a final specification along with detailed text. These assignments were evaluated using a rubric which has a set of six criteria and students were rated on a five point scale. In the Concept Map assessment technique, students were asked to list all words they could associate with the concept design on their first day of class, and then to map those words into a structure showing links and relationships. The same procedure was repeated at the conclusion of the course and the baseline maps were compared to the end of term maps. In the Freewriting technique, students were instructed to write continuously for five to ten minutes and at the end of the allotted time, they were instructed to summarize what they had written so far. McGourty et al.[12] point out that at present the outstanding issue is to develop rubrics and other assessment measures that will allow cross-institutional evaluation of reflective portfolios and mention that investigation of approaches to better score the concept maps and improve the understanding of how they should be used for outcome assessment is still ongoing.

One other method used to measure design knowledge is the video recording of design teams, analyzing the activities performed by the students within the design teams and accordingly evaluating them based on a predefined rubric. However as Bailey et al.[2] rightly put it, the video recording process is not realistic to evaluate large number of students within several design teams as watching and reliably scoring the tapes require a huge amount of time. Researchers at University of Massachusetts Dartmouth are trying to overcome this by planning to construct a computer simulation, which puts students in design scenarios and asks questions at key points to gain insight on how students would proceed[13].

Some educators use common exams, which ask students open-ended and close-ended questions to assess the effectiveness of first year engineering courses. Administration of tests and closed-response questionnaires to students are examples of quantitative research techniques, which result in numeric data that can be statistically analyzed[9]. Utilizing questions that are close-ended has some advantages[5] including ease of scoring. In contrast, utilizing open-ended items can be more challenging because of the difficulty obtaining sufficient reliability across multiple raters. However, measuring procedural skills which generally encompass issues within the domain of engineering design is very difficult to measure using solely multiple-choice questions. Several tools for assessing the design knowledge of students with the use of open-ended and close-ended questions in University of Massachusetts-Dartmouth are still in developmental stages[13]. These include Design Process Knowledge Test, which is a set of close-ended questions used to assess the declarative knowledge of design students, while another tool involves the use of open-ended questions, where students are asked to assess a design task through essay or survey.

Classroom assignments, in the form of team-based reports, are also often used in assessing students' attainment of engineering design knowledge. Assessing changes in individual knowledge generally cannot be based directly on reports written by an entire team because there might be a possibility that all students have not contributed equally in the documentation of the report. Thus, the knowledge gained by students is likely to vary within a team. Bailey et al.[3] also observed a wide variability in grading among the twenty different faculty teaching ENGR102 each year at University of Arizona and a decision to include pre-service teachers in the development and application of assessment was made.

Short essay responses have also been used in the past, as they are useful tools to measuring student's engineering design knowledge in project-based courses. However definition of a well-defined criterion describing how these essays should be graded is of paramount importance. The two main methods of scoring these essays include the analytical method and the holistic method. Leydens et al.[9] defines the analytic rubric as one which uses scales to rate different aspects of the responses provided by students while the holistic rubric uses a single scale to evaluate the larger process reflected through the response. According to Bailey et al.[5], the advantage of analytic rubric is that it provides a more objective way of assessing students' strengths and weaknesses while enabling teachers to have a clear picture of the elements that the students have difficulties in answering and which need to be re-taught. The disadvantage of analytic rubric over holistic rubric is that the students are compared with the ready-set standards developed in accordance to instructor's expectations about what the students are supposed to know.

According to Janet K. Allen of Georgia Institute of Technology[4], assessing the engineering design knowledge of students when they actually do the design is important but also presents difficulty in implementation. When the goal of the assessment is to measure the change in the students' engineering design knowledge, pre-test/post-test experimental design[2] is selected. Several factors need to be considered while developing the pre-test and post-tests, which include:

- There is no right answer to a problem.
- The focus in engineering design course should be mainly on the process of design and not on the end results of the design.
- It is difficult to measure the students' engineering design knowledge by how well their designs perform when built and demonstrated.
- It is difficult to measure the design knowledge on an individual level, when the design always occurs in teams.

The Transferable Integrated Design Engineering Education (TIDEE) project, which was the result of a joint effort of faculty from Washington State University, University of Washington and Tacoma Community College, has been focused on assessing design capabilities of students in freshman and sophomore years[6]. Recently, however the TIDEE collaborators shifted their focus from articulation between 2-year and 4-year programs to capstone course assessment[7], as the result of the 2002 survey of capstone design course instructors (conducted by the TIDEE consortium of colleges in the Pacific Northwest) showed that many struggle with accessing design adequately. Performance criteria required to determine whether educational design objectives have or have not been achieved, has been identified through the TIDEE workshops involving faculty and engineers from industry. According to Davis et al.[6], these criteria may span the four levels of achievement, which include 1) Basic Knowledge, 2) Application of Knowledge, 3) Critical Analysis and 4) Extension of knowledge or may also include evidence of knowledge, demonstration of process skills or quality of products delivered. They also proposed two different assessment instruments to fit design and educational objectives at mid-program and end-of-program points. For example, all the students of CEEGR 100 at Seattle University were given the TIDEE assessment during the second and third class periods. This assessment began with a 15 minute short answer pre-test that assesses the individual students' knowledge about the design process, teamwork and design communication. The second portion consisted of a 35 minute session where the teams of 3-4 students apply the design process and effective communication to complete a design assignment on time. The last part of the assessment was a take-home reflective essay which was intended to allow the students to assess their knowledge and performance in terms of effective design, teamwork and communication practices. A comparison of the pre-course and post-course surveys indicated that the students developed a clear understanding of the profession (Thompson[10]).

Davis et al.[8] mentions that the goal of the mid-program-point is that students should be given the opportunity to demonstrate their knowledge and skill to perform design, while at the end-of-program point; the students must have an opportunity to demonstrate much more sophisticated skills for planning, implementing, evaluating and improving their processes. These opportunities exist when the students work in design teams that last typically ten to thirty weeks and require expertise from different disciplines. Proper documentation of the design steps performed by the students is necessary to score their achievements. Much of the evidence required to score these achievements may be obtained from weekly progress reports and lists or tables related to the phase of the project addressed in that week. The end-of-program assessment is also capable of measuring student design achievement at advanced levels as desired by employers of engineering graduates.

Instrument Development & Pilot Tests for Validity Analysis

Mindful of our findings in the literature, we have developed an instrument (Comprehensive Assessment of Knowledge on Engineering Design – CADEK) to be used as a pre-test /post-test instrument to assess the knowledge level on engineering design. This instrument consists of 20 constructed-response questions designed to measure the skills and concepts that could be taught in an introductory Engineering Design courses. The questions were developed by a team of faculty members who were currently teaching the introductory engineering design course. The concepts on the CADEK included knowledge and skills related to engineering design process, working in teams, and design communication. The test was developed to require approximately 45 minutes for each student to complete.

Grading guidelines and a rubric were also developed. Each question in CADEK is graded on a scale of 0 to 10, with 0 being the lowest, and 10 being the highest score. These scores are awarded in steps of 0.5 and the questions are evaluated on the basis of the completeness and appropriateness of the answer expected for the particular question. Those questions, which were related to the definitions and explanations of the various engineering design concepts, are scored on the basis of comprehensiveness and un-ambiguity. These scores are awarded, based on the student's understanding of the relevant concepts. Multiple choice questions are graded 0 for the wrong choice and 10 for the correct choice. Finally, the questions involving sketches were evaluated on the basis of the completeness, line type, alignment, and the clarity of features indicated in the sketch. Once all the questions are graded for a particular student, a cumulative score was prepared for that student, by equal weighting all the individual scores of the questions. This total score is obtained out of 100 points and reflected the engineering design related knowledge acquired by the student.

During the pilot testing phase, a sample of 21 students enrolled in the introductory engineering design course was asked to complete the CADEK at the end of the semester. Following each individual item, students were asked to rate two statements concerning their perspective of whether the question was appropriate to measure learning in the course. These two questions were:

1) "I have acquired related knowledge to this question during the design class I have just completed," and
2) Any person who takes this course should be able to answer this question."

Students checked off whether they agreed, disagreed, or felt neutral to each statement. In order to effectively compare items to each other using means and standard deviations, the answer of "agreed" was coded as 3, "neutral" was coded as 2, and "disagree" was coded as 1.

One of the CADEK questions is given in Table 1 to further explain the instrument and its pilot testing. Earlier version of the question presented in table specifically asked the use of certain tools: AHP or pairwise comparisons for understanding relative importance of criteria; and Pugh charts for concept selection. However, a discussion among several faculty members teaching a similar course resulted in concerns regarding using specific tools in comparison to others, or using various names in reference to specific decision tools. Accordingly, the instrument was revised to adopt a more generic language (e.g., "an appropriate design evaluation and selection tool" was used in place of Pugh charts).

Table 1. Sample question from CADEK

E. a. Five concepts are presented below for the source of power/driver for the design of a self-propelled wheel chair. Determine the top three contending concepts using the following evaluation criteria and an appropriate design evaluation and selection tool.

	Please indicate your agreement with the statement by putting an X in the most appropriate cell.	Disagree	Neither disagree nor agree	Agree	No answer
1	I have acquired related knowledge to this question during the design class I have just completed.	0%	4.8%	95.2%	0%
2	Any person who takes this course should be able to answer this question.	0%	4.8%	90.5%	4.8%

Table 2 displays the frequency distributions for the students' self perceptions of whether they feel they had acquired the particular knowledge or skill being measured by each item during pilot. Because the data obtained by both questions in the student perception questions for each item were so similar, only the student's self perceptions are displayed and discussed below.

Table 2. Descriptive data for student perception ratings having personally acquired this knowledge or skill

Item	Frequency who disagreed	Neutral	Frequency who agreed	No response	Average rating	Standard deviation
A	1 (4.8%)	2 (9.5%)	18 (85.7%)	0 (0%)	**2.81**	0.51
B	1 (4.8%)	7 (33.3%)	13 (61.9%)	0 (0%)	**2.57**	0.60
C	4 (19.0%)	5 (23.8%)	11 (52.4%	1 (4.8%)	2.35	0.81
Da	4 (19%)	4 (19%)	13 (61.9%)	0 (0%)	2.43	0.81
Db	1 (4.8%)	0 (0%)	19 (90.5%)	1 (4.8%)	**2.90**	0.45
Ea	0 (0%)	1 (4.8%)	20 (95.2%)	0 (0%)	**2.95**	0.22
Eb	0 (0%)	4 (19%)	14 (67.7%)	3 (14.3%)	**2.78**	0.43
Fa	2 (9.5%)	5 (23.8%)	14 (66.7%)	0 (0%)	**2.57**	0.68
Fb	11 (58.4%)	8 (38.1%)	2 (9.5%)	0 (0%)	1.57	0.68
Fc	0 (0%)	6 (28.6%)	15 (71.4%)	0 (0%)	**2.71**	0.46
Fd	1 (4.8%)	5 (23.8%)	15 (71.4%)	0 (0%)	**2.67**	0.58
G	0 (0%)	1 (4.8%)	20 (95.2%)	0 (0%)	**2.95**	0.22
H	0 (0%)	0 (0%)	21 (100%)	0 (0%)	**3.00**	0.00
I	0 (0%)	1 (4.8%)	19 (90.5%)	1 (4.8%)	**2.95**	0.22
J	13 (61.9%)	3 (14.3%)	3 (14.3%)	2 (9.5%)	1.47	0.77
K	0 (0%)	3 (14.3%)	16 (76.2%)	2 (9.5%)	**2.84**	0.37
L	8 (38.1%)	4 (19%)	4 (19%)	5 (23.8%)	1.75	0.86
M	1 (4.8%)	4 (19%)	11 52.4%)	5 (23.8%)	**2.63**	0.62
N	0 (0%)	1 (4.8%)	14 (66.7%)	6 (28.6%)	**2.93**	0.26
O	0 (0%)	1 (4.8%)	13 (61.9%)	7 (33.3%)	**2.93**	0.27

The results suggested that students perceived most items to be an adequate reflection of the material covered in their introductory engineering design course. 15 out of the 20 questions received ratings of 2.57 or better. Only three questions received less than 2. These questions are related to knowledge on benchmarking types, green design, and material properties. Based on these ratings and student comments one question was removed from CADEK. Current version of CADEK is presented in the Appendix. We consider CADEK to be in its preliminary stages and continue to work on its validation.

Conclusion

In the paper, we report the development process of CADEK. While the students' perspectives on the appropriateness of the test for measuring learning in introductory design courses is important, additional checks for validity of the instrument are still required. In another study, we report on the utilization of the instrument as a pre/post-test to measure the effectiveness of changes to the curriculum. Along with this study, we are currently exploring student learning gains to specific questions.

Future studies on the instrument to enhance its validity include additional expert-review and think-aloud protocols. Although experts were utilized in the initial construction of the test, we may seek out additional expert review to determine if the questions are both relevant to and representative of the domain of engineering design knowledge. Think-aloud protocols, in which students verbalize their thoughts as they complete the instrument, could also be helpful in determining whether the items are functioning as intended.

References

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Appendix.
COMPREHENSIVE ASSESSMENT OF DESIGN ENGINEERING KNOWLEDGE (CADEK)

CADEK Design Team Knowledge Assessment – Version 1 August 2005

ASSESSMENT INSTRUMENT

Purpose: Formative assessment of students' knowledge of the engineering design process, teamwork, and design communication.
Instrument Type: Constructed-response questions related to the engineering design process, teamwork, and design communication.
Implementation: Requires 45 minutes for administration.

INSTRUMENT DEVELOPMENT

Developed and in process of validation at The Pennsylvania State University as a deliverable for a Schreyer Institute Curriculum Innovation Grant. Partial support for development, pilot testing, and validation of this assessment was provided by the Schreyer Institute for Teaching Excellence.

Note: First three questions are adopted from the TIDEE instrument.

COMPREHENSIVE ASSESSMENT OF DESIGN ENGINEERING KNOWLEDGE (CADEK)

Name: Date:

Objective: Demonstrate your knowledge of key components of team-based engineering design: Engineering design process and design tools, teamwork, and design communication.

Assignment: You have 45 minutes to provide responses to the questions given below.

Criteria: Your performance will be evaluated based on the number of appropriate responses (elements and/or attributes) you provide for each question.

A. In the space below, describe and/or diagram your understanding of the engineering design process.

	Please indicate your agreement with the statement by putting an X in the most appropriate cell.	**Disagree**	**Neither disagree nor agree**	**Agree**
1.	I have acquired related knowledge to this question during the design class I have just completed.			
2.	Any person who takes this course should be able to answer this question.			

Other comments:

B. Please list elements required for effective teamwork in design projects, and explain why each element is important.

	Please indicate your agreement with the statement by putting an X in the most appropriate cell.	**Disagree**	**Neither disagree nor agree**	**Agree**
1.	I have acquired related knowledge to this question during the design class I have just completed.			
2.	Any person who takes this course should be able to answer this question.			

Other comments:

C. In design projects, documentation and exchange of design information are important. List features that contribute to effective communication.

	Please indicate your agreement with the statement by putting an X in the most appropriate cell.	**Disagree**	**Neither disagree nor agree**	**Agree**
1.	I have acquired related knowledge to this question during the design class I have just completed.			
2.	Any person who takes this course should be able to answer this question.			

Other comments:

D. a. In the design process, why is it important to perform an **external search** (database search, dissection, etc.) BEFORE an **internal search** (idea generation within the team)?

	Please indicate your agreement with the statement by putting an X in the most appropriate cell.	**Disagree**	**Neither disagree nor agree**	**Agree**
1.	I have acquired related knowledge to this question during the design class I have just completed.			
2.	Any person who takes this course should be able to answer this question.			

Other comments:

b. Why is it important to perform a customer needs analysis during the design process?

	Please indicate your agreement with the statement by putting an X in the most appropriate cell.	**Disagree**	**Neither disagree nor agree**	**Agree**
1.	I have acquired related knowledge to this question during the design class I have just completed.			
2.	Any person who takes this course should be able to answer this question.			

Other comments:

E. a. Five concepts are presented below for the source of power/driver for the design of a self- propelled wheel chair.

- Electric Motor
- Internal combustion engine/petrol
- Internal combustion engine/natural gas
- Steam engine
- Compressed air

Determine the top three contending concepts using the following evaluation criteria (assume all criteria are of equal weight) and an appropriate design evaluation and selection tool:

- Cost
- Size/weight
- Safety
- Availability of standard parts
- Range
- Pollution (noise, emissions, etc).

	Please indicate your agreement with the statement by putting an X in the most appropriate cell.	**Disagree**	**Neither disagree nor agree**	**Agree**
1.	I have acquired related knowledge to this question during the design class I have just completed.			
2.	Any person who takes this course should be able to answer this question.			

Other comments:

E. b. Let '>' stand for 'more important than', if:

- Cost > size/weight
- Safety > availability of parts
- Pollution > range
- Size/weight > pollution
- Availability of parts > cost

Use an appropriate comparison tool (make appropriate assumptions for fundamental scale values of relative importance) to obtain the weight order for the evaluation criteria.

	Please indicate your agreement with the statement by putting an X in the most appropriate cell.	**Disagree**	**Neither disagree nor agree**	**Agree**
1.	I have acquired related knowledge to this question during the design class I have just completed.			
2.	Any person who takes this course should be able to answer this question.			

Other comments:

F. Answer the following multiple choice questions.

a. Which one is not an external search method that could be applied during the concept generation? Please circle one.

A. Brainstorming B. Literature review C. Patent search D. Benchmarking

	Please indicate your agreement with the statement by putting an X in the most appropriate cell.	**Disagree**	**Neither disagree nor agree**	**Agree**
1.	I have acquired related knowledge to this question during the design class I have just completed.			
2.	Any person who takes this course should be able to answer this question.			

Other comments:

c. When should the customer needs assessment be performed in relation to concept generation?

A. Before B. Never C. After D. During

	Please indicate your agreement with the statement by putting an X in the most appropriate cell.	**Disagree**	**Neither disagree nor agree**	**Agree**
1.	I have acquired related knowledge to this question during the design class I have just completed.			
2.	Any person who takes this course should be able to answer this question.			

Other comments:

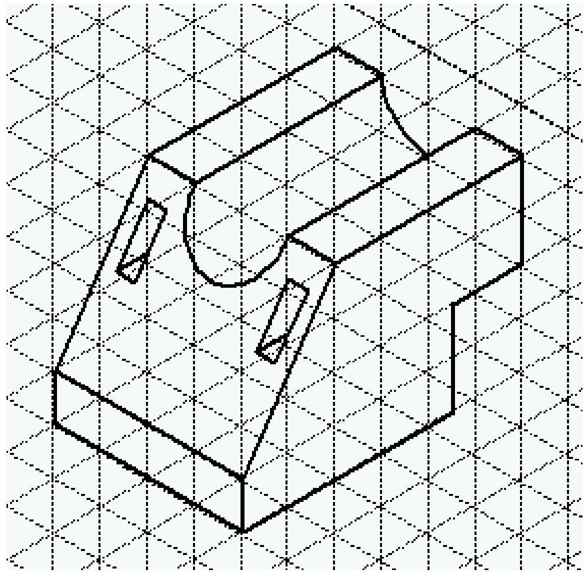
d. In the design process what should follow after conceptualization (idea generation)?

A. Preliminary design B. Detailed design C. Prototyping D. Customer needs assess.

	Please indicate your agreement with the statement by putting an X in the most appropriate cell.	**Disagree**	**Neither disagree nor agree**	**Agree**
1.	I have acquired related knowledge to this question during the design class I have just completed.			
2.	Any person who takes this course should be able to answer this question.			

Other comments:

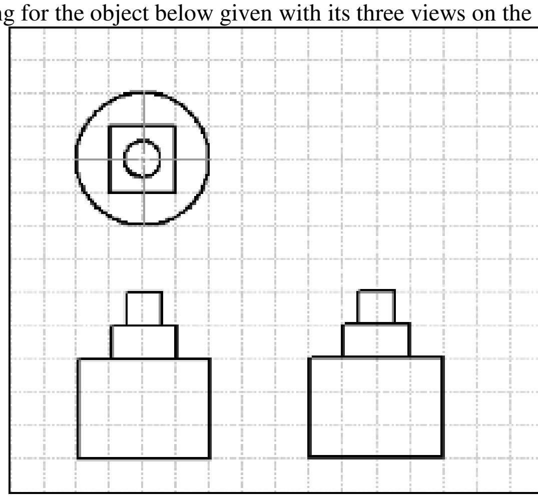
G. Given the 3D drawing below sketch the three principal (Front, Top Right) views in the space next to the figure. You will be evaluated on the completeness, line type, alignment, and clarity of features.



	Please indicate your agreement with the statement by putting an X in the most appropriate cell.	**Disagree**	**Neither disagree nor agree**	**Agree**
1.	I have acquired related knowledge to this question during the design class I have just completed.			
2.	Any person who takes this course should be able to answer this question.			

Other comments:

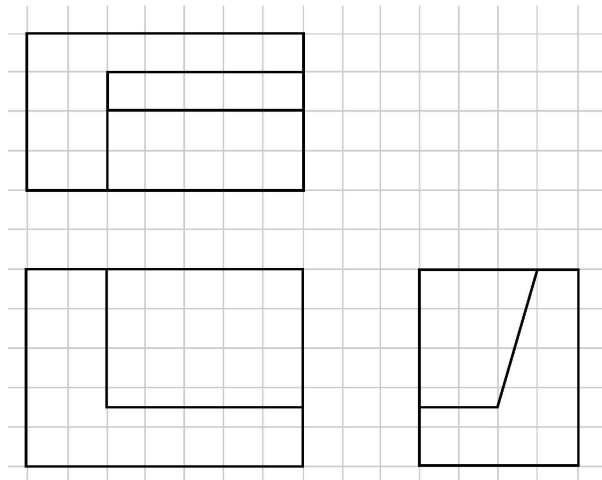
H. Please complete the dimensioning for the object below given with its three views on the figure.



	Please indicate your agreement with the statement by putting an X in the most appropriate cell.	**Disagree**	**Neither disagree nor agree**	**Agree**
1.	I have acquired related knowledge to this question during the design class I have just completed.			
2.	Any person who takes this course should be able to answer this question.			

Other comments:

I. Sketch the isometric pictorial for the object given with 3 views below in the space next to the figure.



	Please indicate your agreement with the statement by putting an X in the most appropriate cell.	**Disagree**	**Neither disagree nor agree**	**Agree**
1.	I have acquired related knowledge to this question during the design class I have just completed.			
2.	Any person who takes this course should be able to answer this question.			

Other comments:

J. The major material categories are metals and alloys, polymers, composites, and gases and liquids. Select **ONE** category, and discuss their general properties. List **FIVE** products that use the material.

	Please indicate your agreement with the statement by putting an X in the most appropriate cell.	**Disagree**	**Neither disagree nor agree**	**Agree**
1.	I have acquired related knowledge to this question during the design class I have just completed.			
2.	Any person who takes this course should be able to answer this question.			

Other comments:

K. Discuss the differences between **personal ethics** and **professional ethics.** Give ONE example that ILLUSTRATES the difference.

	Please indicate your agreement with the statement by putting an X in the most appropriate cell.	**Disagree**	**Neither disagree nor agree**	**Agree**
1.	I have acquired related knowledge to this question during the design class I have just completed.			
2.	Any person who takes this course should be able to answer this question.			

Other comments:

L. The environmental impact we place on the earth (I) can loosely be defined by:

I= Population x Affluence x Technology

It is the technology component where engineers can play a significant role. Give two (2) examples of how technology has been used to reduce the impact on the environment of the products we use without compromising on their intended functionality. Please present your answers as a 'Before' and 'After' scenario. For each example, explain what the technology does in reducing the environmental impact of the 'after' product.

	Please indicate your agreement with the statement by putting an X in the most appropriate cell.	**Disagree**	**Neither disagree nor agree**	**Agree**
1.	I have acquired related knowledge to this question during the design class I have just completed.			
2.	Any person who takes this course should be able to answer this question.			

Other comments:

M. A design team has been charged with the task of designing a movable basketball hoop setup. We will let you assist them at various points in the design process. During the first meeting, the design group list down all the tasks that they foresee will be required for the completion of the project (see list below). What is the project completion time?

The sequence of activities is not given. You decide on the activity sequence by taking into account the flow of activities you have completed in your design projects.

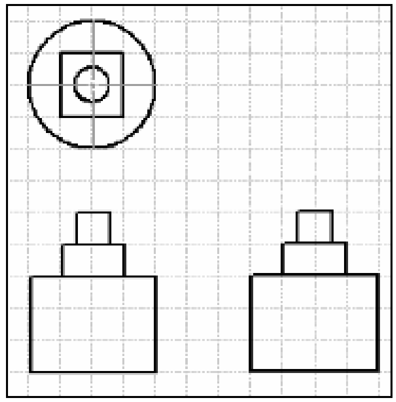
Table 1. List of Task for Design of Basketball hoop setup (not in sequential order).

Task	Description	Duration (weeks)
A	Begin Project	
B	Testing of Final Design	1
C	Material Selection	1
D	Concept Generation	2
E	Final Concept Selection	0.5
F1	Detailed Design of Base Support	1.5
G	Background Research	1
H	Construction and Assembly	2
F2	Detailed Design of Backboard and Rim	2.5
F3	Detailed Design of Support Structures	0.5
I	Completion of Project	

	Please indicate your agreement with the statement by putting an X in the most appropriate cell.	**Disagree**	**Neither disagree nor agree**	**Agree**
1.	I have acquired related knowledge to this question during the design class I have just completed.			
2.	Any person who takes this course should be able to answer this question.			

Other comments:

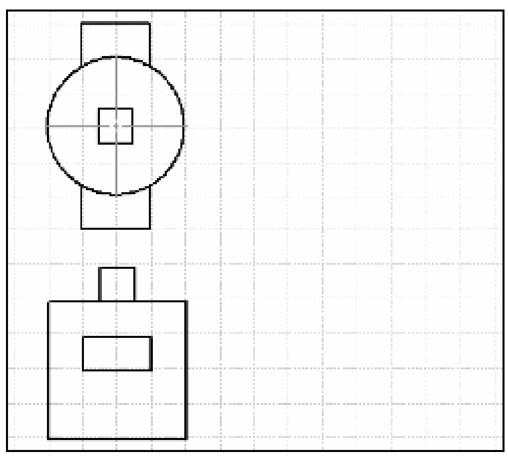
N. Sketch the oblique pictorial of the multiview drawing below in the space provided next to the figure.



	Please indicate your agreement with the statement by putting an X in the most appropriate cell.	**Disagree**	**Neither disagree nor agree**	**Agree**
1.	I have acquired related knowledge to this question during the design class I have just completed.			
2.	Any person who takes this course should be able to answer this question.			

Other comments:

O. On the drawing below, draw the missing view.



	Please indicate your agreement with the statement by putting an X in the most appropriate cell.	**Disagree**	**Neither disagree nor agree**	**Agree**
1.	I have acquired related knowledge to this question during the design class I have just completed.			
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Other comments: