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Comparing Perceptions of Academic Engineering Educators and Classroom Technology Teachers
Research Study Survey Round 2

INTRODUCTORY NOTE TO OUR EXPERT PANELISTS

Dear Colleagues,

Your assistance with Round 2 of this survey is gratefully appreciated. The demographic section has not been changed, however if you participated in Round 1, there is no need for you to provide demographic data again, EXCEPT for QUESTIONS 9 and 14 which will make data analysis easier. If you did NOT participate in Round 1, please be kind enough to respond to ALL the items in the demographic section.

Thank you sincerely,

Michael Hacker, Researcher, (Hofstra University)
Moshe Barak, Ph.D., Research Supervisor, Ben Gurion University, Beersheva, Israel)

Demographic Section:

PLEASE ANSWER this question even if you participated in Round 1.

Name (This will remain anonymous except to the researcher)

Note: You may SKIP this question if you participated in Survey Round 1.

With which Institution are you primarily affiliated? (This will remain anonymous except to the researcher)

Note: You may SKIP this question if you participated in Survey Round 1.

Please indicate whether your institution is private or public

- ○ Private
- ○ Public

Note: You may SKIP this question if you participated in Survey Round 1.

State in which you are located:

Note: You may SKIP this question if you participated in Survey Round 1.

Contact Information (This will remain anonymous except to the researcher)

Email Address

Telephone Number

PLEASE ANSWER this question even if you participated in Round 1.

Into which of the two study groups do you (or did you) best fit? Note: Please be sure to pick one of these two study groups.

- Post-Secondary Academic Engineering Educator
- Secondary School Classroom Technology Teacher

Note: You may SKIP this question if you participated in Survey Round 1.

Please indicate how many years of educational experience you have.

- 0-5
- 5-10
- 10-15
- 15-20
- 20-25
- More than 25

Note: You may SKIP this question if you participated in Survey Round 1.

Please indicate your primary position/role within your institution.

- ○ Post-secondary Engineering Educator
- ○ Community College Faculty Member
- ○ Other Post-secondary Responsibility (Please describe)
- ○ Secondary School Engineering or Technology Teacher
- ○ Other Secondary School STEM Teacher (Please specify subject taught)
- ○ Retired secondary school teacher
- ○ Retired post-secondary faculty member

Note: You may SKIP this question if you participated in Survey Round 1 and/or Round 2

Please indicate the title of the primary course that you typically teach. If you are not presently teaching or have not been teaching for five years or more, please leave this field blank.

Note: You may SKIP this question if you participated in Survey Round 1.

Please indicate whether you have conducted workshops for K-12 teachers within the last three years.

- ○ Yes
- ○ No

PLEASE ANSWER this question even if you participated in Round 1.

What is your gender?

- ○ Female
- ○ Male

Note: You may SKIP this question if you participated in Survey Round 1 and/or Round 2

Please indicate the highest level of education you have completed.

- ○ Some College
- ○ Two-Year College Associates Degree
- ○ College Graduate, Bachelor's Degree
- ○ Master's Degree
- ○ Doctoral Degree (EdD or PhD)
- ○ Professional Degree (MD, JD, etc.)
- ○ Other

Note: You may SKIP this question if you participated in Survey Round 1.

Please describe your prior participation in initiatives linking engineering and K-12 education.

Note: You may SKIP this question if you participated in Survey Round 1.

If you have published recent research papers or journal articles, please list them here.

Note: You may SKIP this question if you participated in Survey Round 1.

If you have been involved in recent funded projects, please list them here.

SURVEY EXPLANATION AND GUIDANCE (REVISED)
This survey is intended to determine which competencies related to engineering and technology are most important for all students in the United States to attain by the time they graduate from high school.

These competencies are not intended to be of specific value only for students who would pursue careers in engineering or technology; rather, they are competencies all students should assimilate as part of their fundamental education.

For each of the following survey items please indicate how important you believe the competency is for all high school graduates in the United States to attain. You would rate an item to be important if you believed that it reflects key knowledge or skill, fundamental principles, organizing concepts, significant ideas, major standards or benchmarks, generalizable ideas, or common themes. You would rate an item not to be important if you believed it to be trivial, too complicated for most high school students, or necessitating too many resources (e.g., instructional time, teacher knowledge, facilities, etc.).

You are asked to rate each item on a seven-point scale where (7) indicates that you strongly agree that the item is important and (1) indicates that you strongly disagree that the item is important. After you respond to each item you have an opportunity to suggest re-wording of the item, suggest deletions, and suggest other competencies that should be added. Competencies have been clustered into five content categories in engineering and technology education that prior research has shown to be overarching: design, modeling, systems, resources, and human values. As this study limits

student competencies to these five categories, please be kind enough to restrict new item suggestions to concepts or skills that you believe fall within them.

If you do wish to suggest a new item related to any of the five content categories, please state that item in behavioral terms (for example students will "model," "design," "evaluate," "create," etc.) as opposed to saying that students will "understand." Additionally, as this research is focused on identifying the most salient and transferrable ideas in engineering and technology education, please ensure that any items suggested for addition are not too technically specific or too atomistic in nature. In this survey round, Round 2, some questions have been modified based on panelist feedback, and a few new questions have been added.

The researchers have attempted to honor as many of the panelists' suggestions as possible without unreasonably extending the length of the survey. We have included all panelists' comments underneath the related item and in this round, you are asked to consider these comments when rating the item. You can choose to change or NOT to change your initial rating.

In the second round, we are asking panelists to give high scores sparingly and avoid the tendency to strongly agree that each item is important. For us to able to establish priorities, we are asking you not to hesitate to mark an item lower on the scale so that the most important items will be more easily discernible.

In an attached file, your initial rating (from survey Round 1) and the combined group's Median rating for each item are indicated. You may want to refer to this attached document for reference.

DESIGN:

To demonstrate knowledge of important engineering and technology concepts and skills, upon graduation from high school students will be able to demonstrate engineering design capability as follows:

D1. Iteratively design and construct a model or full-scale product, system, process, or environment that meets given constraints and performance criteria.

Round 1 Median was 7 (Strongly agree)

Strongly agree	Agree	Moderately agree	Indifferent	Moderately disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Here are panelists' round 1 responses to the above question.
I don't like the wording of this but I can't reword it without changing the meaning. This being one aspect appropriate for all not just Engineering students. ...construct a model of a product.... It is not always possible to create the actual product etc. However, it is possible to create a mathematical, 2D or 3D model that will represent the solution. Iteration is often desired but rarely seen. Eliminate construct; then this could be met in a variety of courses. A key item messing is the concept of modeling to distinguish engineering from other areas such as technology, science and mathematics. Models can be physical, drawings, computational or mathematical, and typically a mixture of these types of models are used in all design activities. I like the word system. It is a "big" word but an important word for students to begin to understand.

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

D2. Solve engineering design problems by identifying and applying appropriate science concepts.

Round 1 Median was 6 (agree)

Strongly agree	Agree	Moderately agree	Indifferent	Moderately disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Click to write the question text

Here are panelists' round 1 responses to the above question.
Because many current design problems may be unsolvable at the high school level, leading many student to get discouraged and "give up" I suggest the following: "Demonstrate the appropriate identification and application of scientific concepts in an iterative engineering design process." limited only by the level of science the student has taken. ...by appropriately identifying, selecting, and applying... I find that students can rarely identify or select the appropriate concepts. Such application is often hindered by the lack of knowledge on the part of the instructor. A key item here is to differentiate between science and engineering by making it clear science is the study of "natural artifacts" whereas engineering is the design and creation of artificial artifacts in the service of mankind Engineering design is part of the process to arrive to the solution to a problem, so I will rephrase it: solve problems by The appropriately use of engineering design, applied scientific concepts and mathematical language I am hung up on "appropriately" apply. Often mistakes lead to learning about *how* to apply scientific concepts

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

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appropriately identifying, selecting, and applying...    I find that students can rarely
identify or select the appropriate concepts.    Such application is often hindered by the
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D3. Solve engineering design problems by identifying and applying appropriate mathematics concepts.

Round 1 Median was 6 (agree)

Strongly agree	Agree	Moderately agree	Indifferent	Moderately disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Here are panelists' round 1 responses to the above question.

Emphasis on "appropriate"...I have seen too many students (seniors in POE) rushing to calculus (because that's what they are currently taking) and without considering a simple algebraic solution, Limited only by the level of math the student has taken. Stem teacher should take these into consideration when designing project based education in order for the student to be challenged and for the student to see the connections. ...identifying, selecting and applying... I find that students can rarely identify or select the appropriate concepts. Lack of instructor mathematical subject knowledge inhibits such a goal. Engineers use mathematics to understand what has happened and what will happen and this is done through models I see STEM as a unit, and there is not need to separate science and mathematics Again, hung up on "appropriately" apply I want them to justify their answers mathematically, but how accurate they are is not as important. That comes with time and learning more advanced math. ~
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Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

D4. Improve an engineering design by identifying, making, and evaluating tradeoffs.

Round 1 Median was 6 (agree)

Strongly agree	Agree	Moderately agree	Indifferent	Moderately disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Here are panelists' round 1 responses to the above question.

No doubt, most difficult for the student without experiences. By identifying, evaluating, and making trade-offs "Specify design criteria and constraints and use them to choose an optimal solution." Optimize means more than this - it would be an iterative process after an alpha and beta prototype. I think here you want to emphasize the criteria and constraints "Optimize" in engineering has a very explicit meaning taken from mathematics. Here what you really mean is to "improve" an engineering design. To state you have "optimized" the design you are explicitly stating that there is nothing more that can be done that will improve the design. In most cases this is never true I would include two words to this statement "…by making and evaluating BENEFITS AND tradeoffs to address…" The word "optimize" suggests a mathematical optimization procedure to me, which it not really what you mean. I would re-word so that you're not using the word "optimize" I would like them to think about optimization, but not necessarily complete optimization of an entire design. The concept of reducing a product or system into sub-parts can be more effective in increasing the ability of high school students to understand optimization. It can be tough concept. Improve rather than optimize ~
Here are panelists' round 1 responses to the above question. No doubt, most difficult for the student without experiences. By identifying, evaluating, and making trade-offs "Specify design criteria and constraints and use them to choose an optimal solution." Optimize means more than this - it would be an iterative process after an alpha and beta prototype. I think here you want to emphasize the criteria and constraints "Optimize" in engineering has a very explicit meaning taken from mathematics. Here what you really mean is to "improve" an engineering design. To state you have "optimized" the design you are explicitly stating that there is nothing more that can be done that will improve the design. In most cases this is never true I would include two words to this statement "…by making and evaluating BENEFITS AND tradeoffs to address…" The word "optimize" suggests a mathematical optimization procedure to me, which it not really what you mean. I would re-word so that you're not using the word "optimize" I would like them to think about optimization, but not necessarily complete optimization of an entire design. The concept of reducing a product or system into sub-parts can be more effective in increasing the ability of high school students to understand optimization. It can be tough concept. Improve rather than optimize

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

D5. Give an example where making a design decision involves weighing tradeoffs between positive and negative impacts and explain the costs and benefits of those tradeoffs.

Round 1 Median was 6 (agree)

Strongly agree	Agree	Moderately agree	Indifferent	Moderately disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Here are panelists' round 1 responses to the above question.
I'm not clear on the difference between this one and D4 This is where ethical issues come into play. Some of the best class discussions I have ever had occurred while discussing these points. Its teaching opportunities like this that make our students better thinkers and socially responsible. Explain, using a specific example.... Requires a higher level of thinking. For me, this would be on a final evaluation of the product - in a comments/reflection paper How about "Give an example where making a design decision using an engineering problem-solving approach involves weighing trade-offs between positive and negative impacts?" "About the use of a particular engineering approach to problem solving" is too confusing Overly complex sentence Give an example of where making a design decision about the use of a particular engineering approach to problem solving involves weighing tradeoffs between positive and negative impacts and explain the costs and benefits of those tradeoffs.

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

D6. Explain why a particular engineering design decision was made, using verbal and/or visual means (e.g., writing, drawing, making 3D models, using computer simulations).

Round 1 Median was 7 (Strongly agree)

Strongly agree	Agree	Moderately agree	Indifferent	Moderately disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Here are panelists' round 1 responses to the above question.

The most powerful tool we have recently gotten was a 3-D printer. The ability for the student to share a "concrete" design with fellow student that was cheap and relatively fast was a major break through in Engineering Ed. ...behind an engineering design decision... Articulate the engineering design decisions using verbal and/or visual means (e.g., writing, drawing, making 3D models, using computer simulations). Don't need the word reasoning ...using different types of models (e.g., writing, drawing, 3D, computer models, math models). How about "communicate" instead of "articulate?"

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

D7. Engage in a socially conscious engineering design activity that relates to a community-based need or global issue (such as providing potable water, providing sustainable agricultural, or utilizing renewable energy sources).

Round 2 Median was 6 (agree)

Strongly agree	Agree	Moderately agree	Indifferent	Moderately disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Here are panelists' round 1 responses to the above question.

I think that this concept needs to be expanded. Even if someone is designing a cell phone case, the engineer needs to consider the processes and materials used. How do these processes and materials impact the environment? Otherwise, it appears that there are "environmental engineers" and the rest of them can totally disregard their stewardship of the planet. While all students should understand the process I don't feel all need to engage in an engineering problem but I'd be happier if they did. We have used this approach in recent years with the academy students; they seem more motivated and willing to collaborate on design problems when a common theme is pursued. If the student chooses. I don't force it, but the student is responsible for reading some Bucky Fuller and discuss his ideas for a better world. Engage in a socially conscious design activity that relates to a community-based need or global issue (such as providing potable water, or improving food production or preservation). water, (delete improving food production) providing sustainable agricultural, or utilizing renewable energy sources.) Widens the spectrum. Learn to be an engineer first on something that you can relate to, then go save the world. I think this is important because it teaches that engineering is not just mechanical, electrical or chemical devices but socially useful processes I think I am biased that this is perhaps the most-engaging context for K-12 students; however, as a standard requirement, it is not necessary.

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

D8. Provide an example and an explanation of how design solutions can integrate universal design principles to help meet the needs and wants of people of all ages and abilities.

Round 1 Median was 5 (Agree)

Strongly Agree	Agree	Moderately Agree	Indifferent	Moderately Disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Here are panelists' round 1 responses to the above question.

Explain how technological design can integrate universal design concepts to help meet the wants and needs of individuals with disabilities. Universal design concepts are more inclusive. Seems to be embraced by D7. Engineering is for everyone, not just people with disabilities Provide an example and explanation of how technological design can help people with special needs and disabilities. Again, showing the social implications of engineering Although the social relevance is high I think that this question is limiting the technological process. Also I will refer to the technology process instead to technological design (to separate to the engineering design) I would like this to encompass a broader audience. If we are trying to say that ALL students should be able to give examples of how engineering is a helping profession, then I agree more. There are so many ways that engineers help the community and individuals.

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

D9. NEW QUESTION AS A RESULT OF PANEL SUGGESTIONS: Engage in a group problem-solving activity to creatively generate several alternative design solutions and document the iterative process that resulted in the final design..

Strongly Agree	Agree	Moderately Agree	Indifferent	Moderately Disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

D10. NEW QUESTION AS A RESULT OF PANEL SUGGESTIONS: Evaluate the effectiveness and appropriateness of the design of common items (such as a can opener, toothbrush, door handle, etc.).

Strongly Agree	Agree	Moderately Agree	Indifferent	Moderately Disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

D11. NEW QUESTION AS A RESULT OF PANEL SUGGESTIONS: Provide examples of how psychological factors (e.g., bias, overconfidence, human error) can impact the engineering design process.

Strongly Agree	Agree	Moderately Agree	Indifferent	Moderately Disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

D12. NEW QUESTION AS A RESULT OF PANEL SUGGESTIONS: Engage in activities which demonstrate the role of risk and reliability in the engineering design process.

Strongly Agree	Agree	Moderately Agree	Indifferent	Moderately Disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

In the box below, please add any further competencies related to DESIGN that you believe are important for ALL high school students to learn as part of their fundamental education. Remember that these competencies should reflect OVERARCHING ideas, not atomistic competencies and should be those that ALL high school graduates should learn, not just students pursuing careers in engineering or technology. If you do suggest a new item related to DESIGN, please state that item in behavioral terms (for example students will "design," "evaluate," "engage in," etc. as opposed to saying that students will "understand".

MODELING:

To demonstrate knowledge of important engineering and technology concepts and skills upon graduation from high school, students will be able to demonstrate modeling capability as follows:

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

M1. Use representational modeling (e.g., a drawing or a simulation) to accurately depict a design.
Round 1 Median was 7 (Strongly agree)

Strongly agree	Agree	Moderately agree	Indifferent	Moderately disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Here are panelists' round 1 responses to the above question.

I have found that many students conceptually need to build something in the form of a mock up before they can accurately plan something. Software applications are both readily available and affordable and should be common tools for all students. The main benefit I see is that by using various applications that are constantly evolving, they begin to understand the similarities and vocabulary which encourage cross curricular thinking ... something very much missing in today's schools. All students should learn a modeling program. This is the language of the design world. This is as important as learning to read music or learning a language.....maybe more so. Use representational modeling (e.g., a system/subsystem loops, written descriptions, a drawing, simulation) to accurately depict a design. Examples support thorough modeling approaches, higher levels of thinking and problem solving. 2D or 3D sketch is fine, no need for CAD Graphic literacy and the use of computationally-based simulation programs seem somewhat orthogonal to one another. I would be inclined to place simulation with mathematical modeling.

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

M2. Develop and test a prototypical scale model of a design to analyze its strengths and limitations.

Round 1 Median was 6 (agree)

Strongly agree	Agree	Moderately agree	Indifferent	Moderately disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Here are panelists' round 1 responses to the above question.

All students should have to build a model of something and evaluate it but I'm not sure it has to be evaluated as an engineering design so I'm not sure what is meant be prototypical in this sense There is no substitute for "understanding" how different materials are processed and react to various applications in the physical world. Students enjoy this greatly. Learning should be fun. Big time factor and students should go back and redesign and initial analysis. This implies that all students need to construct a model and test it. Constructing is not a necessary requirement.

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

M3. Use mathematical modeling (e.g., using the equation for conductive heat flow, $Q=kA\Delta T/L$, to design a shelter) to quantitatively describe and predict the effects of variables on a design.

Round 1 Median was 6 (agree)

Strongly agree	Agree	Moderately agree	Indifferent	Moderately disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Here are panelists' round 1 responses to the above question.

At the pre-college level, I don't see this happening very often, if ever. For ALL students? One can point it out but will lose non-engineering students. Very dependent upon instructor abilities. I understand the reason why this skills is placed here but I think that the mathematical requirements to implement successful models are to high for the "generality" of the high school student body. Could be a computer simulation if students lack the necessary math skills

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

M4. Use simulation software to investigate complex systems and issues.

Round 1 Median was 6 (agree)

Strongly agree	Agree	Moderately agree	Indifferent	Moderately disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Here are panelists' round 1 responses to the above question.

Simulation software is expensive and difficult for some high schools to afford. If they can, it is great to use. Time intense Limited number of such packages, and the learning overhead to use them makes usage problematic. nice if you have it, but not necessary I think M1-M3 are crucial. A problem with complex software is that the focus shifts to teaching the mechanics of the software and not the crucial idea of modeling. Simulations seem to facilitate student understanding of complex interactions in systems. I don't want them to just use the software, but be able to explain the dynamic interactions that occur in a common system.

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

M5. Create and test a physical model of an artifact, process, or system using tools and materials to ensure that a design solution meets given criteria and constraints.

Round 1 Median was 6 (agree)

Strongly agree	Agree	Moderately agree	Indifferent	Moderately disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Here are panelists' round 1 responses to the above question.

Here, again, cost is an issue in high school. Physical model could be misunderstood to be tangible, I feel software could also act as a model or something to be tested. I think the testing should be conducted systematically and thats not stated I would strongly agree if the word "Create" was eliminated...I believe that physical testing and observation is critical, but the skill levels, and time constraints make it extremely difficult for many students...today's student enter with very few "tools" that are needed to build and physically create their models. Perhaps testing existing models (kits, materials samples, etc) could facilitate this experience in a time-efficient way. Tool use fulfills certain students desires and needs to create. Create and test a physical model of an artifact, process, or system using tools, materials and statistical analysis to ensure that a design solution meets given criteria and constraints. The opportunity to do so appears to be diminishing.

This requires the construction of a model, not something I agree with. I would combine this one and the next one to read "Create and test a physical OR VIRTUAL model of an artifact, process, or system using tools and materials to ensure that a design solution meets given criteria and constraints."

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

M6. Create and test a virtual model of an artifact, process, or system using simulation software to ensure that a design solution meets given criteria and constraints.

Round 1 Median was 6 Agree)

Strongly agree	Agree	Moderately Agree	Indifferent	Moderately disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Here are panelists' round 1 responses to the above question.

I think both questions might be combined so students understand to systematically test anything. Again, it comes down to time...to get student to the skill level where they can use the testing and analysis features of the software takes time, and I have found consistently that without a physical model to observe, a simple constraint like "allowable clearance" or "tolerance" is totally foreign to them. Limited number of such packages, and the learning overhead to use them makes usage problematic. Virtual models need to be compared with actual physical models to make sure that the virtual models truly represent reality. As long as there is the creation of a physical model to test the virtual model predictions. Students need to know that nothing works exactly like the computer simulation and how meticulous one needs to be when building and testing a real artifact. Don't eliminate labs because of computer models.

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

In the box below, please add any further competencies related to MODELING that you believe are important for ALL high school students to learn as part of their fundamental education. Remember that these competencies should reflect OVERARCHING ideas, not atomistic competencies and should be those that ALL high school graduates should learn, not just students pursuing careers in engineering or technology. If you do suggest a new item related to MODELING, please state that item in behavioral terms (for example students will "model," "evaluate," "create," etc. as opposed to saying that students will "understand".

SYSTEMS:

To demonstrate knowledge of important engineering and technology concepts and skills upon graduation from high school, students will be able to demonstrate systems thinking as follows:

S1. Label and explain a systems diagram of a familiar technological system (e.g., a home heating system) that specifies inputs, processes, outputs, feedback, and control components.

Round 1 Median was 6 (agree)

Strongly agree	Agree	Moderately agree	Indifferent	Moderately disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Here are panelists' round 1 responses to the above question.

In my opinion, systems of all types, from political, to economic, to technological all demonstrate the "BIG PICTURE" The core of synthesis thinking, integrated learning, problem solving for life. The ability to show that every tech system can be broken down and organized helps students, no matter electronics or auto shop, determine a way to solve problems.

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

S2. Identify and explain the function of the interacting subsystems that comprise a more complex system.

Round 1 Median was 6 (agree)

Strongly agree	Agree	Moderately agree	Indifferent	Moderately disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Here are panelists' round 1 responses to the above question.

On a need to know basis if it helps with organization of students problem solving. I suggest to replace the word complex by composed (complex is related to different outputs to the same inputs) I would like them to be able to also hypothesize the dynamic interactions (cause-and-effect) that may occur in a system.

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

S3. Explain the differences and effects of negative and positive feedback in a system.

Round 6 Median was 6 (agree)

Strongly agree	Agree	Moderately agree	Indifferent	Moderately disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Here are panelists' round 1 responses to the above question.

This item is to technical for a general population, Can be replaced for something like Explain the need of feedback to ensure the successful function of a technological system It would be great if the students could explain what negative and positive feedback is and provide an example that is meaningful to them.

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

S4. Design, construct, test, and explain the operation of a system composed of several subsystems to accomplish a given goal.

Round 1 Median was 6 (agree)

Strongly agree	Agree	Moderately agree	Indifferent	Moderately disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Here are panelists' round 1 responses to the above question.

Not as important as other responsibilities The "several subsystems" is the part that I'm getting stuck on in this statement. If this is for all students, not just those heading toward technical fields, then I don't see the need for them to assemble "several" subsystems. I would think students could get a feel for the complexity of designing interacting subsystems by using "at least two" or "multiple" subsystems. It simply would take to much time in a class to do "several". In addition, after re-reading the statement multiple times, I notice it begins with "Construct", not "Design and construct". I'm wondering if that was done purposefully to shorten the time required to complete the task. Does this mean students would be given a plan to follow in order to construct the system? All subsystems would be preselected and students would just have to assemble them? If so, that would save time, but it dilutes the very idea of what technology education is about. Perhaps student should select from a limited number of predetermined subsystems, but I feel strongly that designing the complex system by identifying the best subsystems to use and the best way to put them together (in addition to constructing, testing and explaining the operation of the system) would greatly increase the depth of student learning. I propose the new statement read "Design, construct, test and explain the operation of a system composed of multiple subsystems to accomplish a given goal."

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

S5. Explain the difference between an open-loop control system and a closed-loop control system and give an example of each.

Round 1 Median was 6 (agree)

Strongly agree	Agree	Moderately agree	Indifferent	Moderately disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Here are panelists' round 1 responses to the above question.

Teach on a as needed to know basis The terminology of the question I believe will not be clear for the students in general can be rephrased like ... between system with feedback and without feedback ....

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

In the box below, please add any further competencies related to SYSTEMS that you believe are important for ALL high school students to learn as part of their fundamental education. Remember that these competencies should reflect OVERARCHING ideas, not atomistic competencies and should be those that ALL high school graduates should learn, not just students pursuing careers in engineering or technology. If you do suggest a

new item related to SYSTEMS, please state that item in behavioral terms (for example students will "model," "evaluate," "create," etc. as opposed to saying that students will "understand".

RESOURCES:

To demonstrate knowledge of important engineering and technology concepts and skills upon graduation from high school, students will be able to demonstrate capability in selecting and using resources as follows:

R1. Identify resources that technological systems use to turn desired results into actual results as fitting into categories of people, capital, energy, information, materials, time, and tools.

Round 1 Median was 6 (agree)

Strongly agree	Agree	Moderately agree	Indifferent	Moderately disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Here are panelists' round 1 responses to the above question.

Not sure what "resource categories" means. Most of the technological problems today are huge, infra-structure, water, energy, etc. To address these effectively EVERYONE is going to have to understand these resource categories and how to access them. I add politics to the list Nice if you can add it in, but not necessary I don't understand what this is asking.

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

R2. Select and use appropriate material, energy, and information, tools, and processes to accomplish desired technological results safely, economically, and efficiently.

Round 1 Median was 6 (agree)

Strongly agree	Agree	Moderately agree	Indifferent	Moderately disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Here are panelists' round 1 responses to the above question.

Not a formal topic usually With each assigned task, select and use appropriate material, energy, information, tools and processes to accomplish desired results safely, ethically, economically and efficiently Research and investigation are going to best resource such decisions. Perhaps that aspect needs to be referenced? nice if you can add it in, but not necessary

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

R3. Evaluate technological and scientific information for accuracy, and authenticity of sources.

Round 1 Median was 7 (Strongly agree)

Strongly agree	Agree	Moderately agree	Indifferent	Moderately disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Here are panelists' round 1 responses to the above question.

We tend to talk about it, but never any time to verify. Somewhere, somehow they need to be exposed to the concept of manufacturing tolerances. What they are and what role they play in our technological world This item seems more related to literacy than systems thinking. This might need a little more explanation as well. Emphasize that engineering involves questioning assumptions and changing reality Creating new artifacts is the essence of engineering Critical thinking is a necessary attribute of engineers

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

R4. Safely and correctly use tools and machines to produce a desired product or system.

Round 1 Median was 7 (Strongly agree)

Strongly agree	Agree	Moderately agree	Indifferent	Moderately disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Here are panelists' round 1 responses to the above question.

What is the definition of a tool in this sense? One way to destroy a program is to have a student hurt themselves. Life skills taught with this area. Safely and correctly use tools and machines. The original phrase is too limiting. Manufacturing tolerances and how they work. This item although uses resources, this resources are a totally different kind. Using safely machines is important, but as a resource it is not comparable with the economy, energy, etc. this is more part of the manufacturing process and not the general uses of resources, In summary I see it at a necessary skill but this it not fit this part of the survey Only if the product requires tools and machines.

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

R5. Practice safe, legal, and responsible use of information and communications technology.

Round 1 Median was 7 (Strongly agree) (Strongly agree))

Strongly agree	Agree	Moderately agree	Indifferent	Moderately disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Here are panelists' round 1 responses to the above question.

Taught in other areas of school and reinforced here. All technological systems are capable of damaging usage: to narrow the list to ICT appears to miss the point. Why is the term "advocate" used in this instance and not in other items? An important topic, but the word advocate is too strong; to be knowledgeable about safe, legal..... Ethics and professionalism

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

R6. Identify and discuss privacy issues involved in using information resources.

Round 1 Median was 7 (Strongly agree)

Strongly agree	Agree	Moderately agree	Indifferent	Moderately disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Here are panelists' round 1 responses to the above question.

Discuss when it comes up in ethical discussions Delete the word "practice". How does one practice privacy issues? It seems beyond the school to determine student practice of privacy issues. Identify and discuss in class, yes

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

R7. Identify and discuss environmental, health, and safety issues involved in implementing an engineering project.

Round 1 Median was 7 (Strongly agree)

Strongly agree	Agree	Moderately agree	Indifferent	Moderately disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Here are panelists' round 1 responses to the above question.

Safety has to be the biggest concern. It tends to carry over if taught here. Identify and discuss environmental and health and safety issues involved in implementing and engineering project. Identify and discuss safety and ethical issues involved in implementing an engineering project. I would use safety and ethical in the same statement even though ethics fall under human values. I will add ...implementing and engineering project and its impact in the community.

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

In the box below, please add any further competencies related to RESOURCES that you believe are important for ALL high school students to learn as part of their fundamental education. Remember that these competencies should reflect OVERARCHING ideas, not atomistic competencies and should be those that ALL high school graduates should learn, not just students pursuing careers in engineering or technology. If you do suggest a new item related to RESOURCES, please state that item in behavioral terms (for example students will "model," "evaluate," "create," etc. as opposed to saying that students will "understand".

HUMAN VALUES:

To demonstrate knowledge of important engineering and technology concepts and skills upon graduation from high school, students will be able to demonstrate consideration of human values in proposing solutions to engineering and technological problems as follows:

HV1. Explain, using examples, how intelligent/smart information technology (e.g., artificial intelligence, image enhancement and analysis, sophisticated modeling and simulation, smart houses, smart appliances) is transforming the world of information and knowledge, with profound effects on society.

Round 1 Median was 6 (agree)

Strongly agree	Agree	Moderately agree	Indifferent	Moderately disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Here are panelists' round 1 responses to the above question.

I would add: "with profound effects (both positive and negative) on society." Constant topic of conversation. Students must be prepared for their future. The pace of change, and the role of such technologies, evolves so quickly that it is difficult to see how this might be embraced except as an historical view. Statement seems vague. Perhaps it needs a specific example.

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

HV2. Redesign an engineering design solution to increase sustainability (such as reducing the embodied energy of the product, lowering its energy use, and/or using recycled materials).

Round 1 Median was 6 (agree)

Strongly agree	Agree	Moderately agree	Indifferent	Moderately disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Here are panelists' round 1 responses to the above question.

Not sure this applies to everybody, learning about the need to redesign systems to increase sustainability is useful, but I think engineering design my be assumed to be too narrow if the definition isn't truly understood. Worthy goal: not sure instructors have the ability to deal with such a task. This is a tricky one because "sustainability" is a loaded objective. Students need to understand that the definition of "sustainability" is like the blind men and the elephant. It has no universally accepted definition so to "increase sustainability" requires a careful study of what those who will judge mean by it. This may need a little more. Redesign an engineering design solution to increase sustainability, such as ... As for the survey item, HV2, How about…Redesign an engineering design solution to increase sustainability, such as reducing the embodied energy of the product, lowering its energy use, and/or using recycled materials.

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

HV3. Explain and give an example of how different cultures' engineering design solutions vary based upon the desire to satisfy their cultural values.

Round 1 Median was 6 (agree)

Strongly agree	Agree	Moderately agree	Indifferent	Moderately disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Here are panelists' round 1 responses to the above question.

If the topic comes up. Very high level of understanding of the relative merits of technological systems and national identification with such technologies would be needed: difficult to do! A simple example would be to divide a class into genders. Women and men tend to view design solutions of items differently. That's why design teams should include mixed genders. If there are various cultures in a classroom you could also divide groups that way too to show how solutions are influenced by culture. Gender is easy so always available.

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

HV4. Give an example of and investigate the impact of a tradeoff a company might make between profitability and environmental, health, or safety concerns.

Round 1 Median was 6 (agree)

Strongly agree	Agree	Moderately agree	Indifferent	Moderately disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Here are panelists' round 1 responses to the above question.

If opportunity comes up Statement seems a bit abstract. A specific example might help. Need to be careful on this one as it can become very political. The topic is important but the statement is diminishing the topic. rephrase: Investigate the impact of the company's tradeoff ... Give an example of and provide a rationale for a trade-off a company might make between profitability and environmental, health, or safety concerns

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

HV5. Effectively use social media (e.g., Facebook, Instagram, Twitter) without violating accepted social norms (e.g., not posting personally offensive/rude posts about a person, inappropriate images, or engaging in verbal “fights.”)

Round 1 Median was 5 (Moderately agree)

Strongly Agree	Agree	Moderately agree	Indifferent	Moderately disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Here are panelists' round 1 responses to the above question.

While I wish all students didn't have to know this because of use at the improper time, but I feel its something we will have to teach our kids As a common core issue yes...as a design-engineering, technology ed specific issue I'm not sure A good solid issue, but not sure if various school districts would allow the use of social media on school computers. Certainly an excellent rule to follow under all circumstances. This is a valuable skill, but not one that belongs in a technology education class. As technology teachers we do not need to start monitoring students' personal social media issues. The effective and appropriate use of communication systems and techniques is part of preparing a student to participate in society and is fundamental to behaving acceptably: it cannot be reserved for a single course, and

should not focus on one dimension (so called social media). Being knowledgeable about social media is a school function; to monitor student use seems too much. In my experience, this one is off limits in schools. This one scares me. Most HS students are not using it appropriately. All students should learn this, but it is about social norms and may be hard to teach.

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

HV6. Show evidence of considering human factors (ergonomics, safety, matching designs to human and environmental needs) when proposing design solutions.

Round 1 Median was 7 (Strongly agree)

Strongly Agree	Agree	Moderately agree	Indifferent	Moderately disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Here are panelists' round 1 responses to the above question.

Engineering is all about people Students should learn to evaluate products prior to purchasing as a consumer too. It's crucial for students to understand that doing a task for a few minutes if vastly different from doing it for 8 hours day in and day out. And, that's why we need to carefully design tasks humans will repeatedly perform. Also, that there are fundamental differences in ability by gender and that needs to be taken into account (e.g., men are generally stronger) Show evidence of consideration of human factors (ergonomics, safety, matching designs to human and environmental needs) when proposing design solutions.

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

HV7. NEW QUESTION AS A RESULT OF PANEL SUGGESTIONS: Provide examples of how the societal impact of engineering failure may lead to changes in laws, regulations, and design and use of technologie

Strongly Agree	Agree	Moderately Agree	Indifferent	Moderately Disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Comments and Changes: If you wish, please suggest re-wording or deletion of the item above, and provide a short rationale for your suggestions.

In the box below, please add any further competencies related to HUMAN VALUES that you believe are important for ALL high school students to learn as part of their fundamental education. Remember that these competencies should reflect OVERARCHING ideas, not atomistic competencies and should be those that ALL high school graduates should learn, not just students pursuing careers in engineering or technology. If you do suggest a new item related to HUMAN VALUES , please state that item in behavioral terms (for example students will "model," "evaluate," "create," etc. as opposed to saying that students will "understand".

In the box below, please be kind enough to add any general comments that you might wish to provide.