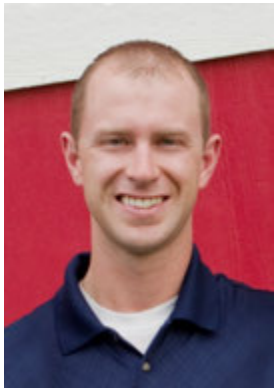
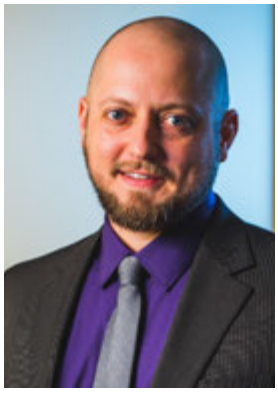
Design Values, Preferences, Similarities, and Differences across Three Global Regions





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Abstract

As technological advances connect countries from across the world, preparing students to contribute to an internationally connected society is paramount. An understanding of the various cultures, traditions, values, and educational practices is necessary for a more-fully integrated and preparatory curriculum. Specifically, we contend that in the area of open-ended design, identifying cultural, regional, and local preferences is a necessary undertaking to assist in preparing students for success in future endeavors. However, as open-ended design is an area that can be challenging to assess and implement, effectively identifying the design values and preferences unique to different locations are necessary. Identifying these preferences and values across locations may help illuminate best-practices to the teaching and learning for an increasingly culturally-sensitive open-ended design process. In this study, 706 American middle school students participated in an open-ended design project and submitted both prototypes and portfolios for their projects. Panels of teachers and researchers from the United States, England, Ireland, and Sweden were recruited to judge the student work through Adaptive Comparative Judgment (ACJ). Each panel was trained on the ACJ software (CompareAssess), introduced to the assignment and the assessment criteria, and provided a login to complete the ACJ. Through the final student project rankings, emerging from each of the judge panels in the ACJ process, highlighted large variations from region to region with only a few student projects appearing in the top ten rank for all regions. Comments provided by the judges, which explain the rationale behind their ACJ decisions, highlighted themes related to significant design values of each region. The identified values may help to enhance design and design-based learning across an internationally-connected society through an understanding of cultural similarities and differences.

Key Words: Adaptive Comparative Judgment, Design and Technology, Technology Education, Design Assessment, International Comparison, Intercultural Pedagogy

1. INTRODUCTION

The emphasis on open-ended and design has spread through the science, technology, engineering and mathematics (STEM) educational movement. Many contend that a student's capability to perform on open-ended design tasks is necessary to prepare students for future employment opportunities as it emphasizes needed skills for today and workforce preparation (Bartholomew & Strimel, 2017; NAE & NRC, 2014; NRC, 2009; NRC, 2012; Strimel; 2014). However, succeeding locally in open-ended design is not enough; students need to be prepared to design in a globally-connected society (Edens, 2000) where cultural and regional differences can complicate collaborative endeavors. For example, something as simple as "unlucky numbers" can derail best-laid-plans and/or create new challenges for designers, architects, engineers, and educators (e.g., 13 is superstitious in the U.S.A. and Sweden, 4 is unlucky in China and Japan) (Idler, 2013; Shah, 2013).

Student success on an international level, particularly in open-ended design, may be, at least partially, dependent on student's understanding of styles, cultures, and preferences around the world. Research has shown that the majority of students are not prepared with this knowledge which is deemed necessary to succeed on a global scale (Gay, 2002).

While limited tools and resources exist to assist in this area, we propose that adaptive comparative judgment (ACJ) may be valuable for informing this area of research and practice. ACJ has recently been implemented in formative assessment and other educational learning settings (Bartholomew, Strimel, & Yoshikawa, 2017; Seery & Canty, 2017). Relatedly, researchers in Ireland have proposed using ACJ as a quasi-Delphi approach for identifying values and preferences of assessors (Seery, Delahunty, Sorby, & Sadowski, 2018). We investigated the potential for ACJ to be employed in this way to identify similarities and differences in design values across several different countries.

2. PROBLEM STATEMENT

In order to understand, teach, and incorporate values of different people and cultures, teachers, administrators, and students need tools, approaches, and resources which can assist them in identifying these important principles (Lindsay & Simeon, 2016). Specifically, in the area of open-ended design, identifying cultural, regional, and local preferences can be challenging (Khan, Pitts, & Williams, 2016; Montgomery & McDowell, 2009). Therefore, research into new ways of identifying cultural design values and preferences needs to be undertaken to inform current educational practices. As these preferences and values are identified, they may be assimilated into best practices for teaching and learning in open-ended design scenarios toward influencing a more culturally sensitive (Getto & Sun, 2017) approach and output.

3. RESEARCH QUESTION

1) What design values, if any, can be identified through adaptive comparative judgment performed by judges from different locations across the globe?

4. OPEN-ENDED DESIGN PROBLEMS

We chose to study open-ended design problems in the context of K-12 education. Specifically, we utilized students from the USA working in Technology and Engineering Education (TEE) and teachers working in the areas of TEE (U.S.A.), Design and Technology (U.K./Ireland), and Teknik (Sweden). Each of these areas emphasizes open-ended design solving and problem-based learning pedagogies in a hands-on classroom environment (ITEEA 2000/2004/2007; Department of Education, 2013; Skolverket, 2011). While a complete illustration of the differences by country, their educational histories, and respective programs, is beyond the scope of this work, we provide a brief overview of the areas in each of the countries involved here.

In the U.S.A, this field of education is called Technology and Engineering Education (TEE). TEE's classes span topics such as computer-aided design, robotics, and control systems while fostering student abilities to design, make, and innovate (Starkweather, 2015). TEE classes are typically "elective" courses but do not have a consistent delivery in school systems across the country.

Similar to TEE, the UK has a program of study called Design and Technology (D&T) education. D&T is a subject which requires certain rigorous classes in which all students are required to utilize the design process (Design and Technology Association, 2014). Despite it being required, there remains a debate with policy makers of its importance and its position within education.

Sweden also has a mandatory curriculum for technology called "Teknik" or "Technology" in compulsory schools (Year 1 to Year 9). This subject has gone through several phases of change to introduce various programs and courses (Regeringskansliet, 2017). Despite it being mandatory, the content, assessment, and rigor fluctuates between schools (Hartell, 2015; Teknikföretagen & Cetis, 2013, Skolinspektionen, 2014).

5. ADAPTIVE COMPARATIVE JUDGMENT.

The Technology Education Research Unit (TERU) in the U.K. (Kimbell, 2007) piloted an innovative approach to design assessment based on comparative judgment theories first set forth by Thurstone (1927). Thurstone suggested that comparative judgments in assessment is more valid than rubric assessments because of the

instinctive nature of comparison. As artifacts go through a series of comparative judgments, a highly reliable rank order emerges (Kimbell 2012a, 2012b; Pollitt, 2004, 2012). A myriad of research related to ACJ, it's use as a tool of assessment, it's validity and reliability, and it's feasibility for implementation has been conducted (Bartholomew & Yoshikawa, 2018).

In the ACJ process, a judge views pairs of work and identifies the "better" item according to predetermined criteria and/or personal expertise. As the judge continues through the process of comparatively judging pairs of work, a rank order is produced. This process also allows judges to add comments with the rationale for the judgments made. These comments allow the judges to provide justification and insight for why judgements were made (Bartholomew, 2017, Bartholomew et al., 2017; Hartell & Skogh, 2015).

The ACJ session also produces a calculated misfit statistic for each participating judge (Pollitt, 2004) which is a measure derived from Rasch-analysis, and can identify potentially controversial items and judges not acting consistently with their peers (e.g., one judge that is assessing differently from the group of judges). A more in-depth explanation of ACJ with the produced statistics can be found in work done by Pollitt (2004, 2012).

6. METHODS

This research took place across two continents. The student work was gathered from a school district located in the western U.S.A. This large school district services over 75,000 students and represents a mainly suburban middle-class population (16% free/reduced lunch which indicates that a student participates in a federally assisted meal program based on their household's economic status). A total of six teachers were recruited for the study based on willingness to participate and possessing similar characteristics (teacher license level, similar years of teaching, similar classes taught, similar school facilities, and recommendation from the district TEE coordinator). Each teacher implemented the study in at least two sections of an introductory TEE course for 7th and 8th graders (12-14 years old). A total of 706 students were included in the study which took place over five class periods (two weeks of an alternating class schedule, 90-minute class periods). Students worked in groups of 2-3 to complete an open-ended design challenge around designing a new container/dispenser for distributing pills to patients in specified quantities and at prescribed times (see similar examples in Kimbell, 2007, 2012). Students designed the product for a specific user (an elderly individual who enjoys traveling internationally) and produced both a physical prototype and a design portfolio for submission.

Students groups moved through a brainstorming process where they were initially provided with materials chosen to stimulate ideation as well as pictures of pill containers and previous student creations. The students then proceeded to work with a "handling collection" consisting of materials to produce a final prototype. Students were also prompted by their teacher, at specified points throughout the duration of the project, to complete their portfolio.

Following the completion of the study all the student-group prototypes were collected and a digital picture was taken of each one, resulting in 176 images of student design prototypes and 175 pictures of student design portfolios (1 group did not turn in a portfolio). All these images were uploaded to the CompareAssess ACJ engine and were assigned to one of six different sessions (one session for each country for portfolios and one session for each country for prototypes).

6.1. Quantitative Data Collection.

Panel members were recruited in each of the participating locations for the ACJ assessment of student prototypes and portfolios: The United States of America, the United Kingdom (including those from Ireland), and Sweden. Panelists were selected based on their experience and expertise in technology and/or design education, and included practicing teachers, researchers, designers, and teacher-trainers (see Figure 1). While the majority of these individuals in the U.S.A. and Sweden had no prior experience with ACJ, the U.K. panel of judges were almost all familiar with ACJ from previous projects (Williams & Kimbell, 2012). The previous collaborations, work, and experience with ACJ of the judges from the UK and Ireland provided the basis for

combining these judges into one group. Further to this point, in previous projects, the judges from these countries demonstrated extremely high interrater reliability (Kimbell, 2012a).

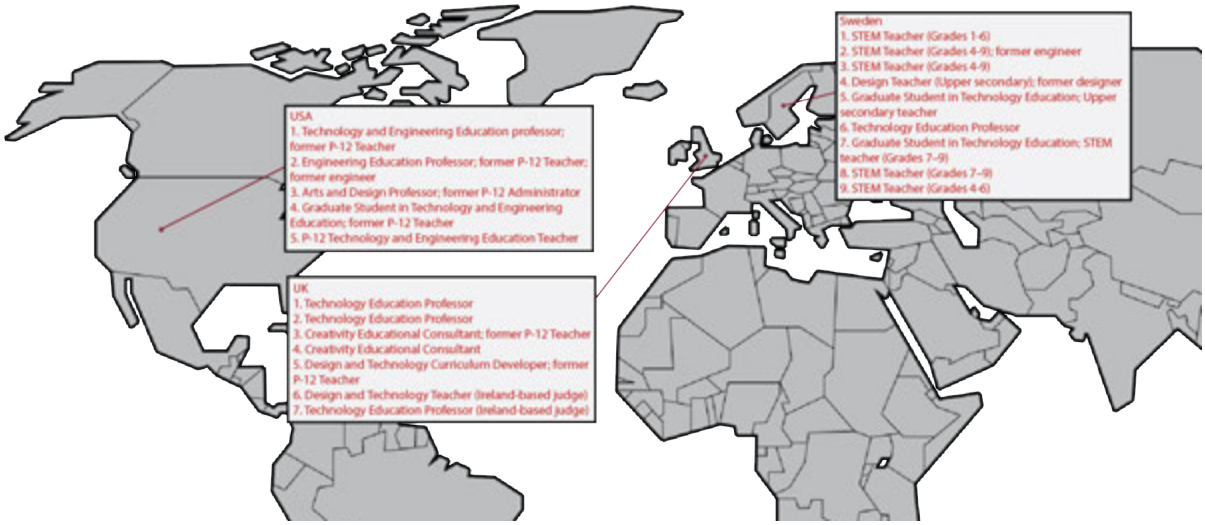

Figure 1. Backgrounds of panel members from each country.

Each group of judges was trained on the CompareAssess ACJ online judging platform, provided with individual logins, and introduced to the assignment and its criteria. Each judge was asked to make 20-30 comparative judgments of portfolios and student prototypes as an initial step in an effort to ensure all judges were confident and competent with the process. Following the initial judgment session, each judge was given the option to ask questions, resolve concerns, and discuss a collective direction in judgment. Subsequently each judge completed additional judgments until pre-determined reliability levels ($r > .90$) were obtained for the resulting rank orders. A researcher monitored the rank order reliability level and upon reaching sufficient reliability levels, the judges were instructed that no additional judgments were needed.

Following the completion of each ACJ session the resulting rank orders, the time taken in judgments, and the judge comments from both the portfolios and prototypes, were recorded for conditioning and analysis. Prior to analysis all quantitative data was conditioned and tests for statistical assumptions were performed and satisfied.

6.2. Qualitative Data Collection.

In addition to the quantitative data recorded from CompareAssess the judge comments, from the ACJ sessions, were recorded. This was specifically done in an effort to identify the why behind judge decisions in ACJ and investigate the research question guiding this study.

Prior to coding, all judge comments from the Swedish judges were translated and reviewed by an independent reviewer to establish a common language across feedback. Additionally, England judge's vernacular used in comments were independently reviewed to ensure a correct cultural understanding of the meaning. The judge's comments were separated according to location and session (portfolio or prototype) and then coded using descriptive coding techniques (Miles, Huberman, & Saldaña, 2013) and grounded theory analysis (Charmaz & Belgrave, 2012). The first step in this process involved descriptively analyzing the comments to form possible codes that appropriately encapsulated the judge comments. This process produced the following codes: aesthetics, brainstorming, complete, criteria, design, design process, problem identification, reflection, consumer, developed, improvement, innovation, thought out, communication, realistic, size, complexity, follow through, potential, secure, usability, prototype, outcome, effort, neatness, construction, criteria, label, and organization. Additional codes, such as "error" (when the software did not properly load an artifact) and "equal" (when judges felt the two artifacts were equal in quality) were added after a second review of judge comments (see Figure 2). The codes were used to classify each comment from judges and the resulting counts for each code were recorded for later comparison across artifacts and between locations.

Judge Comment	Code	Location
Easy to Pack	Size	Sweden
Stylish design, aesthetically thorough	Aesthetics, Design	Sweden
Wins because it is a more developed solution	Developed	U.K./Ireland
Looks easier to use	Usability	U.S.A.

Figure 2. Example of Judge Comment Coding.

7. FINDINGS

The findings from this research include the rank orders and parameter values for both prototypes and portfolios and the judge comments from their comparisons. The findings, from both the quantitative and qualitative analysis, are presented here in conjunction with each corresponding research question.

RQ_1: What design values, if any, can be identified through adaptive comparative judgment performed by judges from three locations across the globe?

After coding the judge feedback, themes emerged which may illustrate judges' values and preferences in both the prototypes and portfolios. Importantly, these themes emerged from judges using an identical assignment description, assessment tool, and evaluation criteria. The themes for the portfolio assessments will be presented first (by location), followed by the themes for the prototypes.

7.1. U.K. Prototype Themes.

The U.K. judges seemed to value uniqueness in ideas when evaluating the prototype images (see Figure 3). Although not universal, novelty was often valued over functionality. Additionally, these judges tended to value if the prototype was developed or looked more complete.

Comment	Code
chose B as the pots were arranged differently! Is it a better pill holder - no idea???	innovation
Marginal - A more complete concept	developed
wins because it is a more developed solution	developed
no idea what [is] going on but different	innovation
potentially more user friendly	usability

Figure 3. Example of U.K. Judge Prototype Comment Coding.

7.2. Sweden Prototype Themes.

The comments from the Swedish judges suggested a value on size, usability, and design (see Figure 4). Judges often commented on whether or not a prototype could fit into a purse or carrying case (one of the constraints for the assignment) and used this as a measure in determining which prototype to select.

Swedish Comment	Translation	Code
a verkar enkel och funktionell.	a seems simple and functional	usability
A is smaler	A is smaller	size
B har en spännande formgivning	B has an exciting design	design
A är en enkel idé och har en kompakt form. Bra i väskan.	A is a simple idea and has a compact design/shape. Good to have in purse/bag	design; size

Figure 4. Example of Swedish Judge Prototype Comment Coding.

7.3. U.S.A. Prototype Themes.

The judge comments from the U.S.A. indicated a value on usability and how easy the prototype was to both use and figure out how to use (see Figure 5). Another common theme in these comments was the size (e.g., how compact the prototype seemed). The judge comments also reflected an importance in design quality.

Comment	Code
Looks easier to use	usability
More compact. user-friendly	size; usability
love the idea looks like it can hold all the days etc.	design

Figure 5. Example of U.S.A. Judge Prototype Comment Coding.

In addition to submitting prototypes, the students also submitted portfolios that were created throughout the design process. The same process was utilized to identify themes for all three regions for portfolios submitted by students.

7.4. U.K. Portfolio Themes.

The themes that emerged from the U.K. judge comments were focused around the *development* of the prototype (see Figure 6). The comments focused on how well students followed through with plans that were initially proposed in student portfolios. They also showed interest in whether or not the students showed uniqueness and creativity in the prototype. These judges appeared more likely to choose a design if it was *different* – regardless of whether it aligned well with the assignment criteria.

Comment	Code
both obvious solutions and very thin. tossed a coin	equal
B - more developed	developed
B has more innovation and exploration but A is more resolved by the end.	innovation; developed
Flower version a bit more interesting ...	innovation

Figure 6. Example of U.K./Ireland Judge Portfolio Comment Coding.

7.5. Sweden Portfolio Themes.

The comments from the Swedish judges revolved more around the actual prototype produced and how well it was communicated in the portfolio (see Figure 7). Communication was the most common theme for the Swedish judges with a majority of comments centered on whether or not a design portfolio fully communicated a particular idea; often this was related to comments around the completeness of the design portfolio. Additionally, many of their comments focused on the prototype that came out of the portfolio instead of the portfolio itself.

Swedish Comment	Translation	Code
a verkar enkel och funktionell.	a seems simple and functional	usability
A is smaler	A is smaller	size
B har en spännande formgivning	B has an exciting design	design
A är en enkel idé och har en kompakt form. Bra i väskan.	A is a simple idea and has a compact design/shape. Good to have in purse/bag	design; size

Figure 7. Example of Swedish Judge Portfolio Comment Coding.

7.6. U.S.A. Portfolio Themes.

The U.S.A. judges most commonly reported that their judgments on the portfolios were based on whether or not the portfolio met the assignment criteria and how well the students demonstrated progress through the design process (see Table 8). These comments specifically mentioned brainstorming, reflection on the design produced, and multiple iterations.

Comment	Code
B has a more polished and perhaps more functional product but A has a better overall portfolio	complete
B provides evidence of understanding more of the criteria throughout the portfolio	criteria
The other one did not identify criteria or constraints	criteria
More complete reflections at the mid-point of the design process	reflection
Better job answering prompts and providing information	complete

Figure 8. Example of U.S.A. Judge Portfolio Comment Coding.

The coding of judges' comments resulted in a variety of codes for each location. Every judge comment was coded and the total quantity of codes was calculated by location (see Table 9) in an effort to identify the overall values, which guided judges' decisions in each location.

	Products		Portfolios	
U.K./Ireland	Innovation	21.60%	Developed	26.65%
	Developed	16.20%	Innovation	22.85%
	Usability	14.46%	Follow Through	10.02%
	Size	13.07%	Equal (both items were the same quality)	5.21%
	Equal (both items were the same quality)	7.67%	Thought Out	5.21%
Sweden	Usability	17.96%	Communication	20.50%
	Size	17.77%	Design Process	13.21%
	Design	16.26%	Complete	12.07%
	Clear Labeling	10.59%	Better	11.62%
	Construction	8.88%	Outcome	10.71%
U.S.A.	Usability	25.30%	Criteria	29.18%
	Size	18.27%	Complete	25.90%
	Design	16.87%	Reflection	13.77%
	Secure	13.86%	Brainstorming	10.16%
	Aesthetics	6.43%	Design Process	6.23%

Figure 9. Top codes produced through thematic analysis by location.

8. CONCLUSION AND RECOMMENDATIONS

This study sought to leverage ACJ—a tool originally designed for assessment—in a modified-Delphi approach to identify similarities and differences in design values from various locations. We posit that understanding these similarities and differences in design values and preferences across different locations can assist in preparing students for future employment and engagement in a globally connected society. The findings suggest that ACJ can be used in a modified-Delphi fashion that presents potential for future research efforts. Further, the data collection, analysis, and accompanying findings resulted in several themes, which may point

toward future areas of research while also providing an interesting foundation for discussion and immediate implementation.

8.1. Prototypes: Form and Function.

Interestingly, the argument for favoring form or function appeared to be one that happens *between* locations rather than *within* locations. In this research the judges in each location showing high-levels of agreement in their paradigm towards the prototype assessment while differing from other locations' judges. The judges in the U.K. consistently demonstrated in their comments that they valued form and judges in the U.S.A. and Sweden appeared more concerned with functionality.

8.2. Portfolios: Criteria, Communicating Results, and Demonstrating a Journey.

Judges from the U.K. emphasized how *developed* a portfolio was or how well it demonstrated progress in design. Judges from Sweden emphasized *communication*; these judges wanted to know how well the portfolio could communicate the process, results, and conclusions to the judges. Finally, judges from the U.S.A. emphasized how well the students identified and followed the criteria and constraints and overall how complete their portfolio was (i.e., did the students fill in each box). While a full discussion of these implications and the associated educational paradigms of each country is beyond the scope of this work, it is interesting to note the contrasting themes and conjecture on the long-term outcomes of students immersed in each set of values.

8.3. "Good Design" – A Regional Phenomenon?

Relatedly, a leading researcher in cultural studies (Hofstede, 2003; 2011) has identified six dimensions of culture (power distance, individualism, masculinity, uncertainty avoidance, long-term orientation, and indulgence) and has assigned a score to each country based on their own culture. This was done using a variety of techniques, criteria, and approaches (Hofstede, 2011) and a look at the identified countries (U.K, U.S.A., Sweden) revealed relative comparability in almost all areas with the exception of "masculinity" – a measurement related to the competitive mindset of individuals (Hofstede, 2011). The U.S.A and the U.K. were very similar in Hofstede's values (scores of 62, 66) while Sweden had a significantly different masculinity score (score of 5). This suggests a potentially significant difference in cultural values around competition (Hofstede, 2003, 2011)—an interesting finding that may be connected with the differences in preferences of the Swedish judges. Further research comparing Hofstede's identified cultural dimensions with emerging design cultures and values from ACJ assessment sessions is an area of particular interest to these researchers.

Seeking to identify the design values of countries through ACJ was an intriguing and fruitful project. As expected, this research raises more questions than answers but we are encouraged by the approach, the initial findings, and our conclusions. It is our hope that future work into "good design" and design education will build and expand on this work.

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