USABILITY vs. ECOLOGY: DEFINING GOOD DESIGN FROM DIFFERENT PERSPECTIVES

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ABSTRACT

This paper investigates the interplay between usability and ecological design in the context of interactive media, seeking to address the challenge of integrating these frameworks into design practices. While usability has long been a cornerstone of Human-Computer Interaction design by emphasizing user-centered metrics, ecological design advocates for a more holistic perspective that transcends anthropocentric views. By comparing the System Usability Scale with the Ecological Systems Scale, this research evaluates the effectiveness of integrating ecological heuristics into usability-focused design processes. The findings reveal a correlation between usability and ECOS scores, suggesting that foundational design capabilities are essential for successful ecological design implementation. Perceived conflicts between usability and ecological principles were attributed to the fast consumption demands of the media design industry rather than intrinsic contradictions. This study advocates for the development of educational frameworks that support ongoing discussions and iterative revisions in design processes. Ultimately, it aims to contribute to a more sustainable design practice that balances user needs with ecological integrity.

Keywords: Sustainability, Ecology, Usability, Interaction Design, Design heuristics.

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KULLANILABİLİRLİK ve EKOLOJİ: İYİ TASARIMI FARKLI PERSPEKTİFLERDEN TANIMLAMAK

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ÖZ

Bu makale, etkileşimli medya bağlamında kullanılabilirlik ve ekolojik tasarım arasındaki ilişkiyi inceleyerek, bu yaklaşımların tasarım uygulamalarına entegre edilmesi sorununu ele almaktadır. Kullanılabilirlik, İnsan-Bilgisayar Etkileşimi tasarımında uzun süredir kullanıcı odaklı metriklere vurgu yapan bir temel ölçüt iken, ekolojik tasarım, antroposantrik görüşlerin ötesine geçen daha bütüncül bir bakış açısını savunmaktadır. Bu araştırma, Sistem Kullanılabilirlik Ölçeği ile Ekolojik Sistemler Ölçeği karşılaştırması üzerinden, ekolojik kriterlerin kullanılabilirlik odaklı tasarım süreçlerine entegrasyonunun etkinliğini değerlendirmektedir. Bulgular, kullanılabilirlik ve ekolojik yaklaşım arasında bir korelasyon olduğunu ortaya koyarak, başarılı ekolojik tasarım uygulamaları için temel tasarım becerilerinin önemini vurgulamaktadır. Kullanılabilirlik ve ekolojik ilkeler arasındaki algılanan çatışmalar, medyanın hızlı tüketim taleplerine bağlanmış olup, bu ilkeler arasında özünde bir çelişki bulunmamaktadır. Bu çalışma, tasarım süreçlerinde süregelen tartışmaları ve yinelemeli revizyonları destekleyen eğitimsel çerçevelerin geliştirilmesini savunarak, kullanıcı ihtiyaçları ile ekolojik bütünlüğü dengeleyen daha sürdürülebilir bir tasarım pratiğine katkıda bulunmayı amaçlamaktadır.

Anahtar Kelimeler: Sürdürülebilirlik, Ekoloji, Kullanılabilirlik, Etkileşim Tasarımı, Tasarım höristikleri.

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1. INTRODUCTION

The rapid development of interactive media design has long prioritized usability, focusing on user satisfaction, efficiency, and performance. Ecological design, on the other hand, challenges this human-centered approach by advocating for a more holistic perspective that considers the broader environmental impacts of design decisions. This research aims to investigate how usability principles intersect with ecological design principles.

The primary objective of this study is to explore whether these frameworks can coexist in design practices and to determine how their integration affects user experience and ecological sustainability. To address this question, the study compares the Ecological Systems Scale (ECOS)—a tool developed to measure the extent to which a design adheres to ecological principles—with the System Usability Scale (SUS), a widely used metric for evaluating the user-centered aspects of design. The goal is to evaluate whether the ecological heuristics introduced in the ECOS scale conflict with, complement, or enhance usability metrics, particularly when applied in interactive media design. This comparison will offer insights into how ecological thinking can be integrated into mainstream usability practices.

Research Questions:

- How can ecological design knowledge be effectively transmitted to designers, particularly through guidelines that emphasize ecological heuristics and holistic thinking?
- What factors influence the motivation and efficiency of designers when incorporating ecological principles into usability-focused projects?
- Do ecological heuristics conflict with fundamental usability metrics, or can they coexist harmoniously within interactive media design?

By addressing these questions, this research aims to expand the discourse on sustainable interaction design, offering practical insights into the integration of ecological thinking and usability in the design process. In doing so, it seeks to move beyond material sustainability towards a deeper, mental shift in design practices —one that fosters environmental stewardship while maintaining usability.

2. LITERATURE REVIEW

In the field of interactive media design, both usability and ecological design present essential frameworks for what constitutes "good" design, though their guiding principles diverge significantly. Usability, grounded in Human-Computer Interaction (HCI), traditionally emphasizes a user-centered approach that prioritizes the satisfaction, efficiency, and performance of users, often viewing them as consumers or customers within a commercial

framework when incorporated by UX (user experience) services in design sector. This perspective is encapsulated in usability heuristics, since they were proposed by Nielsen (1993), which focus on optimizing user interaction with technology by simplifying processes and improving task efficiency.

By contrast, ecological design challenges the anthropocentric assumptions of usability by adopting a more-than-human perspective. This approach extends beyond the needs of human users to encompass ecological systems and other species, reflecting an ontological shift that seeks to dissolve the human/environment dichotomy (Naess, 1973; Abram, 2010). The concept of more-than-human design pushes designers to consider how their creations interact with broader ecosystems and contribute to ecological resilience, advocating for a more holistic approach that addresses the ecological impact of design decisions.

Today, design practices that consider environmental impact are most commonly addressed under the field of "sustainable design." Sustainable design aims for ecological goals such as the effective use of natural resources, energy conservation, and waste reduction (Turhan, 2011).

Over time, various movements reflecting sustainable design, from bioregional to transition design, emerged in design fields (Egenhoefer, 2017). One of these movements, ecodesign, shortened term for “ecological design,” originated in the late 1980s with the rise of environmental movements in the U.S. and Europe. In the early 1990s, after a study across eight sectors, including furniture, automotive, and packaging, Delft University of Technology published the first ecodesign guideline (Brezet & Hemel, 1997). The ecodesign principles, still integrated into today's Delft Design Guide, emphasize clean energy and raw material use, as well as the “reduce, reuse, recycle” fundamentals (van Boeijen et al., 2014).

Another of these approaches, Cradle to Cradle Design, refers to a design philosophy that considers sustainability and environmental impacts throughout a product's entire life cycle, from production and distribution to waste processes (McDonough & Braungart, 2002).

Sustainable design entered the HCI field through Eli Blevis' 2007 article introducing the term Sustainable Interaction Design (SID) and three years later when DiSalvo and colleagues defined the term Sustainable Human-Computer Interaction (SHCI) (Blevis et. al., 2007; DiSalvo et al., 2010). Like other approaches centered on the concept of sustainability, these works, which have integrated a mainstream approach aligned with the Sustainable Development Goals, focus on concrete issues such as energy consumption, product life cycles, and material use (Hansson et al., 2021).

While these studies offer valuable insights into minimizing the environmental footprint of technological products, they tend to focus narrowly on operational and material aspects of sustainability. The originality of this research is its aim to build on this foundation by focusing on the mindset and qualitative principles of ecological design, particularly the normative

qualities that enable a design to be truly ecological and holistic. These principles go beyond metrics of energy efficiency and product longevity, asking instead: What mental frameworks and ecological heuristics are necessary to transcend human-centered design and create systems that align with natural ecosystems?

The second aspect of the originality is its methodology in cross-evaluation of ecological principles with usability heuristics. Although there is little research in the field that brings together these two fields, usability of a product has already been argued as a potential ally of sustainability (Anjos et.al., 2012).

3. METHODOLOGY

In this study, to explore the relationship and impact of usability and ecology heuristics, two specific scales, ECOS and SUS, were utilized. Within the scope of research, a case study of participatory design workshops were conducted at the Interactive Media Design Department at Yıldız Technical University. The case study was organized as a voluntary based workshop series after a training seminar on ecological design. We worked with two groups of undergraduate design students that we categorized as "design team" and "evaluation team" and provided both groups the training. Design team students were asked to incorporate the guideline into their designs. Evaluation team students were asked to evaluate the outcomes according to the ECOS and SUS scales. After the test phase, semi-structured interviews were conducted with design team participants. All participants have been asked consent for their data to be analyzed and published anonymously. The scales and the case study methodology are presented in the following sections.

3. 1. From Ecological Design Guideline to Ecological Systems Scale

The ECOS / Ecological Systems Scale that we propose has been derived from a previous study which presents a guideline for incorporating ecological thinking process in design (Tasa, 2022), through the metaphor of "thinking like a mountain" as suggested by Aldo Leopold (1968). The principles in the guideline can also be used as evaluation heuristics. Hence the evaluation scale that we propose in this research, named Ecological Systems Scale (ECOS), is based on these heuristics as presented as in Table 1.

Tablo 1: Ecological Systems Scale Checklist

1	(Circularity) Non-linear, circular, spiral patterns are observed.
2	(Rhythms) Self-similar, rhythmic, fractal structures are observed.
3	(Solution-centric) Long-term and eco-mimetic solutions are suggested.
4	(Flows) Not objects but flows and processes are in focus and visible.

5	(Spatiality) Presence of an intrinsic spatiality, place-bound experience.
6	(Temporality) Presence of a cyclic time (age, season, etc.) intrinsic to experience.
7	(Locality) Ecological context and local belonging is supported.
8	(Small scale) Smaller than mainstream and in human scale.
9	(Slow solutions) Slower solutions than mainstream approaches.
10	(Low definition) Low-definition and contextual information flow.
11	(Wisdom) Consideration of higher systems, preference of wisdom over data.
12	(Diversity) Diversity of languages, media, and culture.
13	(Mosaic) Non-uniform and heterogeneous distribution of polyculture.
14	(Sensory) All-sensory awareness rather than dominance of visuality.
15	(Edge effect) Stress on marginal and edge areas where encounters occur.
16	(Network) Weaving relations between system nodes/subjects and all others.
17	(Complementation) Stress on not competitive but complementary relations.
18	(Wholeness) 'The whole is more than the sum of its parts" approach is present.
19	(Decentralization) Horizontal and decentralized organization of control and power.
20	(Self-governance) Self-regulating control and limit mechanisms.
21	(Resilience) Resistant flexibility in the face of change.
22	(Closed circuit) A closed-circuit systematization of product / service life cycle.

3. 2. System Usability Scale

The System Usability Scale (SUS) is a simple, 10-item questionnaire developed by John Brooke in 1986 to evaluate the usability of products, services, or systems. It measures the ease of use, efficiency, and satisfaction users experience when interacting with a system. Each question is rated on a Likert scale from 1 to 5, and the total score reflects overall usability. SUS is widely used due to its reliability and versatility across various industries and platforms (Brooke, 1996). In Table 2, the 10-item of the scale is listed.

Tablo 2: System Usability Scale

1	I think that I would like to use this system frequently.
2	I found the system unnecessarily complex.
3	I thought the system was easy to use.
4	I think that I would need the support of a technical person to be able to use this system.
5	I found the various functions in this system were well integrated.
6	I thought there was too much inconsistency in this system.
7	I would imagine that most people would learn to use this system very quickly.
8	I found the system very cumbersome to use.
9	I felt very confident using the system.
10	I needed to learn a lot of things before I could get going with this system.

3. 3. Design Team Workshops

In this gender-balanced team we worked with 6 undergraduate interactive media design students. They were split into two groups of three participants each, named Group-1 and Group-2, and they were given two successive interaction design project briefs, each implemented through a series of three workshops.

Group-1 participants are labeled as 1A, 1B and 1C; and Group-2 participants as 2A, 2B and 2C. Both groups were given the same specifications in both projects as follows:

- They were asked to design the user interface(UI) concept and a low-fidelity prototype of an interactive service/tool for mobile.
- They were expected to attend to the generic usability and UX rules.
- To prevent differing "visual design" capabilities of participants from influencing the test group, they were provided a "design sheet" as a poster layout and asked to use this same layout for the presentation of their projects. See Figure 1 for an example poster submission.
- In this sheet they were expected to present:
  - the product name and the logo,
  - introductory information on "what" their service/tool is about,
  - the reason "why" they offer this service/tool, i.e., both the *problems* they have observed before and the objectives they aim at after,

- "how" the service/tool is used, in a summary of possible *use tasks* and *user scenarios*,
- "who" they design for, i.e., user personas,
- a low-fidelity prototype combined with the basic UI concept.

In the first project, namely Project 1, Group-1 (the test group), was provided the training that consisted of a three-hour seminar and the guideline kit to refer to during design phase. The kit included the seminar presentation file, the guideline booklet, and a quick reference card. Being the control group, Group-2 was neither provided the training nor informed about the extra requirement of the other group.

After three workshops, the design posters were delivered, and both groups were given the second project brief. For the second project, namely Project 2, the test and control groups switched, and this time Group-2 was provided the training and asked to design accordingly, whereas Group-1 was told to set aside the ECOS guideline and follow generic UX principles as in specifications. The reason why we switched groups is to remove any bias that project subjects might have towards being more or less ecological.

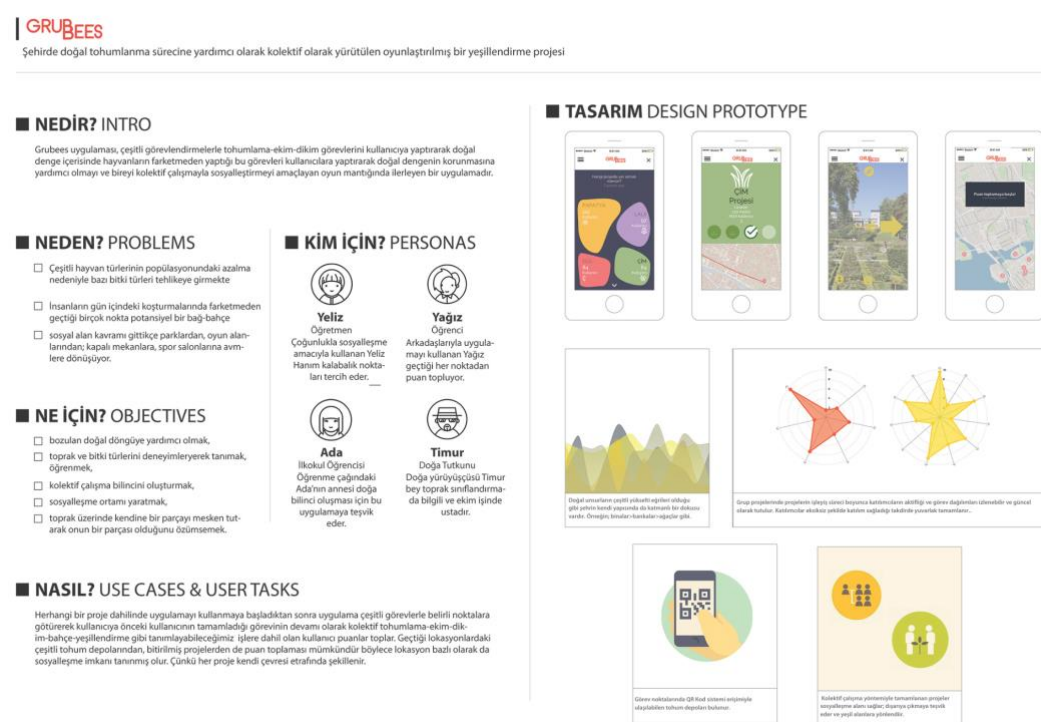


Figure 1: Project submission poster example.

3. 4. Evaluation Team and Testing

Evaluation group consisted of 17 distinct undergraduate interactive media students. This group was also gender balanced and was provided the same training with design groups. They had just completed a fundamental course in usability and UX design, and they were asked to evaluate the 12 projects that design group had produced, according to both System Usability Scale and Ecological Systems Scale.

For ECOS, as in SUS, they were asked to evaluate the projects through a **5-point Likert Scale.** The outcomes were evaluated in a parallel manner with the "positive" questions (questions with odd numbers) in SUS scale: the scores were summed up by subtracting 1 from each and then normalized to a 100-point system.

4. WORKSHOP OUTPUTS

4.1. Project 1: A Novel Social Media Design for Urban Life

The first project brief was to design "a novel social media for emerging social interaction needs in urban life". In this project, Group-1 is the test group –the group that was provided the seminar and the guideline kit- and Group-2 is the control group.

Group-1 (Test Group) Projects concepts are as follows:

- "New Kid in Town" by 1A is a mobile social media application that targets newcomers to a city. From immigrants to tourists, or people who has just moved to a city, it aims to help the adaptation process by connecting them with local citizens and the "unwritten" rules and cultural issues that locals share through the platform.
- "Grubbees" by 1B is a location-based mobile game application. Through the collective missions that require tasks such as seeding and planting in urban areas, the game socializes and engages gamer-users in urban ecology.
- "Komşum/My Neighbour" by 1C is a mobile application with the purpose of creating intimate communities among users who live in the same neighborhood. It aims to establish a voluntary neighbor network where people support each other whenever anyone is in need. (See Figure 2)

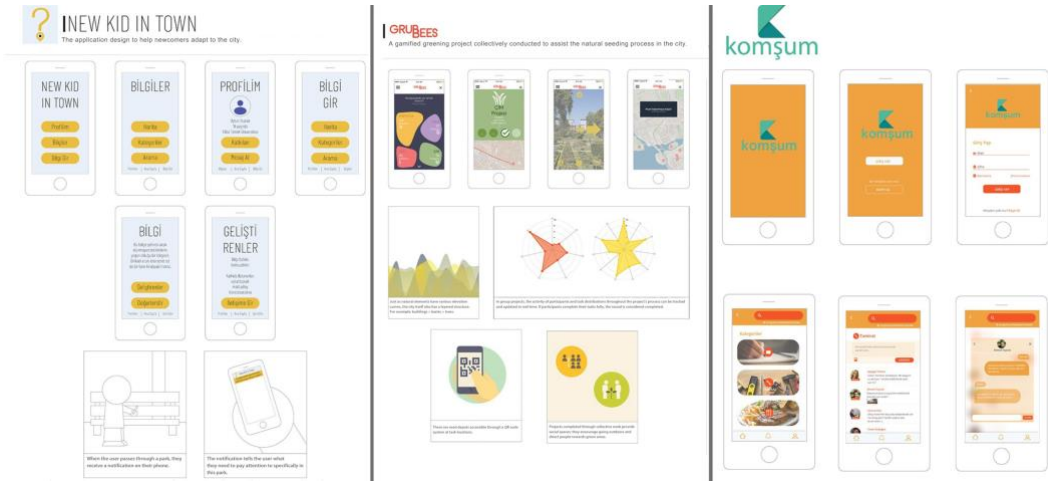


Figure 2. Prototype sections of Group-1 – Project-1 poster submissions. New Kid in Town by 1A (left); Grubbees by 1B (center); Komşum/My Neighbour by 1C (right).

Group-2 (Control Group) Projects concepts are as follows:

- "GamePub" by 2A is mobile social media platform for adult and casual gamers. Contrary to the existing platforms that feature "success", it features styles, weekly time spans and networking for gamers.
- "Musichian" by 2B is a location-based mobile music platform that, by tracking users' navigation and routes in the city, creates density/ frequency maps according to the crowd and maps these data to create custom music lists.
- "Win" by 2C is a mobile platform with the purpose of discouraging people from breaking social rules through a competitive gamification in which citizens report and inform on violations of each other. (See Figure 3)

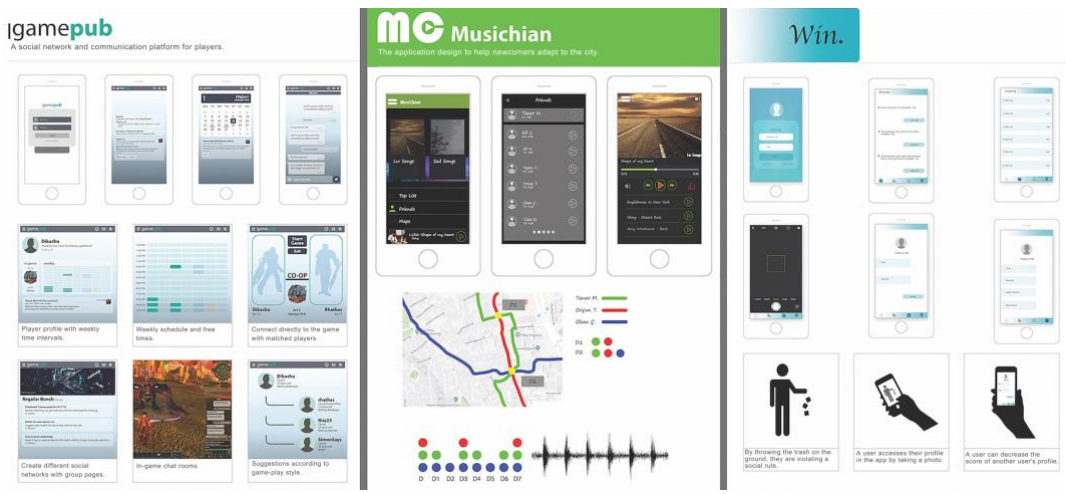


Figure 3. Prototype sections of Group-2 – Project-1 poster submissions. GamePub by 2A (left); Musichian by 2B (center); Win by 2C (right).

4.2. Project 2: Improving Quality of Time Spent in Urban Settings

In the second project the participants were asked to design an interactive service or tool "to improve the quality of time spent in (an) urban setting(s)". To remind, in this project the groups were switched, Group-2 was provided the training and assigned as the Test group, and Group-1 was released from the obligation to apply the guideline.

Group-1 (Control Group) Projects concepts are as follows:

- "Sound of Here" by 1A is a location-based mobile music-streaming platform in which "locations" have and present their own lists that are produced according to the data collected from the activities of visitors.
- "Crowd" by 1B is a map-based mobile application, which, by presenting crowd density maps, aims to prevent queues and waiting times at entertainment venues and restaurants.
- "Bi'Durak/One Stop" is a mobile social media application that gets activated only during the waiting times at the public transportation hubs and stations. The content is user-created with the purpose of creating a spatial memory specific to that station. (See Figure 4)

Figure 4. Prototype sections of Group-1 – Project-2 poster submissions. Sound of Here by 1A (left); Crowd by 1B (center); Bi' Durak/One Stop by 1C (right).

Group-2 (Test Group) Projects concepts are as follows:

- "Sükut/Silence" by 2A is a spatial interaction design project with the purpose of experiencing silence and peace in urban places such as parks. The users can create a noise barrier and interact with others to prevent disturbing noise production.

- "Familiar" by 2B is a mobile map application that directs its users to a shop, atelier, or any other venue that they need, counting on the probability of an acquaintance, (or an acquaintance of an acquaintance) working there.
- "Green Wheel" by 2C is a car-pooling and parking support application specifically aimed for crowded shopping malls. (See Figure 5)

Figure 5. Prototype sections of Group-2 – Project-2 poster submissions. Sükut/Silence by 2A (left); Familiar by 2B (center); Green Wheel by 2C (right).

5. RESULTS & DISCUSSUION

5.1. Overall Scores

The overall SUS and ECOS scores, along with the average and standard deviation calculations for all 12 projects are presented in Table 3. As the number of projects is not sufficient for a thorough statistical analysis, the quantitative outcomes in this section should be regarded only as a precursor to the qualitative step. First, we wanted to check whether numerical results for this scale of research imply an effectuality of the guideline. Then in the interview phase, especially for the results that show an unexpected turn, we evaluated the situation with the designers to be able to reveal hidden factors and to get equipped with suggestions to improve the efficiency of the training for future implementations.

Tablo 3: Overall SUS and ECOS scores

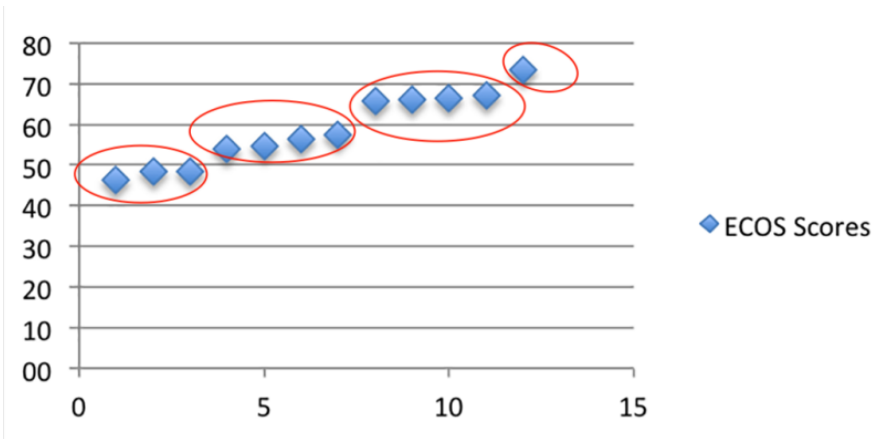
Designer ID	Project Title	SUS	ECOS	SUS	ECOS
	New Kid in				

	Komşum/My				
1C	Neighbor[a]	75.6	65.6	Good	Moderate
	Average	**71.0**	**69.1**		
2A	GamePub	72.5	54.8	Good	Poor
2B	Musichian	41.8	54.1	Poor	Poor
2C	Win	48.7	48.5	Poor	Very Poor
	Average	**54.3**	**52.2**		
1A	Sound of Here	77.1	67.1	Good	Moderate
1B	Crowd	82.7	57.6	Good	Poor
	Bi Durak/One				
1C	Stop	77.5	56.6	Good	Poor
	Average	**79.1**	**59.9**		
2A	Sükut/Silence[a]	67.2	66.3	Moderate	Moderate
2B	Familiar[a]	50.4	46.3	Poor	Very Poor
2C	Green wheel[a]	54.3	48.5	Moderate	Very Poor
	Average	**57.3**	**53.9**		
	TOTAL AVERAGE	**65.4**	**58.7**		
	STD DEV	13.3	8.8		

------- Project 2 -------

[a] Test Projects (the projects that were implemented using the guideline).

When we sorted ECOS scores, four clusters of scores have appeared as in Figure 6.



For this specific project, we categorized the projects' grading as shown in Table 4 by adapting Bangor et al.'s (2009) adjective rating scale. In the discussions that follow, the outcomes are also argued from the point of the acceptability vs. non-acceptability of a score (Bangor et.al., 2008).

Tablo 4: Overall SUS and ECOS scores (Bangor et.al., 2009)

ECOS Cluster	ECOS scores range	SUS scores	Quality
Below average (59) at least 10 points	46.3 - 48.5	NA	Very Poor
Slightly below average (up to avg + std.dev.)	54.1 -57.6	35.7 – 50.9	Poor
Slight above average (down to avg - std.dev)	65.6 - 67.1	50.9 – 71.4	Moderate
Above	>= 73.4	71.4 – 85.5	Good

The outcomes that are in accord with the research question are as follows:

- In Project 1, the test group (Group-1 participants 1A, 1B, and 1C) has performed acceptable (Moderate/Good) scores in both usability and eco-design.
- In Project 1, the average ECOS performance of test group (Group-1) outperforms that of control group (Group-2) by 22%.
- In Project 2, when there is no guideline for Group-1, the ECOS performance of 1B and 1C in the group (2 out of 3 participants) decrease by 21.5% and 13.7%, respectively.
- Group-2 participant 2A performs similar to 1B and 1C. In Project 2, when the guideline is provided to his group, his ECOS score increases from Poor to Moderate by %21.

The outcomes that are negative/indifferent to our research question:

- In Project 2, although the guideline condition is removed for Group-1, participant 1A's ECOS score stays almost the same Moderate value as in Project-1.
- Group-2 participants 2B and 2C performs mostly not acceptable scores (Poor or Very Poor) in both ECOS and SUS, for both projects. Besides, no impact of the guideline is hinted in their numbers. In Project 2, after the guideline is provided to them, ECOS score of 1C remains stable, whereas ECOS score of 1B contrarily decrease by 17%.

5.2. ECOS vs. SUS Scores

In three participants, 1A, 1B, and 2A, a negative correlation is observed between SUS and ECOS scores. In Project 2, when guideline condition is removed, SUS scores for 1A and 1B increase by 16% and 17%, respectively. In parallel, SUS score of 2A decrease by 7% in Project 2, when their group is provided guideline. For the other three participants, the difference is either ignorable or reverse.

In Figure 7 below the outcomes are sorted according to the SUS scores from the lowest to the highest scores, in order to provide a clearer data visualization to inquire for a possible correlation between usability and eco-design through SUS and ECOS scores.

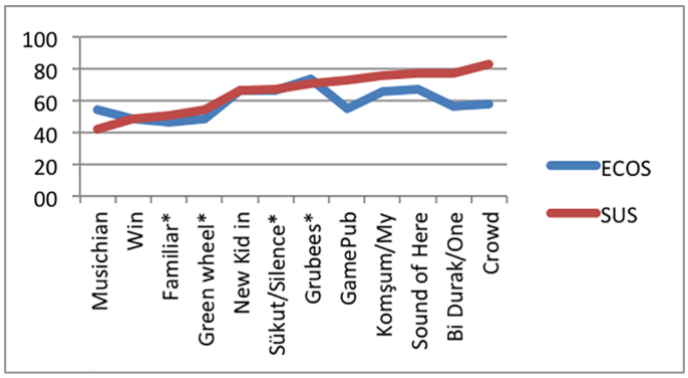


Figure 7. SUS vs. ECOS scores.

In all projects that perform low in usability, ECOS scores are low, either. When SUS scores increase up to a point, ECOS scores increase, too. However, for projects with Moderate/Good usability scores, ECOS scores do not exhibit a stable direct proportion. For a high ECOS score, we argue, a moderate or good usability score seems to be a condition, but not a sufficient one on its own.

In the next phase of the analysis, semi-structured interviews have been conducted with the participants and they were asked to evaluate the outcomes.

5.3. Interview Results

The main topics concerning our research and the associated interview questions are as presented in Table 5.

Tablo 5: Semi-structured interview themes and associated questions

Research Themes	Interview Questions
Comprehension of the Guideline	Do you think you have comprehended the guideline? What has challenged you most?
Application of the Guideline	Were you able to apply the guideline principles in your project? What were the difficulties?
Proficiency of Training	Was the training provided competent overall? Was the 3-hour seminar sufficient in terms of both the allocated time and given content? Was the guideline booklet clear and articulate in terms of language use? How could the efficiency of the training be improved?
Groupings and Test Methodology	Do you think the grouping methodology of the work was suitable to maintain fair and reliable results? Have the subject of the projects had an impact on the SUS/ECOS scores?
Usability vs. Ecology	Do you think there is a conflict or any kind of correlation among the principles of usability and eco-design?
Other Factors	What do you think are the main factors behind your high / low / unexpected / indifferent scores?

In Table 6 below, the overall positive/negative stance of each participant is presented for the five main topics. Distinctive comments, suggestions and other revealed factors are presented next.

Tablo 6: Overall feedback of participants in terms of positivity/negativity

Std. #ID	Test Project ECOS score	Comprehension	Application	Training	Test	Usability vs. Ecology
1A	66.3 Moderate	✓	✓	✓	✓	✗
1B	73.4 Good	✓	✓	✓	✓	✗
1C	65.6 Moderate	✓	✗	✓	✓	✓
2A	66.3 Moderate	✓	✓	✓	✓	✓
2B	46.3					NA

	Very Poor	✗	✗	✓	✓	
2C	48.5 Very Poor	✗	✗	✗	✓	NA

Comprehension:

- 4 out of 6 participants (1A, 1B, 1C and 2A), in accordance with their acceptable ECOS scores (from Moderate to Good), stated that they could have comprehended the guideline.
- 1A underlined the need for a detailed reading, stating that a shallow reading might be misleading.
- 2B and 2C had difficulty in understanding the text, which is apparent in their not-acceptable scores.

Application:

- Participants 1A and 1B were positive about their ability to apply the guideline in their projects which is in accord with their acceptable ECOS scores.
- 1C and 2A stated that, although they had comprehended the guideline in theory, in actualization they had difficulty. 1C specifically was hesitant about the success of her project. Yet, despite having difficulties, ECOS scores of both participants are Moderate as a positive indicator.
- 2B and 2C had difficulty in applying the guideline, as manifested in their not-acceptable scores.

Training:

- All participants except 2C declared that they found the training proficient and the materials comprehensive.
- 2B underlined that the reason behind his low scores is not due to an insufficiency in the training but his personal design skills.
- 2C declared that the training was proficient, but the text was difficult to understand, more examples from the field of HCI could be beneficial and more than one seminar might be necessary.
- 1B suggested the seminar / meeting to take place after the guideline is provided.

- The conceptual and metaphorical approach was inspiring to most. 2B said the metaphors and images were "illuminating" and that the participants "kept reminding each other to think like a mountain".
- 1A stated, however, he was at times confused about whether to take the parameters from a formal, structural, or metaphorical point.
- 2A and 1C also agreed with 2C that more concrete examples from the digital media field to be provided, along with discussions.
- 1C also suggested more than one seminar to be organized.
- 1A stated he spent a significant portion of his time for the first project to study the guideline. Thus, the training time would be better to be allocated separately from the project time.
- 2A stated that he could have scored more if there were regular meetings and discussions in the process. 1B and 1C supported this argument by stating that informal discussions with each other were most helpful in the process.

Groupings and Test Methodology:

- No participant has made a criticism about the fairness of groupings, or any point that could have affected the objectivity of the outcomes.
- Three participants, however, declared that they do not think that project subject has a remarkable impact; so crossing the groups was not necessary at all.
- Being in the first test group, all Group-1 participants had to show an extra effort to remain independent from the guideline in the second project, because they were influenced in the first one. 1A underlined this as the reason why there is not much difference between his ECOS scores. Participant 2A also supported this argument by stating that, if he were provided the training in the first project, in the control/second project his ECOS score would be higher.

Usability vs. Ecology:

- 1B stated there is no conflict and both can score high (in parallel with her scores).
- 1A stated that there is not a conflict in project scale. Contrarily, from a mobile application to city planning, in the long run they are complementary. The score anomalies do not result from such a conflict. Yet, he added, we can talk about an

ideological conflict in the sense that interactive media sector is after acceleration and ecology is after optimization.

- 1C and 2C remarked such a conflict not in general but for specific parameters such as "locality" and "slow solutions".
- 2A pointed out the focus point as the root cause of such a conflict. In usability we focus on users but in ecology on everybody else, he stated. Thus "it needs a deeper contemplation".

Other Factors:

- 1A underlined that it is much more guiding and stimulating to use the guideline while implementing a project from scratch. It was his experience that it would be difficult to revise an already existing project according to the guideline.

5.4. Key Findings and Discussion

The findings of the case study that we derive from the cross-analysis of the scores and interview results, reveal some notable observations that can be insightful for future studies:

- When usability scores were low, ECOS scores also tended to decline. This trend suggests that fundamental design capabilities may serve as precursors to successful ecological design practices. Particularly for participants 2B and 2C, who exhibited the lowest usability scores, the guideline was clearly ineffective. In contrast, the other four students performed as expected, demonstrating the varying impacts of the guidelines across different design approaches.
- Notably, all Group-1 participants had to exert extra effort to avoid following the guidelines in the second project, indicating that the guideline had an internalized effect—a key outcome that underscores the potential for ecological principles to influence design thinking.
- Despite these challenges, the study also identified several opportunities for synergy between usability and ecological thinking. For instance, both frameworks emphasize the importance of efficiency—whether in terms of task performance (usability) or resource conservation (ecology). The conflicting points highlighted by participants were not intrinsic contradictions but rather reflections of the fast consumption demands that are characteristic of media design industries. This observation suggests that industry pressures may complicate the integration of ecological considerations into usability-focused design, indicating a need for more supportive structures within the design environment.

- The research also addressed the question of how ecological design knowledge can be effectively transmitted to young designers. It became clear that while the conceptual and metaphorical presentation of ecological principles is important, practical tools like the ECOS scale can offer a more concrete framework for integrating these principles into design projects. However, the success of these tools depends on the motivation and mindset of the designers themselves—factors like previous experience with sustainability and openness to non-traditional design frameworks significantly influenced how well they adopted ecological heuristics.

6. CONCLUSION

This study highlights the complex relationship between usability and ecological design in the context of interactive media. While both fields offer essential guidelines for creating "good" designs, their perspectives often diverge—usability prioritizes human-centered efficiency, while ecological design seeks a more holistic, more-than-human approach that respects natural systems. Through the comparison of the System Usability Scale (SUS) and the Ecological Systems Scale (ECOS) within the scope of a case study, this research has explored whether these two frameworks can coexist or conflict in the design process.

The study reveals an association between usability and ecological design, where design fundamentals are essential for successful ecological practices. Participants who struggled with usability also found it harder to apply ecological principles. The research identified a potential synergy between usability and ecology, both emphasizing efficiency, yet industry pressures can complicate integrating ecological thinking into design processes.

Additionally, while practical tools like the ECOS scale aid in adopting ecological principles, their effectiveness largely depends on the designer's mindset, experience with sustainability, and openness to innovative design approaches.

For future studies, implementing a long-term course that includes ongoing discussions, collective contemplations, and mid-term revisions may prove more effective in nurturing the integration of ecological thinking within usability-focused design practices.

In conclusion, this study demonstrates that while usability and ecological design may present conflicting priorities in certain contexts, they also offer the potential for a more holistic design approach when integrated thoughtfully. Future research should continue to explore this balance, focusing on refining ecological heuristics in ways that do not hinder usability and on developing tools and educational frameworks that can inspire designers to think ecologically. By fostering a deeper understanding of ecological principles alongside usability metrics, the design community can move towards creating interactive media that serves both human users and the ecosystems they inhabit.

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