Project Notes:

Project Title: Designing and Testing a Gamified App to Increase the Volume and Accuracy of Household Recycling

Name: Lindsey Paradise

Note Well: There are NO SHORT-cuts to reading journal articles and taking notes from them. Comprehension is paramount. You will most likely need to read it several times, so set aside enough time in your schedule.

Contents:

Knowledge Gaps:

This list provides a brief overview of the major knowledge gaps for this project, how they were resolved and where to find the information.

Knowledge Gap	Resolved By	Information is located	Date resolved
What is the root hindrance to households not recycling?	Reading literature and professional correspondence	Articles: 4, 5, 9	10/2/23
How can people be motivated to do things they don't want to do?	Gamification TedTalk, reading literature	Articles: 10-13	11/1/23
Does gamification work in a recycling context?	Reading literature and professional correspondence	Article #14 More to come	11/1/23
What are the appropriate tools to build the app I wish to build?	Conversation with Mrs. Taricco	What I want my…	10/11/23

Literature Search Parameters:

These searches were performed between 8/20/23 and 12/15/2023.
List of keywords and databases used during this project.

Database/search engine	Keywords	Summary of search
WPI Library	household Recycling, barriers, environment	Articles added to Zotero TBR list. In future searches, add a parameter for more recent articles.
WPI Library	gamification	Found articles 10-12, all from within the past 10 years
Youtube	gamification	Article 13, learned about Octalysis and the 8 core human motivators. May want to implement it in the project but more research is needed.
WPI Library	Gamification recycling	Found article #14! This confirms that people (at least Swedish people) do want to use recycling as a way to learn about and improve recycling. The biggest struggle is going to be creating a game that does not not inadvertently hinder the recycling process.
WPI Library	Recycling Importance	Article 20, provided information on why we need citizens to recycle (and not wait for government policies) and also what factors affect motivation to recycle
Google Patents	Gamification	Patent 1, Patent 2, Patent 3

Tags:

Tag Name	
#barriers	#incentives
#machineLearning	#SummerSummary
#AI	#gamification
#recycling	#testingStrategy
#flutter	

Article #X Notes: Title

Article notes should be on separate sheets

KEEP THIS BLANK AND USE AS A TEMPLATE

Source Title	
Source citation (APA Format)	
Original URL	
Source type	
Keywords	
#Tags	
ChatGPT Summary	
Summary of key points + notes (include methodology)	
Research Question/Problem/ Need	
Important Figures	
VOCAB: (w/definition)	
Cited references to follow up on	
Follow up Questions	

Article #1 Notes: Neural Networks Need Data to Learn. Even If It's Fake

Article notes should be on separate sheets

Source Title	Neural Networks Need Data to Learn. Even If It's Fake
Source citation (APA Format)	Zeeberg, A. (2023, June 16). Neural networks need data to learn. Even if it's fake. *Quanta Magazine*. https://docs.google.com/document/d/1ISQKjY6PDkH-5Oyd_WGm95zrnoFQRuHk-0kQhPF_ZvI/edit
Original URL	https://www.quantamagazine.org/neural-networks-need-data-to-learn-even-if-its-fake-20230616/
Source type	Science Magazine
Keywords	Artificial intelligence, big data, computer science, machine learning, neural networks
#Tags	#AI #machineLearning
Summary of key points + notes (include methodology)	Since its birth machine learning has successfully trained using synthetic data because real data can be difficult to obtain because of privacy, expense, and supply. Currently, Microsoft and Google primarily use synthetic data to train facial recognition technology because real data (images of human faces) is expensive and time consuming to collect given the high volume of unique images needed. The medical community is currently working on training AI with synthetic data to read human x-ray, CT, MRI, and ultrasound images which will dramatically increase the speed and accuracy at which patients can receive care.
Research Question/Problem/ Need	How are researchers using synthetic data to train artificial intelligence systems in the absence of real data?

Important Figures	 Even though the faces, generated by Microsoft, look more cartoonish than human, they have still been successfully used to train for facial recognition.
VOCAB: (w/definition)	GPU - Graphics processing unit, a chip used in this study to produce more realistic images
Cited references to follow up on	Learning an appearance-based gaze estimator from one million synthesized images https://dl.acm.org/doi/10.1145/2857491.2857492 “Diffusion models generate incredible images by learning to reverse the process that, among other things, causes ink to spread through water” https://www.quantamagazine.org/the-physics-principle-that-inspired-modern-ai-art-20230105/ An Autonomous Land Vehicle In a Neural Network https://www.ri.cmu.edu/publications/alvinn-an-autonomous-land-vehicle-in-a-neural-network/
Follow up Questions	1. The article mentioned that the images generated by the AI were not photorealistic. If the AI creates images that are less than perfect and then use those images as references for further ones, at what point will the AI generated images be too inhuman for it to be a sufficient training tool? How is this, or how can this, be prevented? 2. How can training with synthetic data be applied to applications other than analyzing an image? 3. If, according to author Amos Zeeberg, using synthetic data is so advantageous, then why are some computer scientists still using real data? What are the limitations of this tool?

Article #2 Notes: By Exploring Virtual Worlds, AI Learns in New Ways

Article notes should be on separate sheets

Source Title	By Exploring Virtual Worlds, AI Learns in New Ways
Source citation (APA Format)	Whitten, A. (2022, June 24). By exploring virtual worlds, AI learns in new ways. *Quanta Magazine*. https://www.quantamagazine.org/ai-makes-strides-in-virtual-worlds-more-like-our-own-20220624/
Original URL	https://www.quantamagazine.org/ai-makes-strides-in-virtual-worlds-more-like-our-own-20220624/
Source type	Science Magazine
Keywords	Algorithms, artificial intelligence, cognition, computer science, deep learning, machine learning, robotics, perception
#Tags	#AI #machineLearning
Summary of key points + notes (include methodology)	The emerging field of embodied AI seeks to use 3 dimensional, interactive worlds, instead of static images, to train AI so that they will be able to execute complex, multistep, tasks. These interactive worlds allow virtual agents to learn and develop human-like neural networks by interacting with their environments through touch and, as of 2020, sound. Much progress, in navigation, object manipulation, and comprehension and execution of complex language instructions, is left to be made.
Research Question/Problem/ Need	What strategies have AI researchers developed to teach their virtual agents new skills?
Important Figures	N/A
VOCAB: (w/definition)	Embodied AI - AI that learns from completing tasks in a 3D environment as opposed to studying 2D images. The 3D environment may be virtual or in the real world.

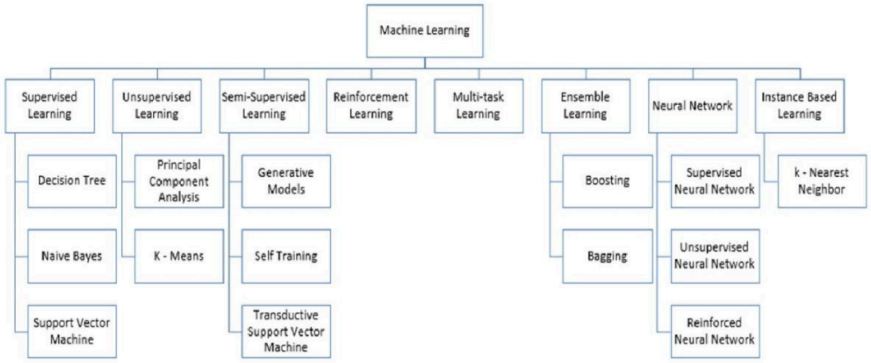
	Neural network - a type of machine learning process that helps a computer to think like humans do by organizing and identifying relationships in the data it receives
Cited references to follow up on	Virtual home environment for AI agents to explore https://ai2thor.allenai.org ThreeDWorld, another environment for agents to explore with a focus on physics https://www.threedworld.org Paper shows that embodied AI was more accurate at detecting specified objects by nearly 12% https://arxiv.org/abs/2202.00660 More about how embodied AI is improving traditional algorithms https://proceedings.neurips.cc/paper/2021/hash/6d0c932802f6953f70eb20931645fa40-Abstract.html https://arxiv.org/abs/2012.00057
Follow up Questions	1. What is preventing the embodied AI from training perfectly in its interactive worlds? 2. Can/has this embodied AI technology be applied to underwater navigation? 3. How can AI be taught to complete complex, language-based tasks? What is the best method to achieve this?

Article #3 Notes: Machine Learning Algorithms - A Review

Source Title	Machine Learning Algorithms - A Review
Source citation (APA Format)	Mahesh, B. (2018). Machine learning algorithms - a review. *International Journal of Science and Research*, *9*(1). https://doi.org/10.21275/ART20203995
Original URL	https://www.researchgate.net/profile/Batta-Mahesh/publication/344717762_Machine_Learning_Algorithms_-A_Review/links/5f8b2365299bf1b53e2d243a/Machine-Learning-Algorithms-A-Review.pdf?eid=5082902844932096
Source type	Journal Article
Keywords	Algorithm, Machine Learning, Pseudo Code, Supervised learning, Unsupervised Learning, Reinforcement Learning
#Tags	#machineLearning

Summary of key points + notes (include methodology)	Key points:
	- The advantage of using ML is that "once an algorithm learns what to do with data, it can do its work automatically"
	- ML algorithms are good at:
	  - Interpreting data (saves humans lots of time)
	  - Extracting data that is relevant
	- There is no one-size-fits-all model
	  - Depends on the kind of problem you want to solve, number of variables present
	- Prominent types of ML
	  - Supervised learning (learn patterns from the training data set then apply them to the test set)
	  - Naive Bayes (good for text classifications)
	  - Support Vector Machine (SVM, uses nonlinear classification to draw margins between the classes)
	  - Unsupervised Learning (no correct answers for teacher, used for clustering and feature reduction)

	- K-means Clustering (classifies a given data set to a certain number of clusters) - Principal Component Analysis (uses a statistical procedure to turn a set of possibly correlated variables into a set of values of linearly uncorrelated variables, simplifies the data) - Semi Supervised Learning (useful when only unlabeled data is available) - Transductive support vector machines (labels the unlabeled data so that the margin between labeled and unlabeled data is the maximum it can be) - Generative Models (a model that can generate data) - Self Training (trained with labeled data then fed unlabeled data) - Reinforcement learning (agent learns how to act in an environment by trying to maximize the rewards it earns) - Multitask learning (aims to solve multiple tasks at the same time) - Ensemble Learning (multiples models are combined to solve a problem) - Boosting (a family of algorithms that converts weak learners to strong learners) - Neural Networks ("a series of algorithms that endeavors to recognize the underlying relationships in a set of date through a process that mimics the way the human brain operates" - Supervised Neural network (the networks output is compared with the predetermined output) - Unsupervised Neural network (no correct output is determines, used to categorize the data according to similarities) - Reinforced neural network (learns how to achieve a goal or reward the way a human would) - Instance based learning (used for classification and regression, produces a class prediction based on the similarity of the query to its nearest neighbors in the training set - K-nearest Neighbor (very slow as data size grows, used for classification and regression)
Research Question/Problem/ Need	What types of machine learning algorithms are there and what is each best suited for?
Important Figures	Graphical representation of the various branches of machine learning.

	
VOCAB: (w/definition)	Machine learning (ML): "the scientific study of algorithms and statistical models that computer systems use to perform a specific task without being explicitly programmed" (381) Data mining: finding patterns in large sets of data, this is made much more efficient with ML Supervised learning: "the machine learning task of learning a function that maps an input to an output based on example input-output pairs" (381)
Cited references to follow up on	M. Bkassiny, Y. Li, and S. K. Jayaweera, "A survey on machine learning techniques in cognitive radios," IEEE Communications Surveys & Tutorials, vol. 15, no. 3, pp. 1136–1159, Oct. 2012.
Follow up Questions	How can one efficiently determine what model will be the best for their project? How long does it take to train an ML model? What type of data is needed?

Article #4 Notes: Perceived barriers to food packaging recycling: Evidence from a choice experiment of US consumers

Article notes should be on separate sheets

Source Title	Perceived barriers to food packaging recycling: Evidence from a choice experiment of US consumers
Source citation (APA Format)	Klaiman, K., Ortega, D. L., & Garnache, C. (2017). Perceived barriers to food packaging recycling: Evidence from a choice experiment of US consumers. *Food Control*, *73*, 291–299. https://doi.org/10.1016/j.foodcont.2016.08.017
Original URL	https://www-sciencedirect-com.ezpv7-web-p-u01.wpi.edu/science/article/pii/S095671351630442X
Source type	Journal Article
Keywords	Food packaging, recycling, choice experiment, consumer preference, perceived barriers, information
#Tags	#barriers #motives
ChatGPT summary	"This study investigates the factors influencing consumer recycling behavior, with a focus on food packaging materials. The research conducted an online survey involving 1500 American households and used a choice experiment design to assess the impact of message targeting and media delivery on consumer recycling behavior regarding plastic or boxboard sandwich containers. The study found that consumers perceived the need to clean packaging as a significant barrier to recycling, whereas packaging material type and the number of packaging parts did not strongly influence recycling decisions. Interestingly, individuals motivated by energy conservation were less deterred by the cleaning process. However, the study revealed that information campaigns, delivered through infographics or videos, did not significantly affect recycling behavior. Nevertheless, these campaigns did alter consumer preferences for packaging material, with consumers favoring paper and boxboard over plastic. The results suggest that while

	information campaigns may not directly improve recycling rates, they can influence packaging material choices. Future research should focus on identifying and addressing the specific barriers faced by consumers with lower education and income levels to enhance recycling efforts and consider alternative strategies for promoting recycling behavior." 9/24/23 Link to Prompt and Response

Summary of key points + notes (include methodology)	Key Points
	- 2001 questionnaire determined that "convenience, concerns for future generations, the environment, and personal satisfaction" were the main reasons for recycling and "inconvenience, storage problems, and distance to recycling centers" were the main reasons not to
	- A variable pricing strategy (charging more for things that promote trash) showed the biggest increase in recycling rates
	- Increased convenience, decreased cost, and changed perception of social norms increased recycling
	- Poorer people and people with lower education levels were more likely to report there were no recycling programs in their area and that recycling does not make a difference for the environment.
	- Members of all 3 groups showed the highest sensitivity to cleaning the packaging (meaning the cleaning the product is a big hindrance)
	- Information treatments did not affect willingness to overcome barriers to recycling
	-
	Interesting Points or Stats
	- Recycling has been shown to lower greenhouse gasses
	- Recycling rates have been increasing in the US since recycling programs (still no universal plan in the US) began, but still the rates are relatively low compared to other countries
	- If a product is not labeled as recyclable, the majority will believe that it is not recyclable
	Methodology / Experiment Design
	- Before being administered, the survey was reviewed by food product and packaging companies for accuracy and relevance
	  - Tested with a small group, then revised for better comprehension
	- Participants were selected by Survey Sampling International to create a participant pool that modeled the national census (quotas for gender, age, income and education level and geographic region, were met)
	  - Slightly higher than average education levels reported
	- Online survey of 1500 American households to understand consumer grocery shopping habits, attitude towards recycling, and determine whether demographics have an effect on a consumer's motives and perceived barriers
	- Choice experiment implemented to evaluate drivers and barriers to product recycling (specifically of an on the go sandwich container since 49% of Americans eat a sandwich daily)

	- Participants were asked which of two containers they were more likely to recycle (also had a "neither" option). The sandwich and cleaning effort remained the same for each option.
	- The variables tested were: packaging material (paperboard or plastic), if the packaging needed to be cleaned (rinsed or scraped), number of parts to be separated (1-4), and time required for recycling (5, 10, 20, 30, or 60 sec)
	- Each participant evaluated 5 of the 20 scenarios
	- Participants were divided into 3 groups: controle (viewed no media), group 1 (viewed an infographic with a general message about the benefits of recycling), and group 2 (viewed a targeted video clips about detailed energy saving benefits of recycling)
	Results
	- Results were reported in a Willingness to Accept (WTA) format, the amount of money (based on household income) that a participant was willing to accept to overcome a certain barrier was calculated
	- Respondents reported having to clean a container before recycling it as a barrier
	  - Less of a barrier if the participant was drawn to recycling for energy conservation
	- All groups showed a negative preference for time spent recycling
	- 3% of participants chose not to recycle in any scenario (shows some have an entirely negative view of recycling)
	- The type of material and the number of steps in the recycling process were not barriers
	- "Providing information treatments through two different mediums with different specificities of the messages did not affect consumer willingness to overcome barriers to recycling."(but did alter preference for packaging material (preferred paper over plastic))
	- Latent class analysis was used to sort the participants into 2 groups
	  - motives -focused (87%): low disutility for cleaning, reported motives as driving their recycling decisions
	  - WTA for cleaning = $0.10
	  - Barriers-focused (13%): high aversion to cleaning
	  - WTA for cleaning = $0.51
	- Participants were also surveyed on how important incentives and barriers were to their choice to recycle
	  - Incentives: "recycling reduces waste sent to landfills, protects wildlife, reduces water pollution, saves energy, leads to cheaper goods in the long run, is mandated in your area, is cheaper than trash pick up, and general sustainability"
	  - Barriers: "recycling takes too much time, costs too much, do not remember to recycle, takes too much effort, no recycling bins available, does not make a difference to the environment, recycling guidelines are too confusing, no recycling program in

	your area, and no curbside pickup" - Different demographics reported different significance of incentives and barriers: "Males ranked reduce waste sent to landfills,Protects wildlife, Reduces water pollution, Save energy, Cheaper goods in the long run, and General sustainability as less important than females for their reasons for recycling. Older consumers perceived Reduce waste sent to landfills as more important than younger consumers, however, the effect is small. Wealthier households viewed Cheaper goods in the long run and cheaper than trash pickup as less important to recycle than poorer households. Respondents self-reporting as democrats are more likely to be driven by motives such as Reduce waste sent to landfills, Reduce water pollution, Save energy,and Mandated in your area,while republicans reportProtect wildlife,and General sustainability as less important." - "Males were more likely to report that money was an important reason for not recycling. Those with lower education levels were more likely to report that recycling costs too much and takes too much effort, and that recycling guidelines were too confusing. It is interesting to see that consumers with lower levels of income and education were more likely to report that there were no recycling programs in their area and that recycling does not make a differ-ence for the environment. Respondents who self-identify as republicans were more likely to report that time and effort were important reasons for why they do not recycle. Older respondents were more likely to report that recycling does not make a difference for the environment as a barrier to recycling."
Research Question/Problem/ Need	How do particular packaging characteristics foster or hinder recycling? Are information campaigns effective at encouraging consumers to overcome barriers to recycling? - This topic was chosen because previous research has focused mainly on cumulative recycling habits not individual products
Important Figures	See Kami PDF for the distribution tables of survey responses
VOCAB: (w/definition)	**Choice experiments**: type of stated preference tools used to study consumer behavior especially when estimating a consumer's willingness to pay for a good or service. Survey participants choose between "bundles" instead of ranking them. This helps to model shopping or choosing in the real world. **Orthogonally**: of or involving right angles; at right angles (Oxford Languages) **Latent class analysis:** the label given to a form of finite mixture modeling where the observed indicators are all categorical (National Institute of Health)

	Ordinal form: numbers that are used to represent the rank or position of an object or a person like 1st, 2nd, 3rd (SplashLearn)
Cited references to follow up on	Talks about barriers to recycling Gamba, R. J., & Oskamp, S. (1994). Factors influencing community residents' participation in commingled curbside recycling programs. Environment and Behavior, 26(5), 587e612. Halvorsen, B. (2008). Effects of norms and opportunity cost of time on household recycling. Land Economics, 84(3), 501e516. Perrin, D., & Barton, J. (2001). Issues associated with transforming household attitudes and opinions into materials recovery: A review of two kerbside recycling schemes. Resources, Conservation and Recycling, 33(1), 61e74. http://doi.org/10.1016/S0921-3449(01)00075-1. Sidique, S. F., Lupi, F., & Joshi, S. V. (2010b). The effects of behavior and attitudes on drop-off recycling activities. Resources, Conservation and Recycling, 54(3), 163e170. http://dx.doi.org/10.1016/j.resconrec.2009.07.012. US EPA. (2011). Reducing greenhouse gas emissions through recycling and composting. Retrieved from http://www.epa.gov/.
Follow up Questions	How can we educate older generations on the importance of recycling? Why do they not view it as important? How can recycling guidelines be made more clear for people of lower education levels? What other barriers may there be to packaging recycling? How can companies use the knowledge of these barriers to better engineer their products to be recycled? The information campaigns tested in this study focused on the positives of recycling. Do you think that a campaign that highlighted the consequences of not recycling would increase participants' willingness to overcome the time and cleaning barriers? I find the motive- and barrier-focused groups created by the latent class analysis intriguing. Was there a relationship between these groups and which information campaign group a participant was in? A 2009 article, Information and the decision to recycle: results from a survey of US households, by Hilary Nixon and Jean-Daniel M. Saphores, found that households with at least one person over age 65 were 1.6x more likely to recycle than those that don't because being retired gives an individual more time to recycle. However, this study found that older respondents were more likely to report that "recycling does not make a difference to the environment" as a barrier to recycling. I am curious to

	explore the older population's relationship with recycling. Should a special effort be made to increase the recycling habits of older people? Should an information campaign be targeted at them to help them see why recycling is important for the environment? Or should my efforts be directed elsewhere?

Article #5 Notes: Information and the decision to recycle: results from a survey of US households

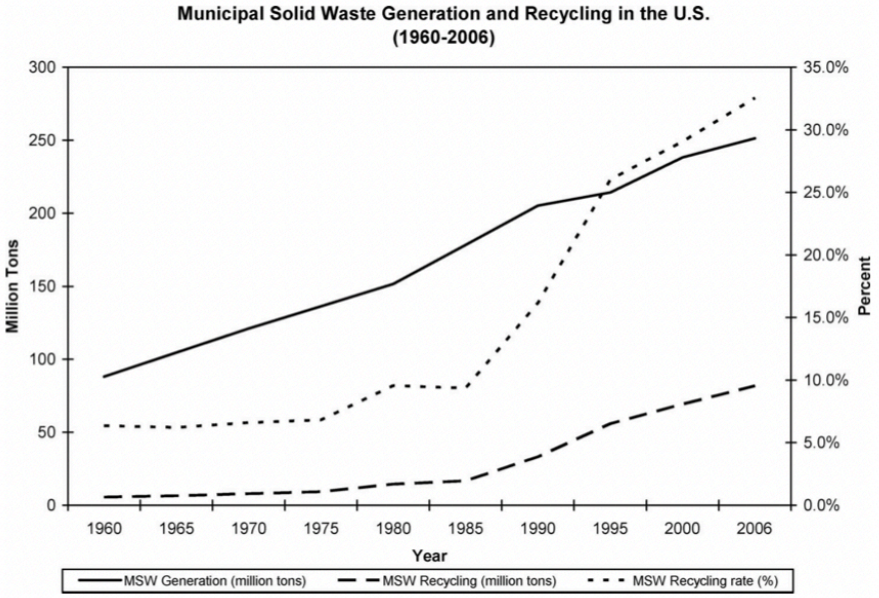
Article notes should be on separate sheets

Source Title	Information and the decision to recycle: results from a survey of US households
Source citation (APA Format)	Nixon, H., & Saphores, J.-D. M. (2009). Information and the decision to recycle: Results from a survey of US households. *Journal of Environmental Planning and Management*, *52*(2), 257–277. https://doi.org/10.1080/09640560802666610
Original URL	https://www.tandfonline.com/doi/pdf/10.1080/09640560802666610?needAccess=true
Source type	Journal article
Keywords	Household recycling, recycling information, environmental attitudes, logistic regression
#Tags	#barriers #motives
ChatGPT summary	"This study, based on a 2006 national survey of US households, investigates the influence of various information sources on the decision to initiate recycling. The research reveals that face-to-face communication through family, friends, or work/school contacts is the most effective medium for encouraging people to start recycling. Furthermore, providing households with recycling information from multiple sources enhances the likelihood of recycling adoption. The study also identifies key obstacles to recycling, including concerns about storage space, time constraints, and safety. Interestingly, the research finds that age and ethnicity are statistically significant factors affecting recycling behavior, while income and education are not. These findings have significant implications for designing effective recycling information campaigns, emphasizing the importance of

	combining insights from environmental psychology and community-specific knowledge. Ultimately, the study highlights the need for a holistic approach to resource management and sustainability beyond individual recycling efforts, involving policies that incentivize sustainable product design and responsible end-of-life product management by companies." 9/24/23 Link to Prompt and Response

Summary of key points + notes (include methodology)	Key points
	- Face to face (family/friends or work/school) communication is the most effective medium to get people to start recycling
	  - Likely because people respond better when they trust the source of information
	  - Providing information from MULTIPLE SOURCES has been shown to be even more beneficial (3 or more)
	- Main concerns include storage space, time, and safety as main obstacles
	- Age and ethnicity are statistically significant to the decision to start recycling but not income or education
	Interesting Points or Stats
	- While recycling rates increased significantly from 1980 to 2006 (9.6% to 32.5%) per capita waste generation rates had remained steady since the 1990s
	  - I believe that the recycling rate is roughly the same now but we are producing much more waste!!
	- Recycling rates vary vastly state to state: in 2006 1.6% in Mississippi but 45.8% in Oregon
	  - Law that requires certain targets to be met by certain states, but states can set their own additional goals
	- Recycling rates for different materials also vary greatly
	  - Glass is especially low
	Literature Review:
	- Justifies why studying the media in which people are exposed to recycling is important. Heavy on the importance of knowledge.
	  - Recycling rates are positively correlated with information campaigns
	  - Campaigns by local community groups > newspapers or radios (shows why face to face is important)
	  - Face to face is better but more expensive, printing feedback cards is more cost effective
	  - Frequent updates and reminders to recycle have been reported to be beneficial, especially when the information seems trustworthy
	- More convenient recycling is, the more likely people will do it (even if they do not care about the environment)
	- Peer pressure and social norms are also big factors
	- value -action gap: even if someone may want to help the environment, these three types of barriers may prevent them
	  - Individuality (laziness or lack of interest)
	  - responsibility (perceptions about who is responsible for dealing

	with environmental concerns) - Practicality (lack of time or information, physical limitations) Methods - Pulled data from a 2006 national survey of US households - Survey participants were selected randomly from Knowledge Network's online research panel (meets RDD survey standards) - 2,136 participants completed the survey (of the 3,048 that were asked) - Revised version of the survey Survey included 4 parts, ranging from broad questions about participants' attitude to the environment to narrow questions about specific policies in their town. - Comments about slight misrepresentations of the US population - An equation was developed to model the probability that a given person would choose to recycle based on parts that can be explained and a variable error term (263) - Two models were created - Model A: how media types influence the decision - Model B: how the number and combination of media types influence the decision - Independent variables included recycling program policies, demographic and socioeconomic characteristics, respondents' attitude towards recycling and the course of the recycling information Results - Print is the most common type of media to inform on recycling, followed by television and radio - 38% of respondents have only received recycling info for a single source - Recycling policies that promote recycling are significant predictors of whether a household recycles or not - Longevity of the program matters too, the longer it has been around, the more likely residents will recycle - Mandatory recycling also increases the likelihood but less so than an established program - A significant relationship between house type and recycling habits was not found, but whether a home was owned or rented was important - Renters less likely to recycle - Mixed results when studying ethnicity - African americans less likely to recycle than whites - Not significant difference between Hispaniscs, whites, and others - Households with at least one person over age 65 are 1.6 x more likely to recycle - Larger households are more likely to recycle - No significant relationship between education or income and recycling Big results:

	- If a participant agreed with the barriers, they were more likely to not recycle - If a participant agreed with the incentives (such as recycling at home being safe) they would be more likely to recycle. - Convenience is the biggest issue - "people who are more aware of the consequences of their actions will be more likely to engage in pro-environmental behavior, such as recycling" - Model B showed that receiving information from combinations of sources (print and family/friends or print and work/school) dramatically increased the likelihood people would recycle
Research Question/Problem/ Need	What is the best method of communication (print, television, radio, family/friends, work/school and others) to influence the decision to start recycling? How can the "lack of communication" barrier best be overcome? - Wanted to provide a more recent and broader view of american households since many of the recent (at the time) studies had been conducted in Europe
Important Figures	 Graph shows that MSW generation is steadily increasing year to year. It also shows that the recycling rate increased sharply from the mid 80s to 90s and then began to slow again. The amount of waste recycled has always been significantly lower than the amount of waste produced.
VOCAB: (w/definition)	**Bivariate correlations:** indicate whether a statistically significant linear relationship exists between two continuous variables (Kent State University) **Altruism:** the belief in or practice of disinterested and selfless concern for the well-being of others (Oxford Languages) **Gumbel distribution:** the asymptotic distribution of the largest or smallest of n random variables Xi when n tends to infinity (ScienceDirect)

	Asymptotic distribution: the hypothetical distribution or convergence of a sequence of distributions. It attempts to find a limiting distribution to a series of distributions (Statistics How To)
Cited references to follow up on	Ando, A.W. and Gosselin, A.Y., 2005. Recycling in multifamily dwellings: does convenience matter? Economic inquiry, 43 (2), 426–438. Clarke, M.J. and Maantay, J.A., 2006. Optimizing recycling in all of New York City's neighborhoods: using GIS to develop the REAP index for improved recycling education, awareness, and participation. Resources conservation and recycling, 46 (2), 128–148. De Young, R., 1989. Exploring the difference between recyclers and non-recyclers: the role of information. Journal of environmental systems, 18 (4), 341–351.
Follow up Questions	Recycling rates for different materials vary greatly (see page 259). Why is this so? Is it a conscious decision? Is there something about the properties of the under recycled materials that dissuade people from recycling them? Is there a way that I could increase the recycling of a specific material? This study determined that safety was a key barrier to recycling, but why? WHat about the recycling process is unsafe? How are people being injured?

Article #6 Notes: Machines Learn Better if We TEach Them the Basics

Article notes should be on separate sheets

Source Title	Machines Learn Better if We Teach Them the Basics
Source citation (APA Format)	Levy, M. (2023, February). *Machines learn better if we teach them the basics*. Quanta Magazine. https://www.quantamagazine.org/machines-learn-better-if-we-teach-them-the-basics-20230201/
Original URL	https://www.quantamagazine.org/machines-learn-better-if-we-teach-them-the-basics-20230201/
Source type	Science Magazine (Quanta)
Keywords	Artificial intelligence, computer science, deep learning, games, machine learning, Quanta Podcast, robotics
#Tags	#SummerSummary
Summary of key points + notes (include methodology)	Max G. Levy's Quanta Magazine article "Machines Learn Better if We Teach Them the Basics" uses the example of a robot tasked with finding and cutting a carrot to demonstrate the advantages of pretraining AI before beginning reinforcement learning. In a typical reinforcement learning process the algorithm begins ignorant. Through the processes of trial and error it learns what actions trigger rewards. This method allows agents to become masters of simple tasks with unchanging rules and environments. However, if the rules or environment were to change even slightly, the AI would have to begin again on a new slate. Humans can generalize, using what they know from experiences to make logical conclusions about how to act in similar environments, but even if an AI has the skills to complete a task, using just the reinforcement learning method it will not quickly succeed in an unknown environment. This is where pretraining seeks to make improvements. Instead of beginning the reinforcement training with no prior knowledge, recent research by Victor Zhong shows that pretraining

	the AI by grounding important concepts, so the agent knows what they are working with and what they are trying to achieve, has improved the speed and complexity at which an agent has performed in a series of games. In Zhong's study, the program's pre-training involved learning from online information in text and video form. One surprising observation from this study was that the benefits of pretraining increased along with the complexity of the games played. Although Zhong's study focused on gaming, pre training is also currently being used to create online shopping assistants. According to Karthik Narasimhan, the breakthroughs in pre-training are "a step closer toward general intelligence". Members of countless fields are eagerly waiting to see what new opportunities this advancement in technology will unveil. Although I have not yet narrowed down to three perspective ideas, I know that I want my STEM1 project to involve code. I love the act of programming as it is a highly logical process. This article combined my love for programming and robotics with the excitement of artificial intelligence (which I may use as a part of my project).
Research Question/Problem/ Need	How can pretraining be used to optimize the reinforcement learning process of an AI agent?
Important Figures	N/A
VOCAB: (w/definition)	Reinforcement learning: the machine learning training method based on rewarding desired behaviors and punishing undesired ones in which the agent learns through trial and error (TechTarget) Computer vision: a field of artificial intelligence (AI) that enables computers and systems to derive meaningful information from digital images, videos, and other visual inputs. Allows the agents to see, observe, and understand. (IBM) Embodiment: when an AI agent occupies a physical or simulated body
Cited references to follow up on	No references to follow up on
Follow up Questions	How can we teach computers to make generalizations? How can we get them to understand the average meaning of a carrot or a bottle so that they can recognize them in infinite environments?

Article #7 Notes: AI's 'unsettling' rollout is exposing its flaws. How concerned should we be?

Article notes should be on separate sheets

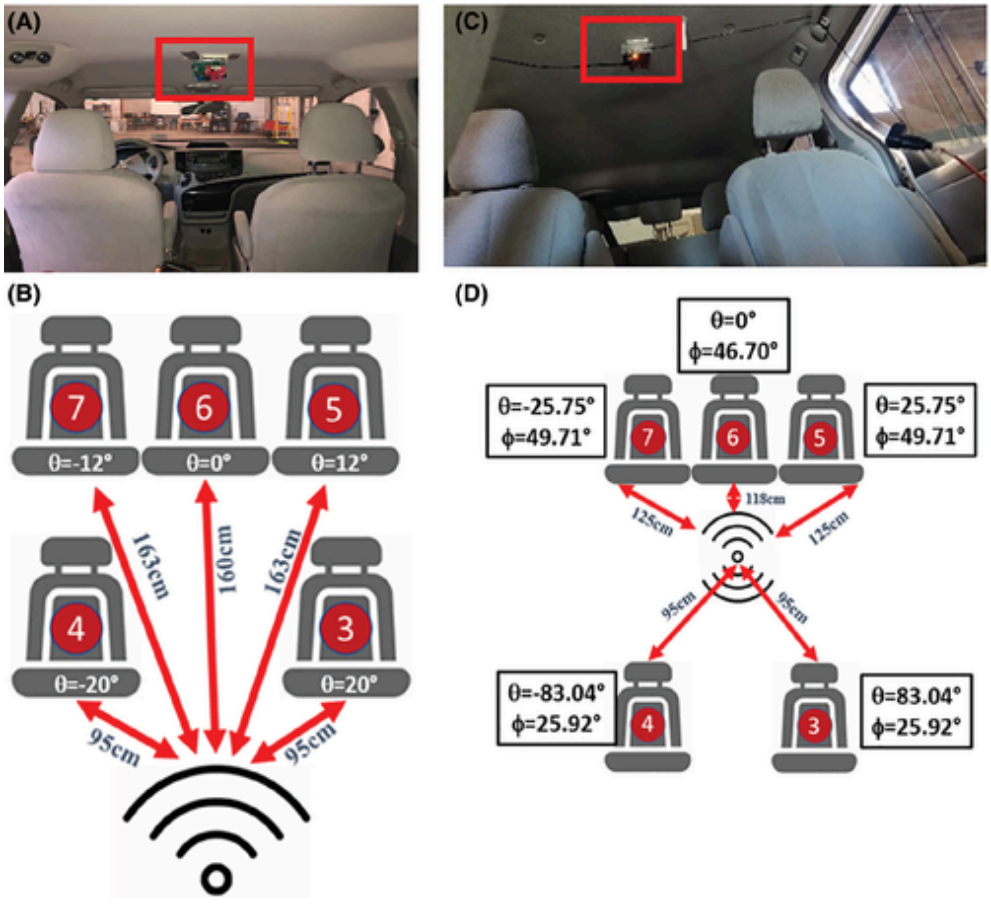
Source Title	AI's 'unsettling' rollout is exposing its flaws. How concerned should we be?
Source citation (APA Format)	Pappas, S. (2023). AI's "unsettling" rollout is exposing its flaws. How concerned should we be?. *Live Science*. https://www.livescience.com/technology/artificial-intelligence/ais-unsettling-rollout-is-exposing-its-flaws-how-concerned-should-we-be
Original URL	https://www.livescience.com/technology/artificial-intelligence/ais-unsettling-rollout-is-exposing-its-flaws-how-concerned-should-we-be
Source type	Science Magazine (Live Science)
Keywords	Bias, AI, misinformation, flaws
#Tags	#SummerSummary #AI
Summary of key points + notes (include methodology)	Stephanie Pappas' LiveScience article "AI's 'unsettling' rollout is exposing its flaws. How concerned should we be?" opens with a call for all people to prepare for the imminent changes in all facets of life that AI will cause. Pappas goes on to discuss two pressing issues found in Large Language Models (LLM) such as ChatGPT and Bard. The first is hallucination. This is when a program replies to a prompt with false information. In some scandals, the program has gone as far as to generate false citations of nonexistent newspaper articles to support its false claims. It is important to note that hallucinations do not occur because the AI program is intentionally trying to deceive you, but instead because their statistical models inferred that the words that it chose made the most sense based on what it had "read". LLM do not understand the meaning of the responses they produce the way a human would. This factors into the second major issue: bias. Human bias is unavoidably present in AI's training data. When the LLM needs to form a response drawing from this data, it will amplify present biases. An example of this is the resume sorting AI that Amazon had to cease using in 2018 because it consistently favored male sounding names

	to female sounding names. The unfair results were not an effect of a poorly created model, but a reflection of the biases present in the data it learned from. There is pressure from Sundar Pichai, the CEO of Google and Alphabet, as well as others, to put regulatory decisions regarding AI usage in the hands of federal agencies instead of the corporations that are creating the technologies. This would help protect the user and minimize the circulation of misinformation. This article pertains to my STEM 1 project because I am interested in incorporating AI in my project. Two problems that I am considering which may use AI are finding parking in cities and taking concise notes and maximizing the effects of time spent studying. Knowing the limitations of the tools I plan to use will be important.
Research Question/Problem/ Need	What flaws should we be aware of when using artificial intelligence?
Important Figures	N/A
VOCAB: (w/definition)	Hallucination: when a program replies to a prompt with false information
Cited references to follow up on	No sources cited
Follow up Questions	How can we work to lessen the bias in the data that the AI models are trained on? Could AI agents like ChatGPT provide an accuracy score that demonstrates its confidence that the response it generated is factual? If AI amplifies the biases that are already present in our data, could we instead use it as a tool to identify those biases?

Article #8 Notes: Improving passenger safety in cars using novel radar signal processing

Article notes should be on separate sheets

Source Title	Improving passenger safety in cars using novel radar signal processing
Source citation (APA Format)	Abedi, H., Magnier, C., Mazumdar, V., & Shaker, G. (2021). Improving passenger safety in cars using novel radar signal processing. *Engineering Reports*, *3*(12). https://doi.org/10.1002/eng2.12413
Original URL	https://onlinelibrary.wiley.com/doi/full/10.1002/eng2.12413
Source type	Research article
Keywords	Car safety, radar signal, sensor, presence-absence detention
#Tags	#summerSummary
Summary of key points + notes (include methodology)	In 2021, Hajar Abedi, Clara Magnier, Vishvam Mazumdar, and George Shaker tested the accuracy of their novel radar signal processing technique in detecting the presence of a living being inside of a parked vehicle. This technology was intended to prevent human and animal death in parked cars by setting off an alarm if life was detected. The team identified that the best way to do this was to identify breathing cycles using radar signals, since the chest motion of a living body would be the only consistent motion within a parked car. The team determined that a radar system was most appropriate for subject detection because it worked reliably under various conditions, could detect life through obstacles, maintained the privacy of the users, and proved to have a low false alarm rate. The team tested a variety of radar models in multiple locations within a vehicle. Ultimately, they concluded that a low-power, mm-wave multi-input-multi-output (MIMO) FMCW radar sensor mounted on the ceiling of the car between the driver and passenger seats would provide the best coverage. The tests took place in seven-seater vans and sports utility vehicles. One drawback to the technology is that it only monitors the seats in the middle and back rows (as this is where children are most likely to sit). The team created a presence-absence detection (PAD) algorithm that processed the data received from the radar. For the tests, the team simulated infant and child breathing patterns using a servo structure inserted into an infant and child size doll. The dolls were tested in booster and rear facing seats placed in each of the middle and back row seats. Over 65 configurations were tested, including an empty car, a car filled with clutter with and without life, a clean and cluttered car with a live adult participant, and with the dolls placed beneath each of the middle and back row seats. In each of the tests the radar transmitted and collected signals for three minutes then the PAD algorithm was run on the data. The team's PAD algorithm detected the presence or absence of life in the parked vehicle with 100% accuracy. It is important to note that the

	technology developed does not consider temperature or carbon dioxide levels within the vehicle, so the alarm will sound whether the occupant is in a life-threatening situation or not. I chose this study because it relates to the “cars get hot in the sun” annoyance that I generated during the notecard brainstorming activity. Since 1990, nearly 1000 children have died as a result of being left in a vehicle. The solution that this team developed seems like a great start to solving this problem, although I believe their design could be improved upon by adding additional features such as temperature and carbon dioxide detection, a method of notifying the driver (such as calling their phone) in addition to setting off an alarm, and a way to rapidly cool their air or increase the oxygen should the passenger be in a life threatening situation.
Research Question/Problem/ Need	How can radar sensors be used to detect life in a vehicle?
Important Figures	 Shows the installation options tested.
VOCAB: (w/definition)	Doppler effect: an increase (or decrease) in the frequency of sound, light, or other waves as the source and observer move toward (or away from) eachother. The

	effect causes the sudden change in pitch noticeable in a passing siren, as well as the redshift, seen by astronomers. (Oxford Languages) Cardiopulmonary: relating to the heart and the lungs (Oxford Languages)
Cited references to follow up on	*Heatstroke Death of Children in Vehicle*. Department of Meteorology & Climate Science, San Jose State University, [Online]. United States; 2021. https://noheatstroke.org/. Accessed January 21, 2020 Sensing solutions for child presence detection. *IEEE Sens*, [Online]. https://www.iee-sensing.com/en/automotive/safety-and-comfort/vitasense Accessed February 8, 2020.
Follow up Questions	If this model works, why haven't they licensed it to a car dealership? Why is it that not all cars have a PAD system? Would consumers want a way to disable the system? Would this compromise it?

Article #9 Notes: Challenges to reducing post-consumer plastic rejects from the MSW selective collection at two MRFs in São Paulo city, Brazil

Article notes should be on separate sheets

Source Title	Challenges to reducing post-consumer plastic rejects from the MSW selective collection at two MRFs in São Paulo city, Brazil.
Source citation (APA Format)	Correa, C. A., De Oliveira, M. A., Jacinto, C., & Mondelli, G. (2022). Challenges to reducing post-consumer plastic rejects from the MSW selective collection at two MRFs in São Paulo city, Brazil. *Journal of Material Cycles and Waste Management*, *24*, 1140–1155. https://doi.org/10.1007/s10163-022-01387-9 could not find issue number
Original URL	https://link.springer.com/article/10.1007/s10163-022-01387-9

Source type	Journal Article (Journal of Material Cycles and Waste Management)
Keywords	Municipal solid waste (MSW), Material recovery facility (MRF), Post-consumer plastics (PCPs), Selective collection, MSW gravimetry
#Tags	#recyclingStats
ChatGPT summary	"This study conducted a comprehensive analysis of Materials Recovery Facilities (MRFs) in São Paulo City, focusing on their ability to manage and sort post-consumer plastic waste effectively. The findings reveal several key points. Firstly, the MRFs demonstrated high recovery yields (>40%) for materials like paper, cardboard, metals, and certain plastics (e.g., PET, HDPE, and PP). However, challenges arose from the lack of clear resin label identification, inefficient sorting at the source, and limited recognition capabilities of MRFs for specific plastics like PS and vinyl. Moreover, the complexity of packaging design, multilayered materials, and food-contaminated post-consumer packaging further hindered plastic recovery. Additionally, the presence of non-identified plastics, particularly in multilayer packaging, posed difficulties in sorting and reduced the value of recyclable streams. Glass in the selective collection disrupted sorting and increased the volume of rejects. While MRFs were found to perform better with well-established recycling streams, complexities in PCP waste composition presented significant challenges. This study underscores the need for improved waste collection, sorting at the source, and better market conditions to enhance recycling rates, especially for post-consumer plastics." 9/24/23 Link to Prompt and Response
Summary of key points + notes (include methodology)	Key points / key results: - Better source materials (meaning that people only recycle recyclables, and what they do recycle is not contaminated) will produce more efficient MRFs. Even large scale recycling begins on a household level - "The results suggest failure in the mechanized sorting process at both MRFs, which may stem either from contaminated waste at the source, lack of proper material identification or operational faults" - The results of the gravimetric analysis have shown that both MRFs provided higher recovery yields (> 40%) for paper, cardboard, Tetra Pak, ferrous and non-ferrous metals (aluminum), akin to some post-consumer plastics (PET, HDPE/LDPE and PP) that ranged from 38% for PP up to 89% for HDPE," (saying that the machines aren't as good at detecting plastic compared to the other materials) - "Losses in recovery yields of recyclable plastics after the screening process resulted from lack of clear resin label identification, inefficient materials sortation by households and poor recognition capabilities of the MRFs screening devices to target and segregate specific types of plastics such as PS and vinylic." - "Packaging design complexity, multi-layered material diversity, and food

contaminated post-consumer packaging pose further challenges to improve the plastics recovery capabilities of the two MRFs."
    - MRFs need to overcome these so more plastics can be recycled
    - If PCPs are contaminated with food, the MRF will reject it, meaning that it won't be recycled

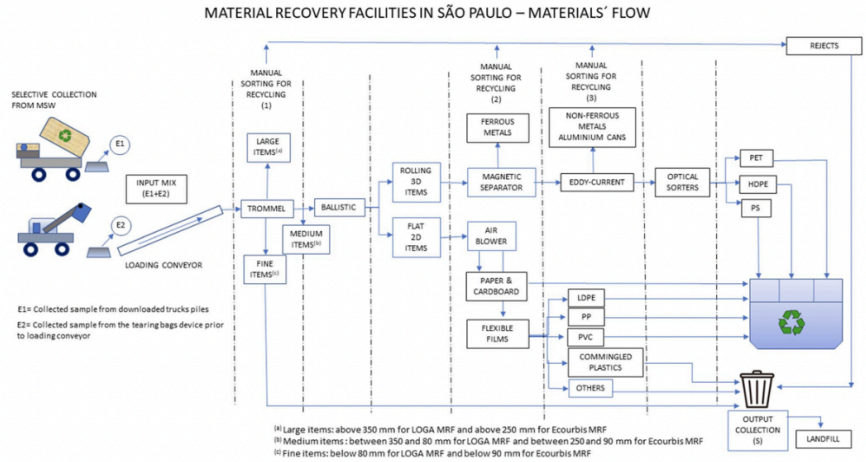
- Since there are so many barriers to mechanical recycling, alternative options such as waste-to-energy and chemical recycling are being explored
- Optical methods, such as light spectrophotometry (a method that reads the wavelengths which are associated to a specific color reflected by the surface of the material) , and near infrared sensors (which differentiate materials density) are being used to classify materials at MRFs
- "post-consumer plastic waste introduces further complexities in the sortation of well-established recycling streams that MRFs were designed for"
- The MRFs can be tweaked to improve their sorting capabilities, but it would be better if people sorted on a household level.
- Manual sorting, at the facilities, yields more rejects than mechanical sorting due to lack of human ability to easily distinguish plastic types
- If there is no market for a material, even if it can be recycled, it won't be
-

Interesting Stats / points:

- "Best practices for recycling plastics require that they are properly separated and washed before reprocessing, although washing is not considered a full decontamination process for food-contact packaging and/or cosmetics"
- Lots of stats regarding how much recycling is produced, how much is recycled, how much comes from virgin plastics
- In 2005, 6.3 billion tons of solid plastic (NOT ALL WASTE, JUST PLASTIC) waste were generated. Of these, only 9% was recycled.
- Not only is recycling good for the environment, it also helps to divert stress from landfills. Recycling plastics, as opposed to putting them in the trash, improved the quality of ash produced in incinerator and the quality of compost
- Food contaminated plastics devalued Post-Consumer Resins, also required more resources, like water treatment, to be cleaned
- Only 50% of the MSW produced in the city was processed by MRFs
- Rejects if the facility should not exceed 10% by weight
- Rejectable materials made up only 7.4 % of the input, but 35.6% was rejected at output (meaning that usable materials are being rejected)

Introduction:

	Data Source/Methods:
	- Explained the recycling process of each of the two facilities
	  - I find it interesting how human detection was involved throughout the entire process. Is it really an automated system?
	- Sampling methodology
	  - Over the course of a year, 7 sampling campaigns were carried out for each MRF (once every two months, on varying days of the week)
	  - Samplings aimed to carry out in situ comparisons on specific dates
	  - 3 collection points were established for each facility, 2 at the input mix (saw the recyclables as received from the households) and one at the output, after the mechanical and manual sorting processes had been carried out (they looked at what was rejected, including non recyclables, contaminated recyclables, and unsorted releases)
	  - Once collected they were transported to a lab and stored at room temperature
	- Gravimetric analysis
	  - Waste was spread out on a plastic sheet
	  - Recyclables were sorted visually and manually into 22 typologies, then stored at 4 degrees C for future analysis
	- Material recovery yields
	  - Calculated from the total amount of the averaged recyclable waste for each category at each collection divided by the sum of the total amount of the averaged recyclable waste for each category plus the amount that was set to landfills
	- Results and Discussion
	  - High concentration of paper/cardboard, plastics, glasses, and metals
	  - Fewer nonferrous metals (like aluminum cans) because people would collect them and sell them directly
	  - Figure 5, lots of recyclable materials are being sent to landfills (NOT GOOD)
	  - Perhaps because they were missed by the optical sensor and skipped in the manual collection
	  - PET was the most preferred plastic materials for recycling, followed by HDPE and PP
	  - multi layer films and flexible plastics were identifies if both input and output batches, it is thought that these may cause problems in the MRF and drop efficiency
	  - The products with more consolidated markets and higher market value had higher performing MRYs (the machines/people are better at sorting the materials that generate more money)
	  - Glass messes up the system because the machines came from countries where glass was handled separately

Research Question/Problem/ Need	This study attempted to identify the limitations of the two automated Material Recovery Facilities in Sao Paulo City so that the amount of recycled plastic waste being sent to landfills from those facilities may be reduced.
Important Figures	 Flow chart for recyclables in Sao Paulo, shows what methods are used to sort devices and the instances in which they may be rejected
VOCAB: (w/definition)	**Cascaded recycling:** when plastics are recycled over and over and the quality is retained (Alliance to End Plastic Waste **Post-Consumer Resins (PCR):** A material made from recycled plastics, can be used to to make films, containers, and other products more sustainable than if they had been produced with virgin plastics (Integrated Packaging Film) **Post-consumer Plastic Recycling:** plastic that has been made into a product, used, thrown away, collected, cleaned, reprocessed and made into something new (Green Warehouse) **In situ:** in the original place (Oxford Languages) **Gravimetric analysis:** a method of quantitative chemical analysis in which the constituent sought is converted into a substance (of known composition) that can be separated from the sample and weighed (Britannica) **Non-ferrous metal:** metals and alloys that do not contain iron, including aluminum, copper, lead, nickel, tin, titanium, and zinc **Ferrous metal:** metals and alloys that contain iron as their primary element (TWI Global) **Incipient:** in an initial stage; beginning to happen or develop (Oxford Languages) **Real-case study:** an in depth or intensive study of a single individual or specific group (Deakin University)
Cited references to follow up on	ABRELPE (2018) Panorama dos Resíduos Sólidos no Brasil 2017. São Paulo: Associação Brasileira de Empresas de Limpeza Pública e Resíduos Especiais. Gadaleta G, De Gisi S, Binetti SM, Notarnicola M (2020) Outlining a comprehensive techno-economic approach to evaluate the performance of an advanced sorting plant for plastic waste recovery. Process Saf Environ Prot 143:248–261. https:// doi. org/ 10. 1016/j. psep. 2020. 07. 008

	. Hotta Y, Visvanathan C, Kojima M (2016) Recycling rate and target setting: challenges for standardized measurement. J Mater Cycles Waste Manag 18:14–21. https:// doi. org/ 10. 1007/ s10163- 015- 0361-3 All Stats regarding recycling: 1. Statista (2021) Annual production of plastics worldwide from 1950 to 2020. https:// www. statista. com/ statistics/ 282732/ global- production- of- plastics- since- 1950/. Accessed 28 Jun 2021. 2. Geyer R, Jambeck JR, Law KL (2017) Production, use and fate of all plastics ever made. Sci Adv 3:e1700782. https:// doi. org/ 10. 1126/ sciadv. 17007 82 3. Ellen MaCarthur Foundation (2016) The new plastics economy. Rethinking the future of plastics. https:// www. ellen macar thurf ounda tion. org/ publi catio ns/ the- new- plast ics- econo my- rethi nking- the- future- of- plast ics. Accessed 22 Aug 2018. 4. Ellen MaCarthur Foundation (2017) The new plastic economy, catalyzing action. https:// www. ellen macar thurf ounda tion. org/ publi catio ns/ the- new- plast ics- econo my- catal yzing- action. Accessed 22 Aug 2018 5. Tsiamis DA, Torres M, Castaldi MJ (2018) Role of plastics in decoupling municipal solid waste and economic growth in the US. Waste Manag 77:147–155. https:// doi. org/ 10. 1016/j. wasman. 2018. 05. 003 6. Kaza S, Yao L, Bhada-Tata P, Van Woerden F (2018) What a waste 2.0: a global snapshot of solid waste management to 2050. Urban development series. World Bank, Washington, DC 7. Hegberg BA, Hallenbeck WH, Brenneman GR (1993) Plastics recycling rates. Resour Conserv Recycl 9:89–107
Follow up Questions	How can MRFs be customized to tackle the challenges posed by increasing complexities of post-consumer waste segregation and recovery remain an open question to further research? Is it the machines doing the sorting or the people providing unsorted and contaminated PCPs that need to change? What can be done with “undesirable” recyclables like styrofoam? If there is no market for a good, what can be done with it so that it does not end up in a landfill?

Article #10 Notes: Does Gamification Work? — A Literature Review of Empirical Studies on Gamification

Source Title	Does Gamification Work? – A Literature Review of Empirical Studies on

	Gamification
Source citation (APA Format)	Hamari, J., Koivisto, J., & Sarsa, H. (2014). Does gamification work? -- A literature review of empirical studies on gamification. *2014 47th Hawaii International Conference on System Sciences*, 3025–3034.
Original URL	https://ieeexplore.ieee.org/document/6758978
Source type	Conference Proceeding from the 2014 47th Hawaii International Conference on System Science
Keywords	Gamification, hawaii, literature review
#Tags	#gamification
ChatGPT summary	"This comprehensive review of empirical studies on gamification presents a structured framework for assessing the effects of gamification, drawing on definitions and discussions related to motivational affordances. The literature review covers various aspects, including the results, motivational affordances examined as independent variables, psychological and behavioral outcomes resulting from gamification, the contexts in which gamification is implemented, and the types of studies conducted on gamified systems. The key findings indicate that gamification does have positive effects, but these effects are highly dependent on the context and user engagement. The review also highlights the need for more rigorous methodologies and a better understanding of how contextual factors and user qualities influence gamification outcomes, paving the way for further research in this evolving field." 10/2/23 Link to Prompt and Response
Summary of key points + notes (include methodology)	Key Points: - Independent variables (examined motivational affordances) - Dependent variables (examined psychological/behavioral outcomes from gamification) - Gamification has been shown to have positive effects, but the effects are greatly dependent on the context in which the gamification is being implemented and the users using it Introduction: - Lately gamification has been used to support positive patterns in service use, like increasing activity and interaction, quality of actions and productivity. - Works by making the experience intrinsically motivational and "gameful"

- Impactful in business settings
  - "Over 50% of organizations managing innovation processes will gamify aspects of their business by 2015"
  - Among other reasons, being used by companies to make the learning process feel like a game (like codecademy)

Conceptualizing Gamification:

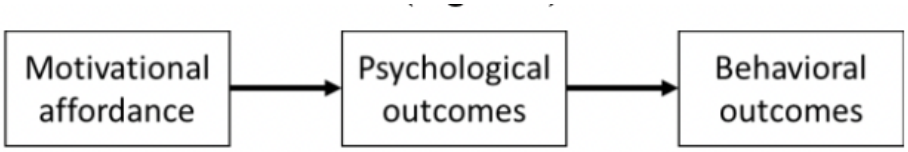
- Gamification has 3 main parts
  - 1. The implemented motivational affordances
  - 2. The resulting psychological outcomes
  - 3. The further behavioral outcomes
- This study is looking for
  - What motivational affordances previous studies have implemented
  - What psychological outcomes have been measured
  - What behavioral outcomes have been measured
  - What services have been gamified
  - Which methodologies have been used to study the effects

Literature review:

- Step 1: General Database search (methods)
  - Searches made in several data bases including Scopus, Science Direct, and Google Scholar
  - Searched with terms: gamification, gamif*, gameful, and "motivational affordance"
    - Terms were used for all fields (tile, abstract, keywords, etc)
  - Compared the number of search results and peer reviewed papers for each database
  - Google Scholar had the most results, Scopus had the most peer reviewed articles
- Step 2: focused searches
  - The search was further narrowed down using this criteria:
    - Was a peer reviewed paper published in an international venue
    - Empirical study included
    - Research methods explicated
    - Paper studies clearly identifiable motivational affordances
    - The study was on gamification rather than on full games
- Step 3: Additional Searches Through References
  - One new, satisfactory paper was found
  - In total, 24 papers matched the criteria
- Step 4: Analysis
  - To analyze the difference motivational affordances and resulting outcomes, they combined a model of motivational affordances with a concept matrix
- Results:
  - Common question amongst papers - does gamification work
  - There was a great variety between the methods and results of the studies

- Motivational affordances:
  - Motivational affordances found in the studies were sorted into 10 categories
  - points , leaderboards, and badges were the most commonly tested motivators
- Psychological and behavioral outcomes
  - Most studies examined behavioral outcomes, used experiments or statistical analysis from existing services ot implementations designed by the researchers, often investigated through survey methods
  - Studies that did focus on psychological outcomes focused on motivation, attitude, and enjoyment
    - Used interviews or questionnaires
    - Only 1 with psychometric measurements
- Reported Results
  - The majority of studies found gamification to produce positive effects and benefits
  - 2 studies found all of their tests of motivational affordances to be positive, most studies just had a majority
  - To explain the non-positive results, suggestions that gamification might not be effective in a utilitarian service setting or that engagement by gamification can depend on several factor such as the motivation of the users or the nature of the gamified game
  - Some studies showed that the results of gamification may not be long term but is instead due to novelty
  - Once in place, removing a gamification system may have detrimental effects, possibly due to loss aversion
- Contexts of gamification
  - Context of gamification refers to the core service or an activity being gamified
  - education/learning contexts were the most common in studies
    - Showed positive outcomes such as increased motivation and engagement
    - Negative effects like increased competition, task evaluation difficulties, and design features
  - Although gamification has been touted as a potential marketing strategy, none of the studies evaluated were conducted in an explicitly marketing context
    - The dependent variables measured in studies show increases in service/system use, which is an important marketing metric
      - Suggests that gamification should be used for managerial and business purposes
- Types of Studies

	- Studies on gamification were mostly quantitative, only 2 of the 24 were purely qualitative - Discussion - Literature review shows that gamification does work, but there are caveats - Most of the quantitative studies concluded positive effects to exist only in part of the considered relationships between the gamification elements and studied outcomes - Qualitative studies showed that gamification as a phenomenon is more manifold than the studies often assumed - Suggested that confounding factors exist, pertaining to two main aspects - The role of the context being gamified - The qualities of the users - More rigorous methodologies should be used in further research - Methodological limitations in the reviewed studies (shortcomings): - Sample sizes too small - proper , validated psychometric measurements were not used when surveying experiences and attitudes - Some lacked control groups - Some relied only on user evaluation - Controles between implemented motivational affordances were often lacking and multiple affordances were often investigated as a whole (showed many factors together but not their individual effects) - Many presented on descriptive statistics and did not infer about the relationships between constructs - Experiment time frames were often too short (meaning novelty may have skewed the subjects experiences) - Lack of clarity in reporting results - Did not use multi-level measurement models including all motivational affordances, psychological outcomes, and behavioral outcomes - Avenues for future research - Outside pressures (such as extrinsic rewards) tend to undermine intrinsic motivations which would undermine gamifications - The youtube video on Octalysis seemed to combine intrinsic and extrinsic factors - People interact with game like systems in different ways Limitations of this review - Studies that used different terminology may not have appeared in the search
Research Question/Problem/	Fulfills the needs of reviewing previous studies on gamification, creating a

Need	framework for examining the effects of gamification, and pointing out knowledge gaps in existing literature.
Important Figures	 **Figure 2. Gamification** The 3 main parts of gamification as conceptualized by this study.
VOCAB: (w/definition)	Empirical Study: research which "is based on observed and measured phenomena and derives knowledge from actual experiences rather than from theory or belief" (La Salle University) Gamification: "a process of enhancing services with (motivational) affordances in order to invoke gameful experiences and further behavioral outcomes" Psychometric: "a scientific discipline concerned with the question of how psychological constructs (e.g./ intelligence, neuroticism, or depression) can be optimally related to observables (e.g., outcomes of psychological tests, genetic profiles, neuroscientific information). Inferential: "characterized by or involving conclusions reached on the basis of evidence and reasoning" (Oxford Languages) Manifold: "many and various" (Oxford Languages)
Cited references to follow up on	Results of gamification may not be long-term [25, 15, 16]
Follow up Questions	Although this paper seems to be against extrinsic motivators, other research supports using extrinsic motivators for gamification? What, in the papers this study analyzed, led them to believe that extrinsic motivators would undermine gamifications? What makes someone a good candidate for experiencing positive outcomes with gamification?

Article #11 Notes: The effect of gamification on motivation and engagement

Source Title	The effect of gamification on motivation and engagement

Source citation (APA Format)	Alsawaier, R. (2018). The effect of gamification on motivation and engagement. *The International Journal of Information and Learning Technology* , *35*(1), 56–79. https://doi.org/56-7810.1108/IJILT-02-2017-0009
Original URL	https://www.proquest.com/docview/1977184867?accountid=29120
Source type	Journal Article / literature review
Keywords	Gamification, game-based learning
#Tags	#gamification
ChatGPT Summary	NA
Summary of key points + notes (include methodology)	Discusses various definitions of gamification - "game-based mechanics, aesthetics, and game thinking to engage people, motivate action, promote learning, and solve problems" - "use of game elements, mechanics, features, design, and structure in a non-game environment or context" - Important, gamification rewards effort, not 'winning' Gamification is a rational tool to use because so much of the population (about 58% of the US) plays video games, hits a wide age range too Advantages of Gamification over GBL - The difference between game based learning and gamification is that GBL literally turns it into a game and gamification just makes the task feel like a game - GBL is only for education, content must have a beginning and end - "Gamification is not when learning is changed into a computer game but rather when adding a design layer of game elements to enhance learning, increase engagement, and encourage positive behavior." Theoretical connections to Gamification - There is not substantial research relating gamification to theoretical principles Self-determination theory - Principles of autonomy, competence, and relatedness - People are motivated when their results are shown on leaderboards - About being intrinsically motivated to play a game - "Intrinsically motivated activities are those that the individual finds interesting and performs without any kind of conditioning, just by the mere pleasure of carrying them out (Francisco-Aparicio et al., 2013, p.

114)

NLS Theory - New Literacy Theory
"Challco et al. (2015) argued that gamification
allows for learning to happen individually as the learners feel extrinsically and intrinsically motivated through gaining points and winning awards. At the same time, the social aspect of gamification through collaboration and competition, they added, is very important"

Behaviorism: relation conditioning to gamification
"According to González et al. (2016), gamification can produce significant
behavioral change "from an early age using the dynamics of games" (p. 549)."

Motivation and Engagement

- Motivation and engagement are two separate but related concepts
- "Engagement indicates the passion and emotional involvement in participating and completing learning activities"
- "Motivation is divided by some researchers into five components: intrinsic and
- extrinsic motivation, task value, ability belief, and expectancies for success (Hsieh, 2014).
- Intrinsic motivation is triggered by human needs for mastery, curiosity, and overcoming challenges. Extrinsic motivation is relevant to elements not related to the task value such as rewards, grades, "performance and competition or evaluation by others" (p. 419)."
- Don't make a challenge too hard or people don't want to do it

Emotions, fun, and play in gamification

- Fun is a really important element of gamification that can transform ones attitude toward a task
- "For many learners, the fun part in a gamified environment is the product of solving problems and overcoming challenges as they engage critical thinking skills."
- The task doesn't need to be hidden or disguised, it just needs to be made fun

Player Types
Four player types are killers, achievers. Explorers, and socializers, each reacts the best to a different facet of amifiction

- Killers: badges and points on leaderboards
- Achievers: badges and points (status)
- Socializers: Social interaction
- Explorers: quests
- Philanthropist (type added later): purpose

Gamification Features

Avatars
"Avatars are representative of players in the sense that they reflect their aspirations, vulnerabilities, and the different roles they play in life. Players need to choose or create their avatars as manifestations of their autonomy needs:"

- Allow players to uniquely and diversely represent themselves
- People can be whoever they want to be

Quests and Challenges
"Quests are a series of challenges that require players to solve mystery engaging critical

	thinking skills (Whitton and Moseley, 2010)." - Give direction and purpose, adventure and critical thinking skills - Ability to fail and try again (your avatar can die and respawn) Badges Digital badges are a "validated indicator of an accomplishment, skill, quality, or interest that can be earned in various learning environments" (Grant, 2013, p. 1). In the context of education, badges are chosen in a gamified environment to accommodate different learners considering their motivation levels and capabilities (Abramovich et al., 2013). - Good signs of players progress Points and Levels \ Some game proponents consider points as an essential part of a gamified world or an "absolute requirement for all gamified systems" (Zichermann and Cunningham, 2011, p. 36) According to Hanus and Fox (2015), the groups of students who seem to be most engaged in a gamified classroom environment are low achievers or learners with weak intrinsic motivation. For those types of learners, "rewards and incentives might increase intrinsic motivation" (p. 160).
Research Question/Problem/ Need	Goal: To analyze previous literature on gamification and educate the readers on topics such as conceptualizing gamification, advantages of gamification over game-based learning, theoretical connections to gamification, motivation and engagement, connecting gamification to motivation and engagement, emotions and fun in gamification, player types and gamification features, gamification in action, and implementation guidelines. Additionally aims to identify gaps in the current literature and the gaps between theory and practice
Important Figures	No figures included
VOCAB: (w/definition)	Pedagogical - relating to teaching SDT - self determination theory GBL - game based learning Serious gaming - term used to describe games intended for education, industry, training, and simulation
Cited references to follow up on	NA
Follow up Questions	Why does the author stress that qualitative data needs to be gathered for gamification in addition to quantitative data? Does gamification produce the same effects in a nongame context?

Article #12 Notes: Game design principles and motivation

Article notes should be on separate sheets

Source Title	Game design principles and motivation
Source citation (APA Format)	Oxarart, A., Weaver, J., Al-Bataineh, A., & Bataineh, M. T. (2014). Game design principles and motivation. *International Journal of Arts & Sciences*, *7*(2), 347–359. https://www.proquest.com/docview/1644633249?accountid=29120&parentSessionId=yN7JrndwsyYIuUYm0tN%2FVm%2FJFJiWRbKWIy5bf3cCU3Y%3D&pq-origsite=primo
Original URL	https://www.proquest.com/docview/1644633249?accountid=29120&parentSessionId=yN7JrndwsyYIuUYm0tN%2FVm%2FJFJiWRbKWIy5bf3cCU3Y%3D&pq-origsite=primo
Source type	Journal Article
Keywords	Gamification, student motivation, achievement
#Tags	#gamification
ChatGPT Summary	NA
Summary of key points + notes (include methodology)	- There is a significant relationship (at the 0.01 level) between motivation and learning with the use of game design principles - Study took both quantitative and qualitative data Introduction - 91% of 2-17 year olds play video games - Others say 97% of the population - So many people play video games everyday, how can we make people want to complete a task like it is a game? Psychology of Motivation - Choice is a leading factor in motivation, users should be able to guide their own path - Emphasis on the importance of intrinsic motivation (as opposed to extrinsic which may not work in the long run) - Users need to be given the opportunity to fail in a safe environment, one

failure should not doom them forever
- Learning should challenge a student some

Impact of Gamification
- "Gamification is heavily supported by goal theories, out of the box educational models and theories of fun; "
- Gamification strategies are very popular in companies in sales and human resources
- Gamification has been shown to increase employee satisfaction
    - Has also taught kids to read
- "Gee also explains how game design principles encourage learners to interact with one another to achieve common learning goals. One commonality in video and computer games is working in teams or pairs to achieve goals."

Methodology
- Quantitative and qualitative data was collected
    - Quantitative: pre and post test scores
    - Qualitative: open response survey questions
- Testing took place over the course of one unit in a small 8th grade social studies classroom in Illinois
    - Students took a pre test to get a baseline idea of their knowledge
    - Gamification techniques were incorporated into the curriculum
        - There were "quests" that all students had to complete with the class, but also side quests and alternative quests that helped the students to reinforce the knowledge that they missed in the pretest.
        - Students were encouraged to work together because there were some rewards that they class could only earn if everyone did well
        - Student earned xp points when they completed activities
- The post test scores were significantly higher than the pretest scores (6.11 to 9.20)
- Additionally, survey results showed that most students were more motivated to complete their tasks, they were more engaging and fun
- A paired t test was conducted for significance
- "The results of our study clearly indicate a relationship between this classroom using game design principles with academic benefits such as increased student motivation and achievement."
- "Another trend that was revealed by the survey data was that students were motivated by the choices they were given in a gamified curriculum."

Recommendations
- Integrate technology as a vessel for gamification since one of the major appeals of video games is that they are digital or exist in a fantasy realm

Research Question/Problem/ Need	Do game design principles implemented in the classroom curriculum positively affect student motivation and achievement?
Important Figures	**Table 1.** Survey Results. Statement — Mean — SD 1. I think that I will learn more in Social Studies class because of VGD. — 3.47 — .894 2. Learning Social Studies through video game design helps me learn better. — 3.56 — .918 3. I am confident in my ability to do well in Social Studies because of VGD — 3.73 — .915 4. I am motivated to learn in Social Studies class because of VGD — 3.49 — .815 5. Learning Social Studies through video game design is challenging. — 2.51 — .869 6. I am excited about the VGD. — 3.64 — 1.069 7. Learning Social Studies through VGD helps me stay focused in class. — 3.31 — 1.125 8. Learning Social Studies through VGD system works. — 4.42 — .783 9. I think that I will learn more in Social Studies class because of VGD. — 3.47 — .894 10. Learning Social Studies through video game design helps me learn better. — 3.56 — .918 11. I am confident in my ability to do well in Social Studies because of VGD — 3.73 — .915 This figure shows the students survey results after using the gamified curriculum. This shows that the 8th grade students reacted positively to the video game design. They reported feeling more motivated because of the VGD and that they were confident in their ability to do well in the class because of it.
VOCAB: (w/definition)	Likert scale - a rating scale used to measure opinions, attitudes, or behaviors followed by 507 options, good for agreement, satisfaction, or frequency VGD - video game design
Cited references to follow up on	NA
Follow up Questions	How much extra time did it take the researchers to develop the gamified curriculum? Would the average teacher have time to implement this? I feel as if Thai study could have benefited from a control group (since students should score higher on a post test than on a pre test if they are learning anything in the classroom). So, what were the advantages of exposing all students to the gamification and looking at the pre and post test scores?

Article #13 Notes: Gamification to improve our world: Yu-kai Chou at TEDxLausanne

Source Title	Gamification to improve our world: Yu-kai Chou at TEDexLausanne
Source citation (APA Format)	TEDx Talks. (2014). Gamification to improve our world: Yu-kai Chou at TEDxLausanne. On YouTube. https://www.youtube.com/watch?v=v5Qjuegtiyc
Original URL	https://www.youtube.com/watch?v=v5Qjuegtiyc
Source type	Youtube Video
Keywords	Octalysis, gamification
#Tags	#gamification
ChatGPT Summary	N/A
Summary of key points + notes (include methodology)	Yu-kai Chou developed the Octalysis framework which outlines the eight core drives of all things humans do. These may be implemented into work to make it feel like a game. - Gamification works on everyone because everyone plays games DO NOT RELY ON POINTS, BADGES, AND LEADERBOARDS (PBLs) - Do not make it fun and drive people the way you think it will - "Good gamification does not start with game elements but really starts with how it motivates our core drives" Octalysis Framework A. 1. Epic Meaning a. Motivated because you feel like you are a part of something bigger than yourself (you have to save someone or something important, only you can do it, you have a mission) 2. Development and accomplishment

	a. Motivated because you feel like you are improving or achieving mastery (emphasis on short term accomplishments and leveling up) 3. Empowerment of creativity and feedback a. lots of possibilities, freedom to try new ideas out 4. Ownership and possession a. when you own something, you want to do everything you can to protect, improve, and get more of it (often used with virtual currencies) 5. Social influence a. Motivation based on what others think, do, or say (causes you to compare yourself to them and in turn want to improve yourself) 6. Scarcity and impatience a. Wanting something because it is rare or hard to get (act now or it will disappear mentality) 7. Unpredictability and curiosity a. When you don't know what will happen next you will always be thinking about it, chance of something very good or bad happening at any moment (like in gambling) 8. Loss avoidance a. You act to avoid bad things happening to you or something you care about Extrinsic Motivations: Scarcity, Ownership, Accomplishment Intrinsic Motivations: Empowerment, Social Influence, Unpredictability Positive/ White Hat: accomplishment, Meaning, Empowerment - These are good because you feel like you have power and control Negative / Black Hat: scarcity, avoidance, unpredictability - Less sustainable in the long term, not the best to rely on
Research Question/Problem/ Need	How can the 8 core human drives, as outlined in the Octalysis framework, be implemented to turn work into a game?

Important Figures	 shows the octalysis hexagon framework
VOCAB: (w/definition)	Gamification: “the craft to take all those fun exciting elements of games and pouring them into boring non-game contexts”
Cited references to follow up on	N/A
Follow up Questions	What is the ideal number of elements to incorporate into a game? Should those elements come from different categories? Is it possible to over-do gamification? Are the benefits of gamification produced with these methods long lasting?

Article #14 Notes: Make Waste Fun Again! A Gamification Approach to Recycling

Article notes should be on separate sheets

Source Title	Make Waste Fun Again! A Gamification Approach to Recycling
Source citation (APA Format)	Helmefalk, M., & Rosenlund, J. (2020). Make Waste Fun Again! A Gamification Approach to Recycling. In A. Brooks & E. I. Brooks

	(Eds.), *Interactivity, Game Creation, Design, Learning, and Innovation* (pp. 415–426). Springer International Publishing.
Original URL	https://link-springer-com.ezpv7-web-p-u01.wpi.edu/chapter/10.1007/978-3-030-53294-9_30
Source type	Book Chapter
Keywords	Gamification, recycling, waste management, mechanics, behavior, bin
#Tags	#gamification #incentives #recycling
ChatGPT Summary	"This study addresses the pressing need to enhance recycling rates by exploring the potential of gamification as a means to motivate and engage individuals in recycling behaviors. To investigate this, the researchers conducted four focus groups to bridge the gap between gamification and recycling behavior. The findings highlight that functional solutions are preferred, and gamification should be implemented digitally to effectively bridge the gap between behavior and knowledge. The study identifies various gamified mechanisms, including feedback, "awards, achievements, collaborative and competitive elements, and supplementary functions, which can be employed to promote recycling and sustainability. It underscores that individuals exhibit intrinsic motivation to recycle but require more information and feedback to reinforce their efforts. The research contributes to the understanding and practical application of gamification in waste management, providing insights into how it can positively influence recycling behavior while emphasizing the importance of continued empirical testing and further research in this area. 10/13/23 Link to Prompt and Response

Summary of key points + notes (include methodology)	Key Points:
	- Many people lack the knowledge and incentives to recycle
	  - Gamification can be used to motivate people to recycle
	  - Functional solutions as well as digital solutions, were preferred
	  - Feedback, awards, achievements, collaborative and competitive elements, as well as supplementary functions worked as motivators
	  - "It may be so that gamification can be used to disseminate knowledge of the environment [2] and the importance of waste separation, which would spring long-term effects on waste management behavior."
	Introduction:
	- Recycling is the UNs 12th sustainable development goal

- Push for a circular economy!
- Much of the recycling starts with the user, with the household
- Waste management behaviors has been shown to be predicted by environmental values, situational characteristics, and psychological factors
- Evidence that the most important factors from someone to start considering recycling are time and resources
    - Information is needed to change norms and habits
    - Important for citizens to know the potential consequences of not sorting

Theory - Towards a Framework of Gamification

- A gamified task should be able to motivate and engage people using mechanics and features of games
    - Competitive elements, social interaction, leaderboards, badges
        - Mechanics should have a positive psychological effect on the user
- Gamification has grown in popularity, it is being used in various domains
- Good gamification makes it a game inside and out, not just a leaderboard slapped in something people don't want to do
    - Also causes various positive psychological effects (emphasis on engagement and motivation)
        - Motivation can be intrinsic or extrinsic, it is not one size fits all (gamification focuses more in intrinsic)
        - Not that gamification is not fully explored yet, we are still learning what effects what
    - Gamification is a mechanic hat triggers a positive psychological outcome that then encourages a behavioral outcome

Methods

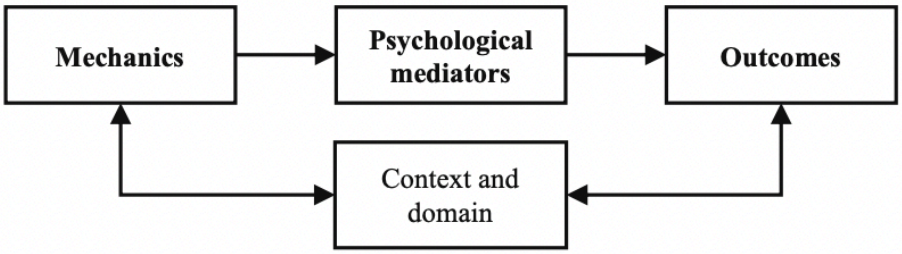
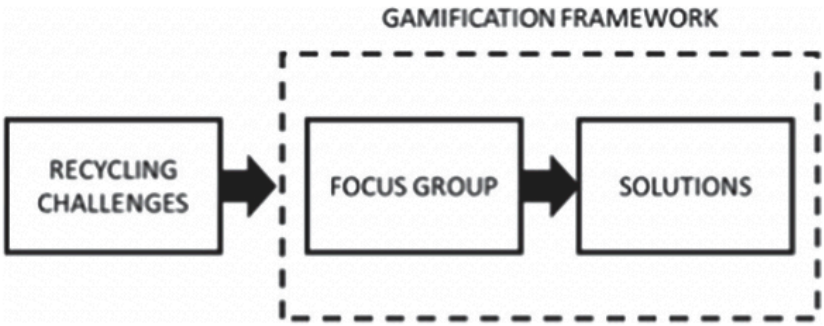
- Used focus group design to explore how and why individuals categorize and recycle waste
    - Also measured their cognitive, emotional reasoning and how that related to behavioral outcomes
- 4 focus groups were conducted
    - Partly open semi-structured interview scheme
    - Structure: introduction, transition, core questions
    - All conducted in Sweden, various combinations of ages, employments, and genders
    - Participants were shown a picture of a curbside recycling bin with divided compartments
    - Moderator asked all questions so no one remained silent
    - Sessions only 60-80 minutes
    - Barriers to recycling were introduced to the group, the group suggested solutions based on gamification

Findings and Discussion

- Utilitarian attributes have been regarded as the most important ones to recycling
- “Regardless of which gamification mechanic is implemented, it should consider the diverse processes when people recycle.”

	- Motivation to separate waste is highly intrinsically motivates, people who do sort know about the existing environmental issues and want to actively work to solving them
	  - Since gamification is good at fostering intrinsic motivations, it seems like a good tool to motivate recycling
	- People to need to know what happens to their waste after it is collected so that they will be fully motivated to sort correctly
	- "Participants discuss the issue that they do not see immediate results when being a good citizen, and would like to receive feedback, regardless if it is about the waste management process, or other implications one owns actions has on the environment (which can take many years to realize)."
	- Focus groups suggested that gamifying recycling would make sorting fun and engaging for children
	Mechanics and Psychology
	- Participants preferred mechanics to be as a supplementary function (so something that aids in the recycling process) instead of something that literally turns it into a game (like tossing cans in the bin)
	  - Gamification should not interfere with the physical separation process
	  - Instant feedback and ability to see impact preferred
	  - Participants suggested that increased access to current information could increase motivation
	  - Management companies could show how different zip codes ranked against each other
	  - Or even neighborhood to neighborhood competition
	  - People want to be recognized as doing something good, not something bad
	- Solutions and outcomes
	  - "The FGD's emphasized that effort was a variable that was crucial to satisfy and by gaining knowledge and instant feedback intrinsic motivation would be enhanced, hence resulting in more correctly sorted waste."
	  - Game should be fun, engaging, motivational, invoke a sense of purpose, foster social collaboration/competition, and growth
	Conclusions, Implications and Future Research
	- Functional first! Mechanics should support the function/service
	- Not interfere with the physical process, digital is better
	  - Emphasis on feedback, knowledge, social mechanisms, collaboration/competition,
	  - Also rewards in th for of discounts nature-congruent products and virtual growing elements

Research Question/Problem/ Need	Using gamification to motivate and encourage people to recycle while also filling knowledge gaps has not been thoroughly explored.

	Study wanted to examine "how waste separation can be enhanced [to] increase the amount of correct separated waste".
Important Figures	 **Fig. 1.** Framework for gamification another framework for gamification, very similar to Hamari's  **Fig. 2.** Study framework Shows the flow and structure of each focus group
VOCAB: (w/definition)	**Waste fractions:** "the grouping if waste according to its properties" (Eustat) **Gamification:** "employing the fundamental mechanics of games in non-game contexts" **Self-Determination Theory:** "a broad framework for the study of human motivation and personality" (SelfDeterminationTheory.org) **Disseminate:** "spread (something, especially information) widely" (Oxford Languages)
Cited references to follow up on	A previous research project in south Sweden showed a good potential for sorting more of the household waste [4] Waste management behavior has been shown to be predicted by environmental values, situational characteristics and psychological factors [7]

	There is also a need for citizens to know about the potential consequences of not sorting [13] . However, as the majority of respondents have good knowledge of the general issues of global warming, many indicated that they did not have any particular knowledge of what happens after they have separated the waste. Past literature has shown that knowledge is an important prerequisite for positive waste sorting behavior [9] Waste separation being a functional task, applications on the smartphone offered a greater opportunity to facilitate interaction between customers and the waste company, which then could be gamified with visual elements, achievements or other common mechanics, such as in [32].
Follow up Questions	Would asking users to take a picture of their recycling be considered a hindrance to the recycling process? Are these results reliable to base my project on even though they are from a focus group discussion and the solutions were not put into practice? Would the proposed solutions work for the average person? Would normal people want to scan QR codes on their recycling bins or compete with their neighbors to see who can recycle best? - Would these solutions work for americans (who's recycling culture is vastly different than those in Sweden

Article #15 Notes: Use of Gamification Techniques to Encourage Garbage Recycling. A Smart City Approach

Article notes should be on separate sheets

Source Title	Use of Gamification Techniques to Encourage Garbage Recycling. A Smart City Approach
Source citation (APA Format)	Briones, A. G., Chamoso, P., Rivas, A., Rodríguez, S., De La Prieta, F.,

	Prieto, J., & Corchado, J. M. (2018). Use of gamification techniques to encourage garbage recycling. A smart city approach. *Knowledge Management in Organizations*, 674–685. https://doi.org/10.1007/978-3-319-95204-8_56
Original URL	https://link-springer-com.ezpv7-web-p-u01.wpi.edu/chapter/10.1007/978-3-319-95204-8_56
Source type	Conference Paper
Keywords	Behavioral change, serious games, context-awareness, social computing, multi-agent system
#Tags	#recycling #gamification #testingStrategy
ChatGPT Summary	NA

Summary of key points + notes (include methodology)	Key Points / Interesting Stats:
	- We need to motivate people to participate in recycling programs
	- This study attempted to do this by proposing "a system that encourages citizen participation by obtaining reductions in the waste rate applied by their local government, so that the amount of waste collected to be recycled is increased."
	  - Uses gamification techniques to change the habits of their citizens
	  - Participation increased by 32.2% and amount of waste recycled by 17.2%
	- "gamifying the recycling process in such a way that rewards are offered to users according to the amount of waste deposited in the container."
	-
	Experimental Approach:
	- Used CAFCLA do develop the proposed system
	  - Learns from the users actions and adapts, used MAS
	Experiment consisted of two phases
	- Phase 1: measured the amount of people that recycle and the amount of waste collected in different recycling containers
	  - Tested in an urban area outside of Zaragoza (2200 inhabitants)
	  - 30 recycling containers were deployed (ten blue for paper or cardboard, 10 tellos for plastic, ten green for glass)
	- Phase 2: Measure the app's impact
	  - Users downloaded android application
	  - When a user wants to recycle, they scan the qr code on the bin with their device. They deposit the recyclables, the bin weighs

them
- All of the data regarding the recycling incident (waste quantity, type, user, bin fill status, occupancy of the nearest treatment plant) is sent out to the virtual agents
- The user is given a monthly gaol by the local government, if they meet the goal they get 5 E off their monthly waste rate
- Each month all progress and achievements are reset

Introduction:
- Waste production is on the rise and we are resorting to ways of handling it that hurt the environment
  - Recycling is a way to combat this
- "One of the ways that would help to increase the recycling rate would be a more active participation of citizens in the recycling chain."
  - Give benefits to the people who participate more actively (like a streak??)
- "The concept of gamification is a technique that allows the recycling process to be stimulated and carried out in a more dynamic way so that certain results are achieved."

Background:
- Recycling Methods in the European union
  - Several color coded bins according to the type of material to be recovered. Citizens receive a schedule and bring out the bin the night before. They receive a fine if they do not recycle.
    - In some countries containers for organic waste or electronics
    - In Norway glass is only collected at grocery stores
  - Deposit Refund System, (DRS) (Germany, Sweden, Denmark)
    - Customers pay a tax when buying a recyclable container, when they return it to a machine at the grocery store in perfect condition they receive a 25 e voucher
  - These are not as efficient as the cities need them to be for the :intelligent city" future
  - Drawback
    - Only work for limited beverage containers (only 8% while bins cover 80%)
    - Stores must be open
    - Any dent in the packaging disqualifies the voucher
- Gamification as a technique for behavior change in recycling
  - Allows for higher levels of social commitment and stimulates environmentally friendly habits
- Multi-agent Systems for Data Collection, Action learning and Decision Making
  - Good for simulation situations and solving problems that are

<table>
<tr><td></td><td>difficult for an individual agent to solve
- Able to perceive and react t o changes in their environment
- Have previously been used to simulate recycling behavior and to learn recyclers habits
Proposed Architecture
- Required Infrastructure
- Outlines the various upgrades needed to make the current system Smart City compatible
- Virtual Agent Organization Architecture
-
Results:
- The system collected 17.2% more with the system than without</td></tr>
<tr><td>Research Question/Problem/ Need</td><td>Although there are systems to collect and separate different types of waste, much of the waste that is produced is not disposed of at recycling centers, therefore eliminating the possibility of a material being recovered. The need is for an increase in the motivation of the population and greater citizen participation (in this case urban citizens).</td></tr>
<tr><td>Important Figures</td><td>Table 1. Quantity (Kg) of waste collected from each container
<table><tr><th></th><th>Before system</th><th>After system</th></tr><tr><td>Blue container</td><td>2,214.15</td><td>2,625.98</td></tr><tr><td>Yellow container</td><td>1,731.24</td><td>2,023.82</td></tr><tr><td>Green container</td><td>1,595.07</td><td>1,851.88</td></tr><tr><td>Total</td><td>5,540.46</td><td>6,501.68</td></tr></table>
What is seen in the data
- The table shows that for every category of recyclables, the system increased the mass of products recycled in an urban community in a 2 month window

What it might mean
- This means that implementing this system in cities, especially as we move towards smart cities, may be a plausible way to increase citizen recycling habits
How it supports the narrative
- Helped me to see gamification working to help recycling habits. It also shows that monetary motivation worked in the EU.</td></tr>
</table>

	Table 2. Distribution of the users who participated in the case study distributed by age range What is seen in the data More people recy;ed plastic than any other material (although it was not the greatest mass). The most popular age range for a recycler was 40-60. What it might mean This may mean that media campaigns about recycling should be targeted to people outside the 40-60 age range (assumes that there are a similar number of people in each age group). The 0 recyclers in the 80-90 age group suggests that there is a barrier to recycling or to using this system for older people. How it supports the narrative The table supported the article's narrative by showing the data that the smart bins could collect.
VOCAB: (w/definition)	CAFCLA - Context-Aware Framework for Collaborative Learning Applications) MAS - multi-agent systems DRS - deposit refund system VO - virtual organizations
Cited references to follow up on	22 6 and 7 for gamification working favorably with energy efficiency
Follow up Questions	Why did the team choose to reset the user's progress each month? What advantages did this bring?

	18–30	30–40	40–50	50–60	60–70	70–80	80–90	Total
Blue container	56	163	153	130	97	2	0	601
Yellow container	85	118	163	164	85	5	0	620
Green container	61	141	142	169	84	1	0	598
Total	202	422	458	463	266	8	0	1819

Article #16 Notes: Beginning App Development with Flutter: Create Cross- platform Mobile Apps (Chapters 1-5)

Source Title	Beginning App Development with Flutter: Cross-Platform Mobile Apps
Source citation (APA Format)	Payne, R. (2019). *Beginning app development with Flutter: Create cross-platform mobile apps*. Apress. https://learning.oreilly.com/library/view/beginning-app-development/9781484251812/
Original URL	https://learning.oreilly.com/library/view/beginning-app-development/9781484251812/
Source type	Book Chapter
Keywords	Flutter, Dart, Icons, Forms
#Tags	#flutter
ChatGPT Summary	NA
Summary of key points + notes (include methodology)	1. Hello Flutter a. Flutter is a single set of tools that allows you to code apps for iOS and Android products, as well as deploy it to the Web and desktop. i. Built by Google (2018) with the goal to build better mobile apps ii. There are other Native solutions, but none that allow you to build web in addition it iOS and android apps 2. Developing in Flutter a. Outlines how to install flutter and what other tools are necessary b. Use flutter doctor to make sure all versions of your tools are up to date and check interdependencies between them c. To upgrade, type “flutter upgrade” into the Flutter SDK d. App names should **be all lowercase with underscores** e. When you star a project, it comes with many source folders

	i. Android and ios - for device specific code ii. lib - home of all dart source code iii. test - for test units iv. Pubspec.yaml - project file v. Analysis-options.yaml - warns you when you don't use best practices f. Apps can be tested on emulators or on a physically tethered device g. Hot reloading allows you to see new changes while staying where you are in the app h. Debugging bar will float over source code 3. Everything Is Widgets a. The components of Flutter are called widgets b. Apps can be divided into 2 parts i. behavior - what the app does (logic, data reading, writing, processing) ii. Presentation - how the app looks (the UI, buttons, textbox, labels) iii. Combined into one language in Flutter, this is unique compared to other frameworks c. Starts with a main function i. Maincalls runApp() with the root widget as a parameter, root widget should extend a Stateless Widget d. Built in Widgets i. Value widgets 1. Values can come from local storage, a service on the internet, or the user 2. Used to display values to the user and retrieve values from them ii. Layout widgets 1. Make the scene lay out properly a. Side by side, above, scrollable, wrap, space around… iii. Navigation widgets 1. Allow you app to move between scenes (also called screens and pages) a. Often with the help of a button iv. Other widgets 1. Don't fit into the above categories e. Creating Your own stateless widgets i. Every widget is a class that can have properties and methods ii. Can have a structure with 0+ parameters iii. All have a build method, which receives a BuildContext and returns a single flutter widget f. Widgets have Keys i. Instead of a DOM, Flutter has an element tree

1. Shows a small copy of all the widgets on the screen
   ii. If your widgets are being drawn in the wrong place, data isn't updated on the screen, or scroll position isn't preserved. Using a key may help

g. adding a value into your widget
   i. If the data in the ap changes, the screen needs to change accordingly
   ii. Can change by
      1. Widget re rendering with new data passed from the outside
         a. return className(parameter)
            i. Could also name the parameter here by doing: return className(parName: parameter)
         b. the className constructor must be built to take a parameter of that type
            i. final type name;
            ii. className(this.name){}
      2. Data is maintained within certain widgets

h. Stateless and Staeful widgets
   i. A state is the data within the widget that can change during its lifetime.
      1. If a user is going to be changing the data on a screen, it should be stateful
   ii. Never use a stateless widget unless you must
   iii. Third option is an InheritedWidget

4. Value Widgets
   a. Text widget - displays a string of text to the screen
      i. If this text is a literal (meaning you write out what you want it to say) put the word const in front of it
         1. This creates it at compile time instead of runtime and allows it to run faster on a device
         2. If you use the variable name you can't use const
   b. Icon widget
      i. Icon(Icons.type, color: Colors.name, size: num)
   c. Image widget
      i. Step 1, get the image source (either embedded in the app or retrieved live from the internet)
         1. It should be embedded if its never going to change
      ii. Step 2, size it
   d. Embedded Images
      i. Much faster, but they increase the app's install size
      ii. Put embedded images as a subfolder in the assets folder
      iii. Add assets/images.photoName.jpg to the assets section of the pubspec.yaml folder

1. Pubspec.yaml holds lots of info about your project, people will look there

iv. Run “flutter pub get” in the command line to process the file

v. Put it in your widget by saying Image.asset(‘location’),

e. Network Images
   i. Image.network(imgUrl),

f. Sizing an image
   i. Images are almost always put in a container
      1. Flutter will shrink an image to fit inside if its container, but it will not not stretch to fill it
   ii. Users can customize how images fit their container using methods like: fit: BoxFit.methodName (after adding the image in the Image,asset statement
      1. Fill - stretches in all directions
      2. Cover - scales up to fill space, is cropped
      3. fitHeight - height fits exactly, width is clipped or empty space is added
      4. fitWidth - same (but opposite) as above
      5. Contain - shrink until both the height and width fit, extra space

g. Input Widgets
   i. These don’t maintain their own state, it must be done manually
   ii. Input widgets are unaware of each other unless they are grouped in a form widget
   iii. Belong in a stateful widget
   iv. Text fields
      1. For single textboxes
      2. TextField(onChanged: (String val) => _searchTerm = val,)
         a. This sets a local variable searchterm equal to what the user is typing after each keystroke
      3. If you want to have an initial value in the text field, use the TextEdititingController
         a. TextEditingController name = TextEditingController(text: ‘initial value’) ;
            i. Put this controller as the first parameter in your text field
               1. Controller: name,
      4. The textFields do not need to be wrapped in formfields, they already have the necessary methods
         a. Text fields inside a form field should use TextFormField, those not in a form field should use TextField

5. Make it fancy
    a. Use The InputDecoration widget to decorate the text field
        i. Property - description
        ii. labelText - label above the textfield
        iii. hintText - light text in the field, disappears when the user begins typing
        iv. errorText - error message below the box
        v. prefixText - text in the text field to the left of what the user types
        vi. suffixText: same as above but to the right
        vii. Icon - draws an icon to the left of the text box
        viii. prefixIcon - draws an icon inside the textfield to the left
        ix. suffixIcon - same but to the right
    b. Set obscureText (a parameter of the text field) to true to hide the characters after they have been typed (for passwords)
    c. Change the TextInputType property to have a special keyboard show up (for emails, phone numbers etc)
    d. To limit the type of text that is allowed to be entered, do so with the properties of inputFormatters widget (which characters can and cant be typed, char limit)

v. Checkboxes - contain a boolean value stating whether or not they have been checked, Switch widget works the same way and returns that same values

vi. Radio Buttons - if you select one, the others in the same group are automatically deselected

vii. Group radio buttons by setting the groupValue property to the same local variable
    1. Var hold the value of the one button that is currently on
    2. Changed using the onchanged widget

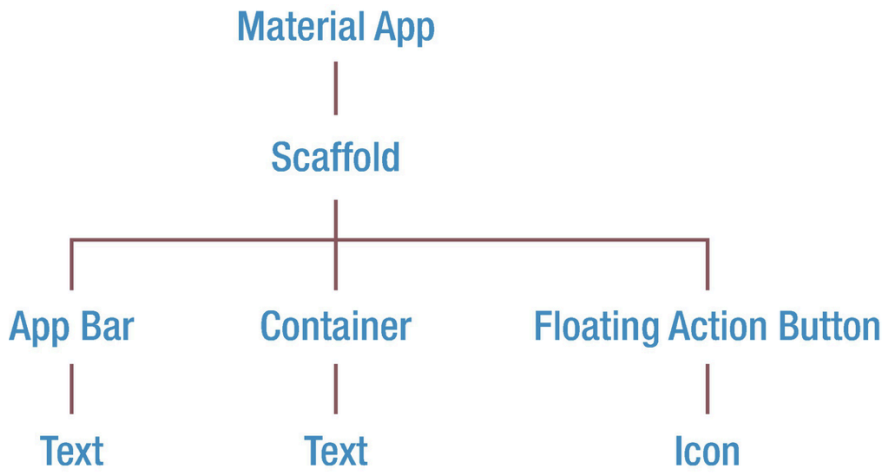
viii. Sliders - good for picking a numeric value between a lower and upper limit
    a. As usual, use the onChanged widget
        i. Also a double value property
        ii. Defaults to a range of 0-1, so you'll want to change this

ix. Dropdowns - good for picking one of a small number of

things
    a. See book for details on implementing

x. Putting the form widgets together
    1. Convenience widget with no visual component.
    2. If you want to use a form to group all of your inputs, you will need a GlobalKey of type FormState
        a. GlobalKey<FormState> _keyName = GlobalKey<FormState>();
        b. This will be set as a property to the form
            i. Key: _keyName, autovalidate:true, child: all form fields,
        c. Autovalidate bool decides whether validations run as soon as any changes are made or if that will be done manually
        d. Key has a currentState property that has handy methods like
            i. save() - saves all fields inside the form by calling each's onSaved
            ii. validate() = runs each fields validator function
            iii. reset() resets each field inside the form back to its initial value
        e. Since not all of the fields have those methods, you must wrap them in a FormField widget that does have those methods
            i. Can wrap any widget using a builder property
                1. Then add the onSaved and validator methods
    3. onSaved
        a. key.currentState.save(), invokes each on saved method
    4. Validator
        a. key.currentState.validate();
            i. Calls each FormField's validator method
                1. Can set autovalidate property to true
                    a. Receives a value, returns a string
                    b. Only works with TextFormField
            ii. If you want it to wait include it in the onpressed
    5. Gives an example for a big form

	5. Responding to Gestures a. Buttons come with onPressed methods, when the user presses the button it does something i. Types: 1. RaisedButton a. Floats above page ii. FlatButton 1. Appears flat, has text iii. IconButton 1. Appears flat has icon iv. FloatingActionButton 1. Usually button right, hint at action 2. Can hold icons v. CupertinoButton 1. Create for iOS devices but looks weird on others 2. Remember to import b. Dismissible i. Responds to swipes ii. Build a list of widgets and wrap them with dismissible c. Custom Gestures i. Tap, long press, scale, drag ii. Remember to include gesture detector widget 1. Wrap around the widget or nest it in a child property 2. Add properties to the gesture detector method and tell it what to do
Research Question/Problem/ Need	Explain the dart language to the reader.

Important Figures	 *Figure 3-3* The widget tree from our example app above Figure 3-3 shows the flow of widgets in a simple app. The material app is the root widget, the rest are subwidgets
VOCAB: (w/definition)	Componentization - “an approach to software development that involves breaking software down into identifiable and reusable pieces that application developers can independently build and deploy” (TechTarget) Decomposition - breaking a problem down into many smaller problems Composition - “enables you to reuse code by modeling a has-a association between objects. If you combine the concept of composition with the encapsulation concept, you can exclude the reused classes from your API”(Stackify) Virtual DOM - Document Object Model Stateless widget - a widget that does not maintain its own state Stateful widget - a widget that does maintain its own state Gesture - how a user interacts with the screen
Cited references to follow up on	For a full list of Flutter Built IN Icons - https://api.flutter.dev/flutter/material/Icons-class.html
Follow up Questions	How can I save the values from a form field? How can I have the number of elements be dynamic?

Article #17 Notes: Beginning App Development with Flutter: Create Cross- platform Mobile Apps (Chapters 6-7)

Source Title	Beginning App Development with Flutter: Cross-Platform Mobile Apps
Source citation (APA Format)	Payne, R. (2019). *Beginning app development with Flutter: Create cross-platform mobile apps*. Apress. https://learning.oreilly.com/library/view/beginning-app-development/9781484251812/
Original URL	https://learning.oreilly.com/library/view/beginning-app-development/9781484251812/
Source type	Book Chapter
Keywords	Widget layout, Flutter, Dart
#Tags	#flutter
ChatGPT Summary	NA
Summary of key points + notes (include methodology)	1. Laying out your widgets a. Lay out screen i. Turn on debugging to see how flutter is handling your screen ii. Toggle debugging painting iii. materialApp widget, creates the outer framework for the app 1. Where you apply the default theme for the app 2. Where you specify routes 3. Has a home widget iv. Scaffold widget

1. Creates inner invisible framework
    a. App bar
    b. Section for body
    c. Nav bar or drawer
    d. Bottom sheet

v. AppBar
1. Creates a header at the top of the screen
    a. Title and icon

vi. SafeArea
1. Use do things aren't cut off

b. Widget sizing
i. Measurements in pixels and points
ii. Box constraints
iii. Asks each widget how big it wants to be and asks if that is okay
1. Uses padding to fill extra space

c. Position widgets above and below each other or side by side
i. Row
ii. Column
iii. Each have a main and cross axis
iv. Child property is a row of widgets
v. Use flex widgets when you want things in rows at some times and columns at others
1. Start, end, center, stretch
    a. Intrinsic width

vi. Use expanded widget if you want all the space to be filled
1. If multiple are expanded then they share the space, can controle how much each gets

vii. Too little space?
1. Allow for scrolling (vertically)
2. Use listView widget
    a. Good for small numbers of widgets
        i. Static lists
3. listView.builder
    a. When your building from a list of indeterminate length
    b. Set to he length of the list you are scrolling through

d. Finger positioning adjustments
i. Images dont have padding, borders, etc, so make sure to put them in a container
1. Each div can only hold one child

ii. Padding
1. Use EdgeInset methods
2. Use alignment properties to tell where in the container it should be

	iii. Determine container size 1. Set width and height a. Only works when that space is available b. Usually let widgets decide their own size iv. Special Layout widgets 1. Stack 2. GridView 3. GridVewi.extent() 4. GridView.count 5. Table 2. Navigation and Routing a. Stacks i. Widget is a full screen ii. Taps button to go through predefined workflow iii. Can travel back b. Drawers i. Drawer on the left part of the screen 1. Contains a menu of choices c. Tabs i. Shown at top or bottom of the screen ii. If you press it you move to the corresponding tab d. Dialogs
Research Question/Problem/ Need	Explain how to layout widgets, navigation, and routing in Dart.

Important Figures

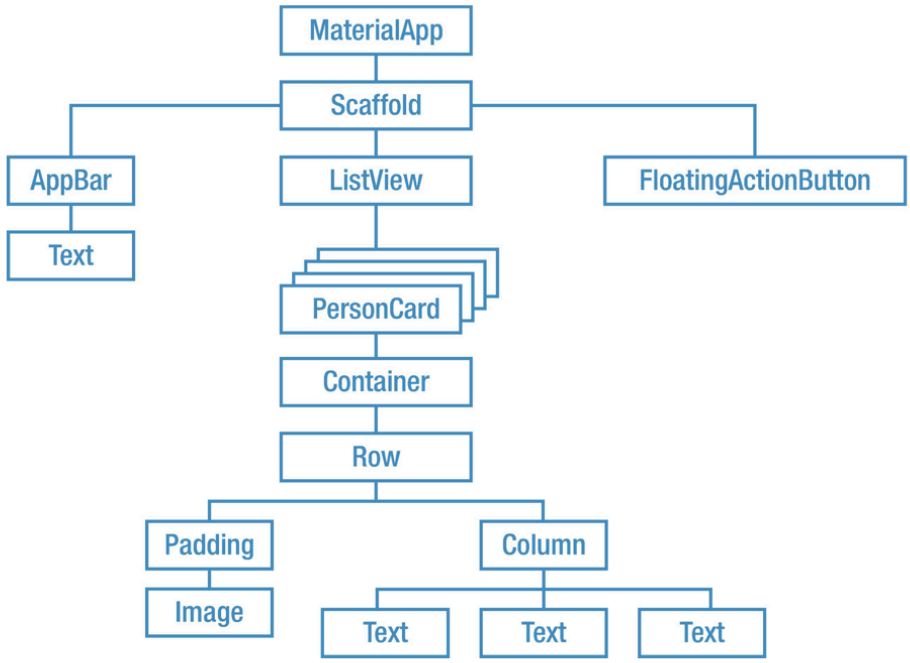


Figure 6-11 Every scene has a widget tree

A more detailed scaffold tree

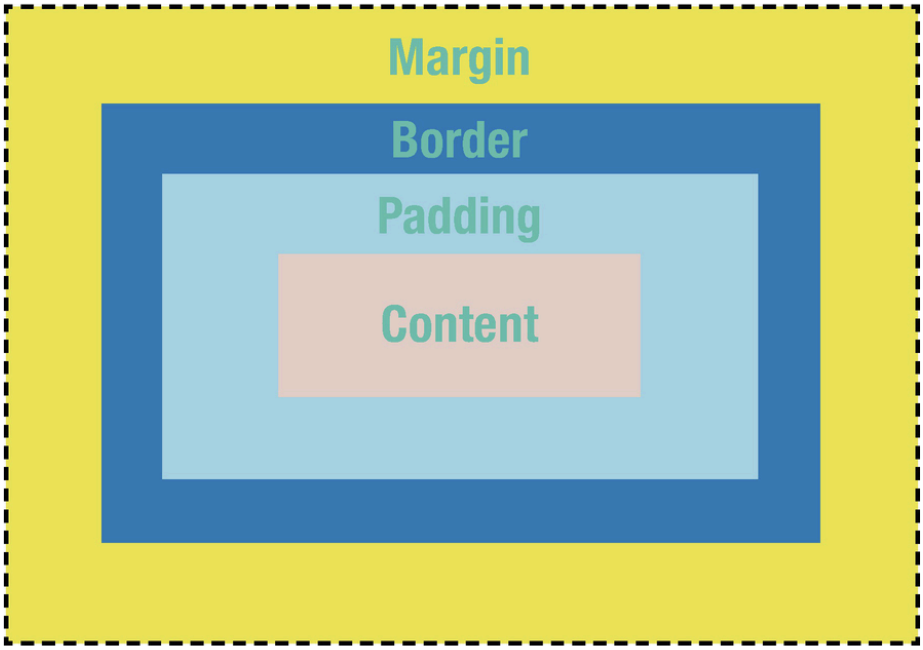


Figure 6-24 The box model defines padding, border, and margin

Follows the same colored box model as HTML

VOCAB: (w/definition)	Scaffold: the structure that holds all of your widgets child : something that is held by another widget
Cited references to follow up on	NA
Follow up Questions	How did this change dynamically when the view is changed from vertical to horizontal? How can I set a starter width without being too rigi

Article #18 Notes: Beginning App Development with Flutter: Create Cross- platform Mobile Apps (Chapters 8-9)

Source Title	Beginning App Development with Flutter: Cross-Platform Mobile Apps
Source citation (APA Format)	Payne, R. (2019). *Beginning app development with Flutter: Create cross-platform mobile apps*. Apress. https://learning.oreilly.com/library/view/beginning-app-development/9781484251812/
Original URL	https://learning.oreilly.com/library/view/beginning-app-development/9781484251812/
Source type	Book Chapter
Keywords	Flutter, Dart, Styling
#Tags	#flutter
ChatGPT Summary	NA
Summary of key points + notes (include methodology)	1. Styling a. Colors i. Can use hex or RGB values (put FF infront if you can't see it) b. Text i. TexStyle 1. Color 2. Decoration

3. fontSize
4. fontStyle
5. fontWeight
6. fontFamily
    a. Some are built in, others must be installed

ii. Custom Fonts
1. Download file and add to pubspec yaml file

c. Container decorations
i. Containers allow you to add decorations to anything you want
1. Holds boxDecoration, holds borders
    a. Border radius for rounded corners
ii. Use boxshape if you want it to be a circle, custom paiter for others
iii. Applied to the layer above the container

d. Stacking Widgets
i. When you want them to occupy the same x y coordinate on the screen
1. Lets you put text on images
2. Set their z values

e. Positioned widget
i. Wrap stacked widgets in a positioned widget to state where they should be (given as a distance from a corner)

f. Themes
i. Groups things and lets you style them easily and in one place (material app)
ii. NEED to set your primary swatch, tells each element what color to use
iii. Also can control
1. Tic marks
2. Rounded corners
3. Animations

g. Applying Theme Properties
i. Apply the style property and tell it what theme to follow
1. Like making text be a level 1 or 2 header

2. Managing State
a. Data that changes while the widget is active and must be rerendered
b. Always consists of 2 classes, one for the widget and one for the state
c. the widget class is public
d. The state class is private
i. Defines an maintains the state
ii. Defines the build method
iii. Defines any call back functions needed for data gathering or event handling
e. If you want to change something, run the setState method

	i. Forces a rerender of the widget f. Use widget.varName to access variables in the state class g. Advanced state management i. Inherited widget 1. Built in 2. Creates a small set of global variables that are made available in a controlled way to all descendants in its tree ii. BLoC 1. You have to write it by yourself iii. ScopedModel 1. Library creates data models with the ability to register listeners iv. Provider v. Redux
Research Question/Problem/ Need	Describe how to apply styles in dart to enhance the appearance of an application and how to handle stateful widgets

Important Figures	 Shows how various heading styles format the text.

	Flutter gives us certain widgets that are stateful out of the box • AppBar • BottomNavigationBar • Checkbox • DefaultTabController • Dismissible • DrawerController • DropdownButton • EditableText • Form • FormField • GlowingOverscrollIndicator • Image • InputDecorator • MonthPicker • Navigator • ProgressIndicator • Radio • RefreshIndicator • Scaffold • Scrollbar • Slider • Switch • TextField • YearPicker Examples of Stateful widgets
VOCAB: (w/definition)	Flutter Theme: “a grouping of styles in logically-defined groups that can be applied together” State: “widget data whose change requires a re-render “ Single responsibility principle: “suggests that we should have one thing responsible for drawing the widget and another thing responsible for dealing with data” BLoC: Business Logic Component
Cited references to follow up on	https://docs.flutter.io/flutter/material/ThemeData-class.html This provides all of the theme options
Follow up Questions	Is there an easy way to keep track of where each variable is available? How do I know which class is inheriting from which? At what point does an application become too complex to be handled by a StateLess widget?

Article #19 Notes: Greenhouse gas emission factors for recycling of source-segregated waste materials

Article notes should be on separate sheets

Source Title	Greenhouse gas emission factors for recycling of source-segregated waste materials
Source citation (APA Format)	Turner, D. A., Williams, I. D., & Kemp, S. (2015). Greenhouse gas emission factors for recycling of source-segregated waste materials. *Resources, Conservation and Recycling*, *105*(A), 186–197. https://doi.org/10.1016/j.resconrec.2015.10.026
Original URL	https://doi.org/10.1016/j.resconrec.2015.10.026
Source type	Journal Article
Keywords	Greenhouse gas emissions, emission factor, source segregated materials, recycling, waste management, life cycle assessment
#Tags	#recycling
ChatGPT Summary	NA
Summary of key points + notes (include methodology)	Big ideas: - GHG EFS for source-segregated materials recycling were derived using partial LCA - Source-segregated materials recycling was generally found to result in GHG savings - Results were found to be highly sensitive to the assumed market substitution ratio - Findings reveal a dearth of high quality material recycling LCI data available Key Results: - All materials except soil, plasterboard, and paint resulted in net GHG savings Introduction

- We need to be able to quantify the effect of recycling certain materials and see where there is room for improvement in terms of GHG
- Previous studies have researched this but they are either not transparent enough or do not cover enough materials
- "In response to growing concerns about the threat of climate change, international action aimed at reducing greenhouse gas (GHG) emissions is accelerating and the solid waste management sector is expected to contribute. "
    - Many countries are committing to reducing their GHG emotions
    - Need to maximize resource efficiency while still reducing GHG
- "Numerous international studies have shown that the recycling of waste materials can result in net savings of GHG emissions (Björklund and Finnveden, 2005, Franchetti and Kilaru, 2012, Manfredi et al., 2011, WRAP, 2006, WRAP, 2010a). This is because recycling materials into new ("secondary") products can displace production of "primary" products that can require significant inputs of energy and raw materials"
- Emission factors relate the quantity of a pollutant emitted to a unit of activity
    - Usually a CO2 equivalent per ton of waste (CO2e/t)
        - The estimations made are typically only applicable to certain geographical areas with certain technologies available
- The United States Environmental Protection Agency (US EPA) has developed a Waste Reduction Model (WARM) to assist solid waste managers and organizations to measure and report their GHG emissions from solid waste management (US EPA, 2015). For ease of use, the model exists as both a web-based calculator and as a Microsoft Excel spreadsheet.

Methods

- Each type evaluated individually
    - 52 material types were evaluated
- Took into account recyclability and material quality loss
- "Emissions of four GHGs, fossil CO_2, biogenic CO_2, CH_4, and N_2O, were included; combined, emissions of these three gasses represent more than 90% of GHG emissions from solid waste management (Bogner et al., 2007)."
- Transport was taken into account when calculating the EFs
- Emissions were modeled for a 100 year time frame, if the material did not break down in that timeframe the emissions were not included)

	Results and Discussion - 50 of the materials were found to result in net GHG savings - Aluminum and aluminum foil had the largest savings, followed by scrap metal, and textile materials - Plasterboard, soil, and paint resulted in net GHG emissions - the se values should be taken cautiously because EFs can vary drastically based on the resources of the location
Research Question/Problem/ Need	To find GHG EFs for a variety of materials to help lawmakers make decisions about recycling. (to show whether recycling a material had a net positive or negative affect on the amount of greenhouse gasses emitted) “The goal of this study was to quantitatively evaluate the GHG emissions from recycling of source-segregated waste materials. “

Important Figures

Waste material type	Calculated emission factor		Literature emission factors		
	Gross	Net	No. of reference studies	Range	Average ± st. dev.
	kg CO_2e/t	kg CO_2e/t		kg CO_2e/t	kg CO_2e/t
Green glass	395	−314	6	−762 to −201	−417 ± 176
Brown glass	395	−314	6	−762 to −201	−417 ± 176
Clear glass	395	−314	6	−762 to −201	−417 ± 176
Mixed glass	395	−314	6	−762 to −201	−417 ± 176
Paper	1576	−459	7	−3891 to 390	−1195 ± 1303
Card	559	−120	5	−3439 to −280	−1010 ± 1095
Books	562	−117	3	−3428 to −811	−1709 ± 1489
Mixed paper & card	559	−120	4	−888 to −280	−601 ± 242
Yellow pages	562	−117	2	−2910 to −888	−1899 ± 1430
Steel cans	529	−862	7	−2360 to −496	−1337 ± 674
Aluminium cans	1113	−8143	7	−19340 to −5040	−11334 ± 3512
Mixed cans	883	−3577	3	−4828 to−2573	−3789 ± 1138
Other scrap metal	883	−3577	3	−4828 to −2573	−3789 ± 1138
Aluminium foil	1113	−8143	1	–	−9267
Aerosols	883	−3577	–	–	–
Fire extinguishers	651	−673	–	–	–
Gas bottles	651	−673	–	–	–
Bicycles	883	−3577	–	–	–
Mixed plastics	339	−1024	6	−2324 to 1470	−788 ± 1007
Mixed plastic bottles	336	−1084	5	−2324 to 1470	−922 ± 1321

Mixed plastics	339	−1024	6	−2324 to 1470	−788 ± 1007
Mixed plastic bottles	336	−1084	5	−2324 to 1470	−922 ± 1321
PET	155	−2192	6	−2324 to −566	−1570 ± 600
HDPE	379	−1149	5	−2324 to −253	−1055 ± 792
PVC	379	−1549	3	−2324 to −566	−1259 ± 936
LDPE	29	−972	4	−1586 to −850	−744 ± 981
PP	379	−1184	3	−2324 to −566	−1279 ± 925
Wood	502	−444	5	−2712 to 1	−619 ± 882
Chipboard & MDF	502	−444	5	−2723 to 1	−620 ± 886
Composite wood materials	502	−444	3	−1266 to 1	−357 ± 431
LDAs	428	−866	2	−1266 to −181	−626 ± 431
SDAs	463	−1349	1	–	−1482
CRTs	272	−228	1	–	−2767
Fluorescent tubes & other light bulbs	518	−779	–	–	–
Fridges & freezers	469	−853	3	−1042 to −181	−626 ± 431
Automotive batteries	938	−435	2	−563 to −487	−525 ± 54
Post-consumer, non-automotive batteries	1129	−205	2	−563 to −487	−525 ± 54
Car tyres	206	−636	2	-1910 to -430	−1170 ± 1047
Van tyres	197	−671	2	−1910 to −430	−1170 ± 1047
Large vehicle tyres	197	−671	2	−1910 to −430	−1170 ± 1047
Mixed tyres	206	−636	2	−1910 to −430	−1170 ± 1047
Furniture	502	−444	1	–	−921
Rubble	16	−2	4	−9 to 2	−2 ± 5
Soil	41	27	2	−2 to 2	0 ± 2
Plasterboard	59	4	2	−139 to 33	−53 ± 122

Plasterboard	59	4	2	−139 to 33	−53 ± 122
Vegetable oil	647	−2759	1	–	−725
Mineral oil	647	−2759	2	−725 to −725	−725 ± 0
Composite food & beverage cartons	629	−452	1	–	−1730
Mattresses	478	−1241	–	–	–
Paint	364	86	1	–	−2840
Textiles & footwear	401	−3376	5	−7869 to−930	−3606 ± 2709
Textiles only	401	−3376	5	−7869 to −930	−3606 ± 2709
Footwear only	401	−3376	2	−5891 to−4385	−5138 ± 1065
Carpets	181	−10	1	–	−2601
AHPs	53	0	–	–	–

This Table shows the GHG EFs for each of the 52 materials modeled. A negative value represents GHG savings

VOCAB: (w/definition)

GHG - greenhouse gasses
EF - emission factor
LCA - life cycle assessment
LCI- Life cycle inventory
Source segregated materials - when resources are separated by type at the source (as opposed to mixed collection)

Cited references to follow up on

United States Environmental Protection Agency (US EPA), 2015. Waste Reduction Model (WARM) version 13. WARM background and overview.〈 http://www.epa.gov/epawaste/conserve/tools/warm/pdfs/Background_Overview.pdf〉(accessed 16.07.2015).
Google Scholar
- to make carbon calculations

Follow up Questions	How much do these factors differ if the materials are mixed when collected? Does it matter where the recycling companies source their energy?

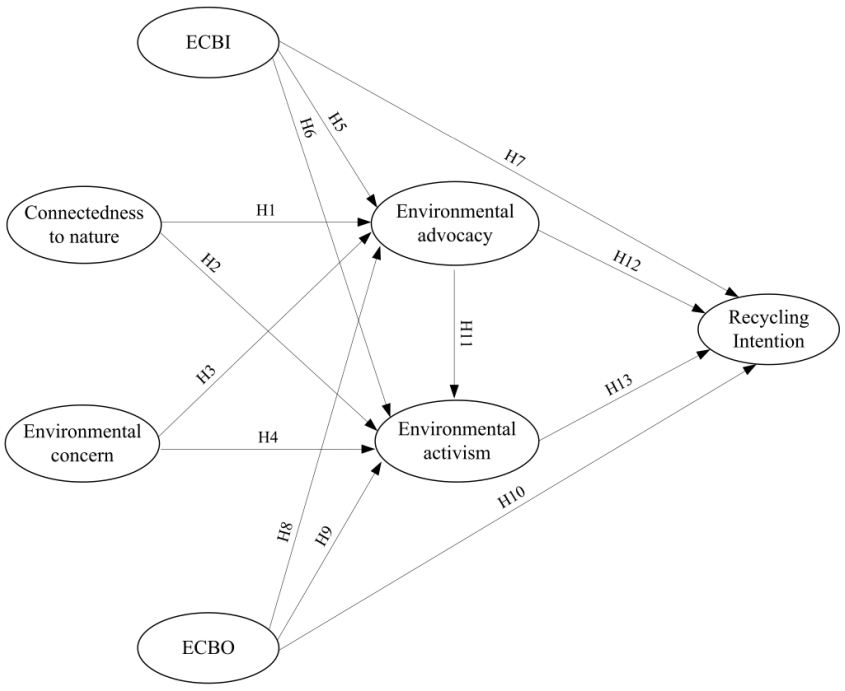
Article #20 Notes: An innovative environmental citizen behavior model: Recycling intention as climate change mitigation strategies

Source Title	An innovative environmental citizen behavior model: Recycling intention as climate change mitigation strategies
Source citation (APA Format)	Yu, T., Lin, F., Kao, K., Chao, C., & Yu, T. (2019). An innovative environmental citizen behavior model: Recycling intention as climate change mitigation strategies. *Journal of Environmental Management*, *247*, 499–508. https://doi.org/10.1016/j.jenvman.2019.06.101 No issue number
Original URL	https://doi.org/10.1016/j.jenvman.2019.06.101
Source type	Journal article
Keywords	Climate change, recycling intention, structural equation modeling, mitigation strategy
#Tags	#recycling
ChatGPT Summary	"This study investigates the role of recycling as a mitigation strategy for climate change, focusing on the recycling intentions of university students within the framework of green education. The research explores the influence of factors such as connectedness to nature, environmental concern, environmental citizenship behaviors, and organizational behaviors on recycling intentions. The study finds that connectedness to nature and environmental concern are significant antecedents to environmental advocacy and activism. Environmental citizenship behaviors within organizations, as well as individual behaviors, positively impact advocacy, activism, and recycling intentions. The results suggest that fostering an environmentally-friendly atmosphere and supporting environmental citizenship play crucial roles in promoting recycling intentions. The study combines the perspectives of the New Environmental Paradigm (NEP) and environmental citizenship to provide insights into the complex interplay of factors affecting

	recycling behaviors. The findings emphasize the importance of green education in shaping environmentally sustainable attitudes and behaviors among university students. However, the study acknowledges limitations, such as the lack of information on specific school initiatives related to environmental sustainability, and suggests that future research could explore these aspects for a more comprehensive understanding of recycling behaviors." Link to prompt and response

Summary of key points + notes (include methodology)	- "Climate change has been led to the increasing magnitude of frequency and severity of extreme weather, causing serious damage to overall economy of a country and individual economy of enterprises"
	
	Introduction
	- Recycling is an important strategy used to combat climate change
	- Because of the worlds lack of sustainable actions we've lost biodiversity and have increased pollution
	
	New environmental paradigm
	- Need to shift away from dominant social paradigm (DSP)
	- NEP includes values of natures intrinsic value, moral responsibility of human activity, and humans responsibility for nature
	- How do environmental issues reflect in human attitudes and value systems
	- NEP scale considers 12 items in 3 dimensions
	-
	Environmental citizenship and pro environmental behavior
	- People regard themselves as a part of an ecological community , pro environmental behavior is about personal virtue not self interest
	- 3 sectors of environmental citizenship
	  - Ecological advocacy
	  - Ecological assistance
	  - Ecological citizen participation
	
	Research methods
	- Research surveys on the NEP, adaptation strategy, and environmental citizenship behavior
	  - 7 point Likert style
	  - Participants were students who took a course on global climate change issues
	- Second survey
	  - Participants had to demonstrate a proficient knowledge of recycling policies
	  - 514 valid surveys were collected from various regions in Taiwan
	  - Ran chi square and anova tests to see if there were relationships between the various survey demographics
	  -

	Results and Discussion
	- "The advocacy and activism are seen as implementing global environ- mental citizenship behaviors, and the individual's connectedness to nature and environmental concern are directly correlated to civil advocacy and activism"
	- "People with a high environmental concern should influence others' recycling intentions and set high goals on environmental issues."
	- "a green education can transmit the atmosphere, approaches, and significance of environ- mental citizenship to students through communication and internalizing environmental citizenship"
	  - The more people know about our environmental situation, the more they will care
	- Recycling is strong strategy for combating climate change
	  - It is something households can do and does not rely on governmental policy
	- When someone feels more connected to nature, their civic virtue is enhanced

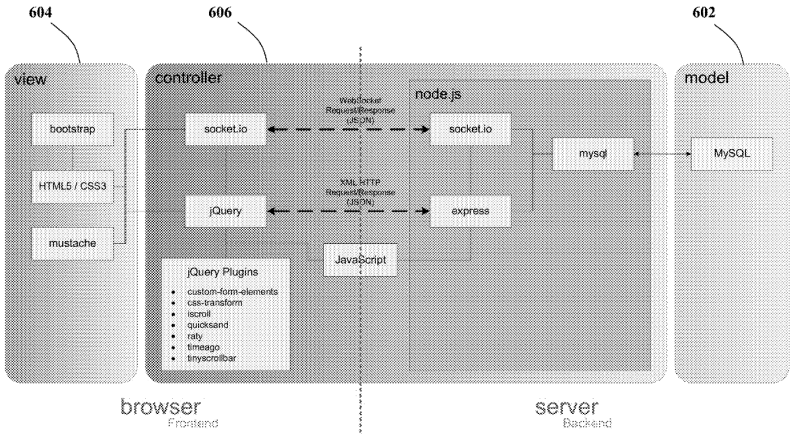
Research Question/Problem/ Need	What are the dominant factors that influence recycling intention?
Important Figures	*Journal of Environmental Management*  **Fig. 1.** The hypotheses of research model. Shows the hypothesis of the research model and how the researchers believe the topics are interconnected

VOCAB: (w/definition)	Environmental citizenship - “pro environmental behavior, in public and private, driven by a belief in fairness of the distribution of environmental goods, in participation, and in the co-creation of sustainability policy” (Dobson 2010) Adaptation - “adjustment of natural or artificial systems in response to the impact cause by climate change to reduce har, or develop favorable opportunities” Mitigation - “reducing the emission amounts of greenhouse gasses” OCB - organizational citizenship behaviors - individuals behavior that prompts the effective function of an organization and improve organizational performance NEP - new environmental paradigm
Cited references to follow up on	NA
Follow up Questions	How can we get people who aren't studying climate change at the university to care about recycling? How much of an effect can citizens have on the environment without the help of governmental policy?

Patent #1 Notes: Method and mechanism for implementing a gamification application

Source Title	Method and mechanism for implementing a gamification application
Source citation (APA Format)	PATTISON, L., WEBB, E., O’Broin, U., Aguilar, A., Lopez, E., GONZALEZ, E., & CANTU, A. (2017). *Method and mechanism for implementing a gamification application* (United States Patent US9623333B2). https://patents.google.com/patent/US9623333B2/en
Original URL	https://patents.google.com/patent/US9623333B2/en
Source type	US Patent
Keywords	Gamification, software

#Tags	#gamification
ChatGPT Summary	NA
Summary of key points + notes (include methodology)	Goal is to provide a system that will help to gamify activities - May alter the application - Also may not alter the application The proposed product can be used to help motivate people - Especially important in business (if employees aren't working then the company is losing money) - Works in education too (people who want to learn more will learn more) - Current solutions for these like incentive programs do not work in the long term Gamification is a tool that can be used to create and enhance engagement of individuals and groups - Prior approaches include online sites and software applications - Unfortunately all of these require customized modifications - Takes time, effort, and money Want to makes a solution that generally addresses the problem so that the solution can apply to literally every activity and application - Wants to do so with low time and low cost - System works on conjunction with one or more gamification contexts/applications Works by configuring the standalone gamification application to include game mechanics that further the goals of the gamification context - Includes mechanisms for scoring and badges - Scoreboards - Gain points and badges by completing tasks Works for any online or offline event All features are configurable by an administrator - User friendly interface - Includes patterns of game mechanics - Lets them choose their notifications - Data backup capabilities - Scoring can be updated manually or automatically - Interface can be used to give star rating - Specific interfaces for first time logins - Provides an example team page View layer may be implemented for a browser front end - HTML - CSS - Javascripts Interface with the view layer - jQuery, socketIO, JavaScript Does not require retrofitting Claimed -

	- A computer implemented with a processor that gamifies any context - Has a memory and a processor
Research Question/Problem/ Need	Make implementing gamification to digital and nondigital contexts by creating a one size fits all gamifying system.
Important Figures	 **FIG. 6** Figure 6 gives an overview of which languages were used to code each part of the application
VOCAB: (w/definition)	Retrofitting - add (a component or accessory) to something that did not have it when manufactured (Oxford Dictionary) Claim - defines the subject matter that is sought to be protected (Legal Information Institute)
Cited references to follow up on	NA
Follow up Questions	Is it typical for patents to cite wikipedia?

Patent #2 Notes: System and method of gamification of real-life events

Source Title	System and method of gamification of real-life events
Source citation (APA Format)	Thomas, A. J., & Dudley, J. (2014). *System and method of gamification of real-life events* (United States Patent US20140335955A1). https://patents.google.com/patent/US20140335955A1/en
Original URL	https://patents.google.com/patent/US20140335955A1/en
Source type	Patent
Keywords	Gamification, real-life
#Tags	#gamification
ChatGPT Summary	NA

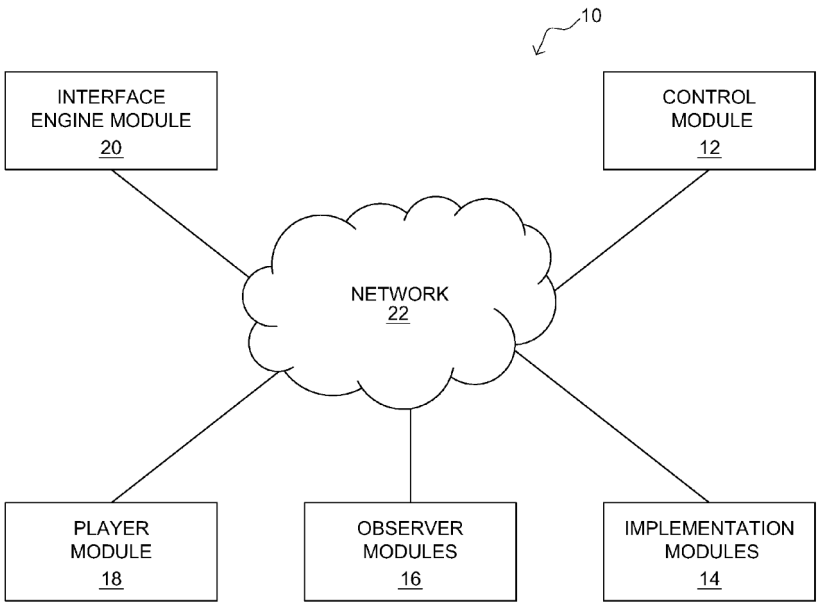
Summary of key points + notes (include methodology)	The patent is for a system and method for gamification of real-life events over a computerized network.
	
	It includes a
	- Observer module
	  - Configured to generate real-life data in response to observation of real life events
	- Interface engine module
	  - Configured to operate an ongoing computerized game that includes game objects
	- Implementation module
	  - Configured to receive an implementation instruction and automatically effect a real-world occurrence associated with the instruction
	- Control module
	  - Includes a processor
	  - Configured to convert real life data from the observer module into a game object
	  - Provides the created game object to the interface engine module for injection into an ongoing computer game
	  - Converts player interaction into an implementation instruction and provide the same to the implementation module
	- Player module
	  - Permits a player to play the ongoing game
	
	Background of the invention:
	- Relates to an ongoing computer game

- Specifically to a system and method of gamification of real life events
- Pertains to video games and their platforms
- Arcade games have declines in popularity
  - Video games are now an art form and industry
- Video games
  - Controlled by a controller
    - These vary across platforms
    - Sometimes use keyboards or mice to control the game
      - Sometimes a combination of these
  - Audio is a key aspect of video games
    - Use speakers and headphones
  - Video games are collaborative
    - Typically suited for 2-4 players but up to 12 has been seen
  - Personal computer systems from Atari and Commodore not regularly have at least 2 game ports
    - PCs typically had either one or no game ports
  - Some games have in game currency that is bought with real world money
- **There are many problems with the current inventions**
  - Limited in function
  - Limited in use
  - Not involving real-life interactions
  - Not being based upon real life
  - Not based on real time environments
  - Being limited in interaction
  - Being limited in application
  - Failing to provide feedback
  - Failing to educate
  - Being too distant from the real world and life events
  - Failing to promote collaboration
  - Failing to promote socially responsible behavior
  - Not relevant
  - Not integrating with social media platforms
  - Failing to service nonprofit organizations
- So this is why we need a gamified version of real life events

The product

- Receives and stores data in various structures
- Graphics are generated from real life
- Data is received from the real world
- Users are able to interact with the objects
- The product is able to transfer money in and out of bank accounts
  - When people make in game purchases some of the profit goes to charity organizations
- Uses R-G and G-R translation models
- User account characteristics may affect how a user influences and or

	contributes to another community
	- Users may be asked questions and provided with choices in game
	- Users may be introduced to each other in real life
	  - This depends on their status in the game
	- The more advanced a user is the larger and more advanced they can build their society
	  - When they get big enough they can begin tackling real world problems with other real people (while still in the platform)
	  - These events are chosen based on how relevant they are to the user
	  - Other factors: size of event, disasters and major world successes
	  - The proposed in game solutions will be sent to real world officials

Research Question/Problem/ Need	Gamify real-world events using a computerized network in a way that allows users to collaborate to propose solutions to real problems.
Important Figures	 FIG. 1 Figure 1 shows the basic framework of the network. The network as a whole consists of a control module, implementation modules. Observer modules. Player module, and interface engine module.
VOCAB: (w/definition)	Video game - “electronic game that involves human interaction with a user interface to generate visual feedback on a video device” Platforms - “ the electronic systems used to play video games”

Cited references to follow up on	NA
Follow up Questions	Why are the real-world problems reserved for users of higher levels? How is an environment of collaboration fostered when there will inevitably be users of any contrasting viewpoints?

Patent #3 Notes: Gamification Platform

Source Title	Gamification Platform
Source citation (APA Format)	AMEERJAN, S. J. L. M., Rodgers, M. P., LEAHY-DIOS, F., GRIESHABER, G. T., Bali, G. S., & LUKEZ, R. E. (2018). *Gamification platform* (United States Patent US10001896B2). https://patents.google.com/patent/US10001896B2/en?q=(gamification+platform)&oq=gamification+platform+
Original URL	https://patents.google.com/patent/US10001896B2/en?q=(gamification+platform)&oq=gamification+platform+
Source type	Patent
Keywords	Gamification, online, business
#Tags	#gamification
ChatGPT Summary	NA
Summary of key points + notes (include methodology)	This product gamifies a data processing application using auditing data. - Accesses the electronic records - Auditing specifications identify one or more transaction types to be executed - Transactions are observed by an auditing facility during operation - **Associates the measured audit parameters with game parameters** - **Uses motivational imagery like scoreboards for display** Field - Relates to field of data processing applications and more particularly to techniques for automatic gamification of data processing applications using performance and auditing instrumentation

Background

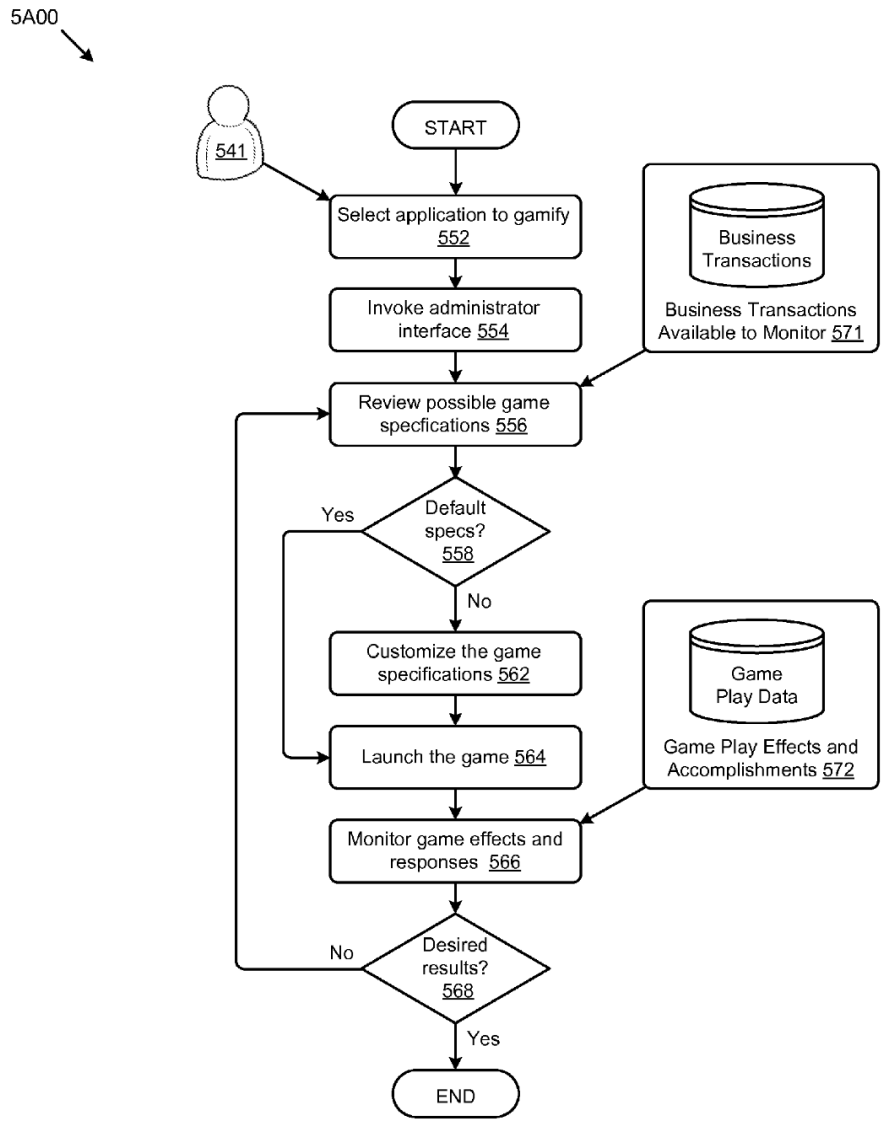
- Gamifications applies game mechanics to nongame contexts
  - Used to increase engagement and performance
  - Often used in business settings
  - Includes features reminiscent of computer games in the applications
- Currently when businesses try to use gamification they have to update each system separately
  - Costs lots of time and money, there is also a risk of disturbing the system
  - Using third party gamifiers is also expensive, time consuming, and often ineffective
- This is why we need an autonomous gamifying platform
  - We need something that will provide a gamification platform that uses operation and data items of an enterprise application to automatically apply game dynamics
    - Use motivational imagery

Claims

- "A method comprising:accessing electronic records comprising a set of application auditing specifications that identify one or more 25 business transaction types to be executed by a data processing application and a set of application specifications that define the behavior of the data processing application and a set of business data describing the one or more business transaction types executed by the data 30 processing application"
  - Set of application specifications has at least one set of event specifications
    - These are stored in the first data type
  - Business transaction types
    - Update transaction
    - Delete transaction
    - Read transaction
    - Close transaction
  - Stores a set of measured parameters which correspond to one or more database transactions
    - Located in the second data structure
  - Determines one or more sets of gamification specifications
    - Determined based on the measured audit parameters
  - Gamification structures are stored in the third data structure
    - Has one or more relational references
      - Have audit parameters
- Presents a user interface
  - Has one or more sets of form elements
    - Check boxes, lists, sliders
      - Lets people choose between the gamification elements
      - User gets to identify which ones should be used or

	provide custom instructions
	- Is able to handle one or more transactions form one or more client devices
	- Game parameters comprise of:
	  - Some audit parameters
	  - Measurement threshold
	  - Measurement rule
	  - Interface screen
	- Product will have a sequence of instructions for the user
	- Fourth data structure is populated with game action
	  - Put into the fifth data structure
	- Allows information to be stored on the host device
	- Allows for team based games

Research Question/Problem/ Need	Design a system that gamifies data processing applications using auditing data.

Important Figures	 **FIG. 5A** This figure shows the flow of the application. It begins with the manager or boss selecting an application to gamify. They then follow simple steps and iterations to implement the game features of their choosing. This will provide their employees with a gamified network.
VOCAB: (w/definition)	Gamification: “the concept of applying game dynamics (e.g. player interaction, game play mechanics, etc.) in non-game contexts to enhance user engagement and performance” Legacy product: a non current version of the product
Cited references to follow up on	NA

Follow up Questions	Does this system actually increase participation and engagement as claimed? What are the different levels of badges available? Is there any monetary incentive associated with doing well? Or just the social pressure?