



Research Exposé:

**Encourage people toward better recycling habits
thanks to gamification: evidence from the Italian city
Pistoia.**

Submitted by:

Student: Silvia Venturi

Supervisor: Katrin Zulauf and Ralf Wagner

Academic Year: 2022 / 2023

Kassel, 23/10/2022

Abstract

This study applies gamification to explore possible contributions of gamification to resource recycling and environmentally friendly habits. Encourage people towards better recycling activities can help consumers engaging in sustainable thinking, which is essential considering that effective resource recycling critically depends on environmentalists' education about the topic and greatly reduce costs resulting from waste mismanagement. Gamification is helpful to encourage such thinking and habits. Research designs, comparing gamified versus non-gamified learning contexts, suggest that any gamification of learning, regardless of the specific game elements used, can produce desirable outcomes for learners.

The thesis investigates the impact of gamification on users' actual behaviors when they start to use a gamified app about recycling.

Previous research focused on users' behavioral intentions toward a resource-recycling digital tool and the factors that affect their behavior. This approach can lead to false results because it does not evaluate the effective behavior. For this reason, in this research a quasi-experimental design is used to test the effectiveness of the gamified app GreenApes.

To note the differences between a context that uses gamified training and an equivalent one that does not, three groups of individuals will be part of the experiment. The first group will use the gamified app GreenApes; the second group will have access to the same, but not gamified, information of the first group; finally, the third is the control group, so it will not receive the treatment.

The sample is made by eighteen adult people living permanently in Pistoia, an Italian medium-size municipality, half of whom are women and half are men.

The purpose of this thesis is to contribute to the achievement of the Development Goals proposed by the European Union and to make Italian and European cities more sustainable in terms of waste management and recycling.

Keywords: gamification, recycling, sustainable thinking, education, waste management, app, Pistoia

INDEX

ABSTRACT	III
LIST OF ABBREVIATIONS	VI
LIST OF FIGURES	VII
LIST OF TABLES	VIII
1. INTRODUCTION	1
<i>1.1) RESEARCH BACKGROUND AND SCHOLARLY DISCUSSION</i>	<i>1</i>
<i>1.2) RESEARCH GAPS, RESEARCH AIM AND EXPECTED CONTRIBUTION (ONLY ACADEMIC CONTRIBUTION)</i>	<i>2</i>
<i>1.3) THEORY AND OVERVIEW OF THE UPCOMING CHAPTERS</i>	<i>3</i>
2. THEORETICAL FRAMING	3
<i>2.1) THE IMPORTANCE OF RECYCLING</i>	<i>3</i>
<i>2.2) GAMIFICATION AS A TOOL TO IMPROVE THE KNOWLEDGE OF SUSTAINABLE ACTIONS</i>	<i>4</i>
<i>2.2.1) OVERVIEW ABOUT GAMIFICATION IN GENERAL</i>	<i>4</i>
<i>2.2.2) GAMIFICATION OF LEARNING</i>	<i>5</i>
<i>2.2.3) THE THEORY OF GAMIFIED LEARNING (LANDERS, 2015)</i>	<i>6</i>
<i>2.2.4) ALTERNATIVE THEORIES TO GAMIFIED LEARNING THEORY BY LANDERS (2015)</i>	<i>7</i>
<i>2.3) MOBILE APPS: LINKING SUSTAINABILITY, LEARNING AND GAMIFICATION</i>	<i>8</i>
<i>2.3.1) GENERAL OVERVIEW ABOUT MOBILE APPLICATIONS AND SUSTAINABILITY</i>	<i>8</i>
<i>2.3.2) JUSTIFICATION FOR THE CHOICE OF THE APP GREENAPES</i>	<i>9</i>
<i>2.4) THEORIES USED IN THE PRE-TESTING PHASE</i>	<i>10</i>
<i>2.4.1) THEORY OF REASONED ACTION AND THE THEORY OF PLANNED BEHAVIOR</i>	<i>10</i>
<i>2.4.2) RECENT DEVELOPMENTS OF THE THEORY OF PLANNED BEHAVIOR AND THE REASONED ACTION APPROACH</i>	<i>12</i>
<i>2.4.3) THE USE OF THE THEORY OF PLANNED BEHAVIOR INSIDE THE RESEARCH</i>	<i>13</i>
3. LITERATURE REVIEW	14
4. RESEARCH MODEL AND HYPOTHESES (OR RESEARCH PROPOSITIONS)	19
<i>4.1) RESEARCH METHODS HYPOTHESIS</i>	<i>19</i>
<i>4.2) EXPERIMENTAL HYPOTHESIS</i>	<i>23</i>
5. METHODOLOGY	24
<i>5.1) RESEARCH DESIGN</i>	<i>24</i>
<i>5.2) APPLICATION DOMAIN</i>	<i>25</i>
<i>5.3) SAMPLE</i>	<i>25</i>
<i>5.4) DATA COLLECTION PROCEDURES</i>	<i>26</i>
<i>5.5) DATA ANALYSIS</i>	<i>26</i>

6. EXPECTED CONTRIBUTIONS	27
6.1) SCHOLARLY CONTRIBUTIONS	27
6.2) IMPLICATIONS FOR BUSINESS AND SOCIETY	28
6.2.1) CONTRIBUTIONS TO THE SOCIETY	28
6.2.2) CONTRIBUTIONS FOR THE ITALIAN SOCIETY, WITH PARTICULAR REFERENCE TO THE CITY OF PISTOIA	29
7. CHAPTERS OVERVIEW	31
8. WORK PLAN	31
8.1) WORKPLAN OF THE FOLLOWING WEEKS BEFORE THE SUBMISSION OF THE MASTER THESIS ...	31
8.2) WORKPLAN OF THE EXPERIMENT	32
9. REFERENCES	1

List of Abbreviations

App → Mobile Application

CO₂ → Carbon Dioxide

CONAI → Consorzio nazionale Imballaggi, Italian National Packaging Consortium

UE → European Union

UN → United Nations

Kt → Kiloton

Kg → Kilograms

TWh → Terawatt hour

List of Figures

Figure 1 Theory of Reasoned Action Scheme	11
Figure 2 Theory of Planned Behavior Scheme	12
Figure 3 Research method scheme	23
Figure 4 Map of free-waste municipalities in Italy.....	30

List of Tables

Table 1 Literature Review	14
Table 2 Thesis chapters overview	31
Table 3 Work plan of the following weeks.....	31
Table 4 Work plan of the experiment	32

1. Introduction

1.1) Research background and scholarly discussion

This thesis aims to test if gamification can be applied with positive results also to sustainability field and in particular to waste management. In fact, the growing number of garbage that is produced in Europe and, in general, in the world is currently one of the most critical problems to be addressed (Audroné & Genovaité, 2019). Waste separation is one of the first phases of the process of waste management and it is fundamental for the success of waste collection (Sukholthaman & Sharp, 2016).

Pre-sorting of wastes at home is essential for various reasons. The first one is the fact that in the case that waste separation is not done correctly there could be contamination and this lead to the reduction of the value of the parts that could be recycled (Low et al., 2016). Secondly, using the waste as a resource is fundamental to contrast economic growth's adverse effects (Ghisellinia et al., 2016), such as carbon emissions and energy consumption. The combination of growth in consumption and increasing waste generation has generated high costs in waste management (Grazhdani, 2016). The idea of recycling has been embraced to try to overcome this problem (Grazhdani, 2016). Third, the quality of recycled materials is becoming increasingly high (Jesson et al., 2014). If the recycling behavior is not correct the cargo is refused and this has critical financial consequences (Jesson et al., 2014). For all these reasons, not only the number of how many people participating in waste separation is important but also the quality (Thomas, 2001).

It is common for people to make sorting errors when they separate waste (Ordonez et al., 2015). The goal of this thesis is strictly related to waste separation and sorting errors. The experiment run across these pages has the purpose of testing if gamification can help people to learn how to do a correct sorting and reduce their mistakes. To do this, people will use the app GreenApes that should help them to improve their recycling habits. Encouraging recycling and sustainable daily activities pushes people to be more conscious about environmental problems and pay more attention on it, since waste separation depends crucially on households' behavior (Chia-Lin et al., 2021).

1.2) Research gaps, research aim and expected contribution (only academic contribution)

Many research gaps in the field of gamification and learning are still unexplored (Martí-Parreno, 2016). The same happens also to the application of gamification for sustainability purposes (Fernandez Galeote et al., 2021).

Behavioral intentions about recycling and environmentally friendly habits using an online platform that involves gamification has already been investigated by other research (Chia-Lin et al., 2021). The study (Chia-Lin et al., 2021) aimed to understand the effectiveness and efficiency of this method for users and the hedonic value in a gamification context in their behavioral intentions. Regardless, this study (Chia-Lin et al., 2021) examines only users' behavioral intentions and it does not investigate gamification's impact on users' actual behaviors. For this reason, this thesis tries to fill this research gap investigating the impact of gamification on users' actual behaviors when people do separate collection.

The aim is to understand whether the correct placement of waste in the various garbage cans improves after using the app GreenApes. Another way of saying that would be investigating whether the app's content has educated users.

This thesis aims to answer the research question of whether an app that uses gamification to educate people about waste separation and sustainable habits can effectively improve actual users' behavior. An experiment will be conducted to answer this question. There will be three groups: the first group will do a pre-test, then will use the app for four days, and they will do a post-test; the second group will do a pre-test, then will read the same information that the app proposes to users printed on paper, without any gamification element; the third group will be the control group, doing the pre-test and the post-test but without any treatment.

The experiment will be conducted in the city of Pistoia, in Italy. Italy is the third European country in Europe for municipal waste sent for recycling in the EU (data Eurostat, 2021). Tuscany is below the Italian average for separate collection of municipal waste and Pistoia does not appear among the provinces with a separate collection rate greater than or equal to 65% (ISPRA, Rapporto Rifiuti Urbani, 2020). For this reason, Pistoia results as a town that well fits the purpose of the experiment since present wide room for improvement in terms of separate collection.

1.3) Theory and overview of the upcoming chapters

The theoretical framework investigates gamification applicated for an educational purpose and will be presented in detail n Chapter 2. The theories that support the topic presented in this research are multiple (Sailer et al., 2019). The most important is the Theory of Gamified Learning, which studies how game elements can influence learning (Landers, 2015). In addition, two other theories will be used in this study. The Theory of Reasoned Action (Fishbein & Ajzen, 1980) and the Theory of Planned Behavior (Ajzen, 1991) that will be used to build the survey distributed to the sample. In Chapter 3, all the literature used for this exposé will be reviewed. In Chapter 4, the research model will be explained in detail. In Chapter 5, will be illustrated the methodology for conducting the experiment. In Chapter 6, the expected contribution for scholars and the society will be explained. In Chapter 7, will be given an overview of the chapters of the thesis and in Chapter 8 will be given a workplan for the future months.

2. Theoretical Framing

2.1) The importance of recycling

The population is growing worldide and so is the degree of urbanization. Consequently, the production of solid wastes is also increasing in both developed and undeveloped countries (Kassim, 2012).

Almost eight billion people in the world generate 2.01 billion tons of urban solid waste every year (World bank data, 2020). 33% of them are not managed sustainably (World Bank data, 2020). In 2020, the world generated approximately 2.24 billion tons of solid waste, impacting of 0.79 kilograms per person per day (World bank data, 2020). By 2050, it is estimated that the total production of wastes will rise to 3.88 billion tons annually (World Bank Data, 2022). The accumulation of piles of solid wastes risks leading to considerable harm to human health in addition to environmental pollution (Kassim, 2012). Groundwater pollution resulting from the mismanagement of solid waste, can cause bacterial, viral, and parasitic diseases (Haseena et al., 2017) and environmental degradation can lead to air pollution, acid rain, soil degradation and loss of biodiversity (Gwangdi et al., 2016).

For all these reasons, as well as trying to minimize the production of waste, it is necessary to promote waste reuse and recycling and to encourage sustainable waste disposal and treatment (Kassim, 2012). Recycling entails the transformation of a waste object or material into new

items (Rotter, 2009). The process of recycling involves four different stages from the waste to the final product (Kassim, 2012). The first stage is the collection of the material. Then wastes are sorted according to their material. Later wastes are processed and finally they are resumed and transformed into the new product (Kassim, 2012).

It is important that households make waste separation at the beginning stage of the life of the waste because otherwise it is much more complicated and costly separate wastes at a later stage (Zhuang et al., 2008). If families do not separate wastes in the correct way, the various parts become contaminated, which reduces the value of the pieces that could be recycled (Low et al., 2016). The quality of the items that can be recycled must respect high standards otherwise the cargo can be refused (Jesson et al., 2014). If the wastes are not correctly differentiated at the beginning, all unsorted wastes will go to landfills or incinerators (Stoeva & Alriksson, 2017), which, in addition to not being able to accommodate an excessive load of waste, risk polluting groundwater and air quality (Kassim, 2012). Consequently, not only it is important to convince citizens to sort their waste, but they must also be aware of the importance of doing it accurately, because the quality of the recycle stream is important (Thomas, 2001). For all the reasons listed in this paragraph, it is in the primary interest of all of society and the governments improving the quantity of the material recycled and recycling attitudes, also with a specific legislation (Stoeva & Alriksson, 2017; Bernstad, 2014) and enhancing sorting equipment in the houses and making waste sorting a social norm (Bernstad, 2014).

2.2) Gamification as a tool to improve the knowledge of sustainable actions

2.2.1) Overview about gamification in general

Gamification is defined as “the use of video game elements in non-gaming systems to improve user experience and user engagement” (Deterding et al. 2011). It involves the application of specific game elements to non-game environments (Sailer et al., 2017). These elements can be badges, points, levels, storyline (Nah, 2014), but also other tools that are useful to push people to engage in particular behaviors (Landers, 2015) and to increase user engagement (Nah et al, 2014). The game is not designed for recreational purpose only, but game elements are added to a situation that already existed in order to improve his efficacy (Landers, 2015).

The fields where gamification can be applied are many and diverse (Landers, 2015), such as banking (Chauan et al., 2021), fitness (Lister et al., 2021), health (Johnson et al., 2016) and

education (Nah et al., 2014) and certainty also sustainability (Whittaker et al., 2021; Negrusa et al., 2015; Douglas & Brauer, 2021).

Ideally, according to Benthem (2002), “Any logical task can be ‘gamified’”, hence gamification can have infinite fields of application. Since the purpose of this thesis is to test if gamification elements can motivate people to do a better waste separation, the focus is to analyze and understand if the app GreenApes can effectively educate people to separate solid wastes into the different garbage cans in the correct way to allow a better recycling process. For this reason, in the next paragraphs will be reviewed the Gamification of Learning, in particular the Theory of Gamified Learning (Landers, 2015) and other theories about gamification and education.

2.2.2) Gamification of Learning

Gamified Learning and Game-based learning are often used as synonyms but, despite they have in common some overlapping literature, it is a mistake not considering them as two separate entities (Sailer et al., 2019). Game-based learning refers to a game in its own right that does not have the final goal to entertain but that gives the opportunity to learn something (Deterding et al., 2011), while gamification is based on adding game elements in an already existing learning process (Landers et al., 2018). According to a study made by Seaborn and Fels, education results as one of the fields where gamification is mostly applied, equal to the 26% of all studies (Seaborn et al., 2015).

Some researchers have tried to explain the relationship between gamification and learning through some theories (Sailer, 2019). Notwithstanding this, the large majority of applied gamification, equals to the 87% of the total, is not explained by theoretical foundations (Seaborn et al., 2015). Nevertheless, have been counted one hundred and eighteen theories about gamification, serious games and game-based learning (Krath et al., 2021).

These theories can be divided into three groups, according to the outcome of gamification. Outcomes can be classified as behavioral outcomes, cognitive-learning outcomes, and effective or motivational outcomes (Krath et al., 2021).

The classification “behavioral outcomes” refers to all the application contexts where gamification generates positives behavioral outcomes (Krath et al., 2021), for example to a learner’s performance on a particular assignment, or to technical skills, or competences (Garris

et al. 2002). Especially regarding this last point, the theories focused on behavioral outcomes are particularly suited for the purpose discussed in this thesis.

The cognitive-learning outcome pertain to all the situations where the individuals learn something cognitively (Krath et al., 2021). The cognitive learning is defined as the “mentalist process of learning” (Fox, 1997), intended as “set of processes and mechanisms by which an individual understands the world through reasoning and problem-solving” (Krath et al., 2021) and differs, for example, from situated learning theory that represents “learning as social relation” (Fox, 1997), and from latent learning which is the “subconscious retention of information without reinforcement or motivation” (Wade et al., 1997). The outputs generated from the cognitive learning can be gains in critical or creative thinking (Qian & Clark, 2016; Behnamnia et al., 2020) or improvements in gaining information and comprehending the subject matter (Connolly et al., 2012; Vlachopoulos & Makri, 2017).

Effective or motivational outcomes are all those driven by motivation (Krath et al., 2021). Motivation is defined as “a force acting within the agent that create a disposition to engage in goal-directed behavior” (Wasserman & Wasserman, 2020) and can result in positive cognitive results like increased learning and success (Keller, 2008). Intrinsic motivation, inclinations, preferences, attitudes, engagement, as well as emotions of self-assurance and efficacy, are all examples of what is meant by motivational learning outcomes (Wouters, 2013). The theory that has been chosen as the cornerstone of this thesis is the Theory of gamified Learning (Landers, 2015). The Theory of gamified Learning belongs, among the groups of theories described, to those with behavioral output (Zaric et al., 2020).

2.2.3) *The theory of Gamified Learning (Landers, 2015)*

The Theory of Gamified Learning explores the relationship between gamification and education and examines how game elements can influence the learning process. The purpose of gamification is altering an intermediary learner behavior or learner attitude. This can be made by one of these two processes: the *mediating process* and the *moderating process*. That behavior or attitude must then itself cause changes in learning directly (as a mediating process), or it must strengthen the effectiveness of existing instructional content (as a moderating process).

The *mediation process* happens when the game designer wants to encourage a certain behavior that will improve learning outcomes by itself. Many potential behaviors or attitudes could be targeted. Nevertheless, for gamification to be effective, the behavior or attitude being targeted

by gamification must also have an impact on learning. Examples of these behaviors could be task-related skills, self-management, motivation (Hattie et al., 1996). By doing that, it is assumed that the characteristics of the game can sway alterations in users' behaviors or attitudes. This obviously does not happen regardless, but the game features should be adapted to the user's ability to improve the effectiveness of gamification (Wilson & al., 2019).

The *moderating process* consists in designing instructions to encourage a behavior or attitude that will increase learning outcomes by making an improvement to pre-existing instruction. It has been proved that an upgrading in the quality of instructions can affect learning outcome (Campbell & Kuncel, 2002). The aim of gamification is to enhance the instructions not to substitute them (Landers, 2015).

The two processes can also be present together in any example of effective gamified learning. The experiment conducted in this thesis utilizes both the mediation process and the moderating process explained by Landers in the Theory of Gamified Learning (2015). The app GreenApes uses gamification tools such as missions, challenges, and prizes to incentivize motivation for doing a correct waste separation and improve the skills of users in differentiate the various types of wastes. Furthermore, the instructions that explain how separate wastes will be gamified through the mobile application. The gamified environment will be compared with a not gamified contests to see if the gamification of learning how to separate wastes has some desirable outcomes.

Gamified Learning Theory (Landers, 2015) was theorized seven years ago and therefore can be considered not recent. However, it is one of the most recent among the gamification theories. In fact, all the articles written after the Theory of Gamified Learning were either critiques of it or empirical cases where the theory was applied.

2.2.4) Alternative theories to Gamified Learning Theory by Landers (2015)

As mentioned previously in Chapter 2.1, theories about gamification of learning can be classified according to the outcome of gamification (Krath et al., 2021). Outcomes can be classified as behavioral outcomes, effective or motivational outcomes, and cognitive-learning outcomes (Krath et al., 2021). The Theory of Gamified Learning is part of the behavioral outcomes cluster (Zaric et al., 2020).

An example of motivational theory is the Self-Determination theory (Deci and Ryan, 1985). Self-determination theory was introduced for the first time by the two psychologists Edward Deci and Richard Ryan in 1985 in the book *Self-Determination and Intrinsic Motivation in Human Behavior*, but it has been discussed many times over the years (Ryan & Deci, 2012; Ryan & Deci, 2020). The theory states that there are two types of motivation: extrinsic and intrinsic motivation. People in general focus on extrinsic motivation, i.e., on external factors that can motivate them as money, rewards, prizes etc. On the other hand, the Self-determination Theory focus on intrinsic motivation, including factors such as independence, knowledge and sense of belonging. Specifically, the theory introduces three concepts that lead to intrinsic motivation: *autonomy*, *competence* and *relatedness* (Ryan & Deci, 2020). Effort and control in one's actions is a key component of autonomy. Competence is about the sensation of having the skills for succeed the task. Finally, relatedness is connected with the sense of belonging and connection with other people. This theory has been utilized many times as support for investigations about gamification. However, it has not been utilized in this research because the app GreenApes uses more extrinsic motivation than intrinsic motivation, and for this reason, the Gamified Learning Theory seemed more appropriate for our purposes.

Cognitive theories are those who study “mental processes such as attention, language use, memory, perception, problem solving, creativity, and reasoning” (American Psychological Association, 2013). An example of cognitive theory is the Cognitive Learning Theory that analyzes how students “receive, process and retain knowledge” (Illeris & Knud, 2004). Since this thesis do not focus about students' behavior, the cognitive theories have not been taken into consideration. The cognitive process is also enacted in this experiment, but the output that want to be achieved concerns a behavior not a cognitive process.

2.3) Mobile Apps: linking sustainability, learning and gamification

2.3.1) General overview about Mobile Applications and Sustainability

According to the definition of Mobile Applications (in short *Apps*) given by Islam and Mazumder (2010), “Mobile applications consist of software/set of programs that runs on a mobile device and perform certain tasks for the user”. Mobile applications can be already installed on the phone or, in the most cases, easily free downloadable from internet (Islam & Mazumder, 2010).

Apps are an effective method of promoting a certain type of behavior and they have a great power in engaging the consumer (Stocchi et al., 2022). Their potential lies in the fact that by transforming communication into interactive experiences for users they can provoke cognitive, motivational, and behavioral reactions (Kim & Yu, 2016). For this reason, it has been chosen an app as tools to test if gamification can improve learning about sustainability. There are many examples of apps about sustainability, but they can be grouped into four sub-groups that are sustainability education, energy reduction, transportation/air quality, and waste management/water conservation (Douglas & Brauer, 2021).

The first group collects all those apps that try to teach people about sustainability in general, trying to push pro-sustainability actions (Douglas & Brauer, 2021; Chappin et al., 2017). Examples of this type of apps can be AWorld Sustainability App, an app that tries to encourage sustainable actions, and GreenApes, the app chosen to conduct this experiment and that has the goal to reward those who care about the planet.

The second group gathers the app about energy reduction, such as Energy Rating Calculator App, Wattcost and Powerpal. They have the aim to make the users conscious about their energy consumption and to teach them how to reduce it.

The third group includes the apps about transportation, such as Ciclogreen, that encourage sustainable mobility in daily travel, and air quality, like AirCare, AirVisual, Breezometer, that help people to understand if the air quality is good. The last group includes all those apps on waste management or water conservation. Examples of apps about wastes are Junker, that suggests to people in which bin the waste should be left, or Zero Waste App, that suggest zero packaging shops and bars, free tap water etc. An example of apps about water conservation is E-Water Foodprint that estimates the water consumption based on inputs such as showers, dishwashing, and the foods eaten.

2.3.2) Justification for the choice of the App GreenApes

The app GreenApes was chosen firstly because it uses gamification to engage users and then because it is intuitive and easy to use, considering that participants in the experiment will have to download and use it on their own. Other apps were also initially considered for the experiment, but they were excluded for the reasons explained in the next lines. An experiment similar to the one described in this thesis was conducted in some major European cities to study the habits of tourists (Aguiar-Castillo et al., 2019). The app used was WasteApp. This app could also be useful for conducting the experiment in this research, but it is not accessible

anymore or, at least, it is necessary to have a permit to gain access. Another gamified tool used in another waste management experiment about waste management is RecycleBank, a New York website that rewards people for taking green actions with discounts and other prizes. Despite this, the app was not suitable for our case since it refers to the U.S. market. GreenApes instead has been developed since 2012 in Florence. Pistoia and Florence are only 40 km away and fit the regulations about recycling of Pistoia. Also, for this reason, the app GreenApes is the app that better fits this research's aim.

2.4) Theories used in the pre-testing phase

2.4.1) Theory of Reasoned Action and the Theory of Planned Behavior

The Theory of Reasoned Action has been developed by Martin Fishbein and Icek Ajzen in 1967 and tries to explain the relationship between attitudes and human action. The main goal of the Theory of Reasoned Action is to comprehend a person's voluntary behavior by investigating the underlying fundamental motivation to take a certain action (Doswell et al., 2011). A person's action is influenced by his intention to perform the behavior, which is dependent on their attitude toward the behavior and subjective norms (Fishbein & Ajzen, 1975). In other words, the best indicator of whether someone will engage in action is believed to be their intention to do so and attitudes and subjective norms, in turn, predict intentions (LaCaille, 2013). Attitude has the meaning of personal beliefs about the consequences of that action and the subjective norms are the individual judgment about what others think that should be done (Hox et al., 1995).

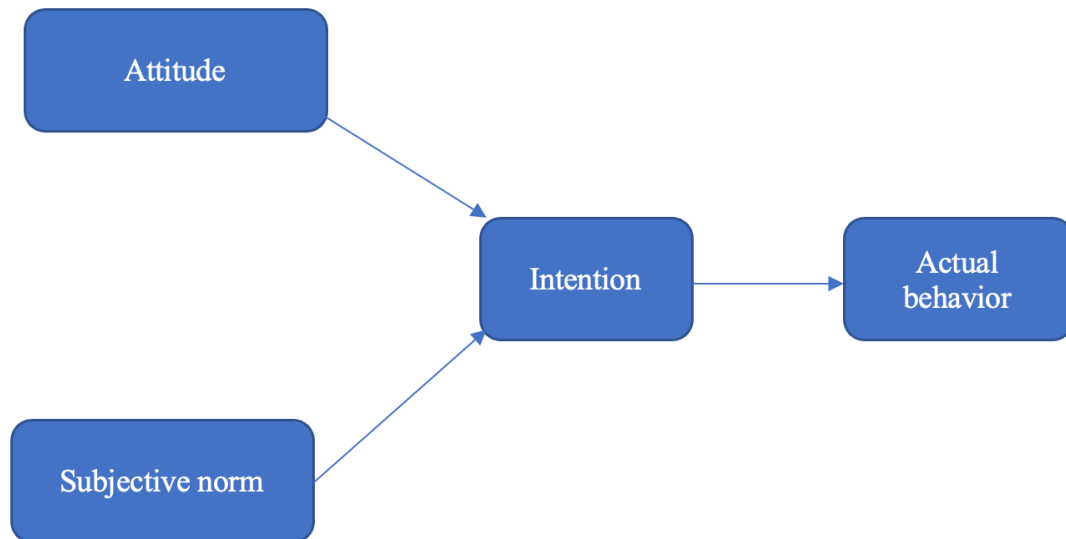


Figure 1 Theory of Reasoned Action Scheme

The Theory of Planned Behavior was developed by Icek Ajzen in 1985 and it is an extended version of the Theory of Reasoned Action. What makes this theory an evolution of the Theory of Reasoned Action is the addition of the perceived behavioral control as influencer of the motivation (Ajzen, 1991). Essentially, the Theory of Planned Behavior implies that individuals are more inclined to engage in particular behaviors when they believe they can do it successfully (Ajzen, 1991).

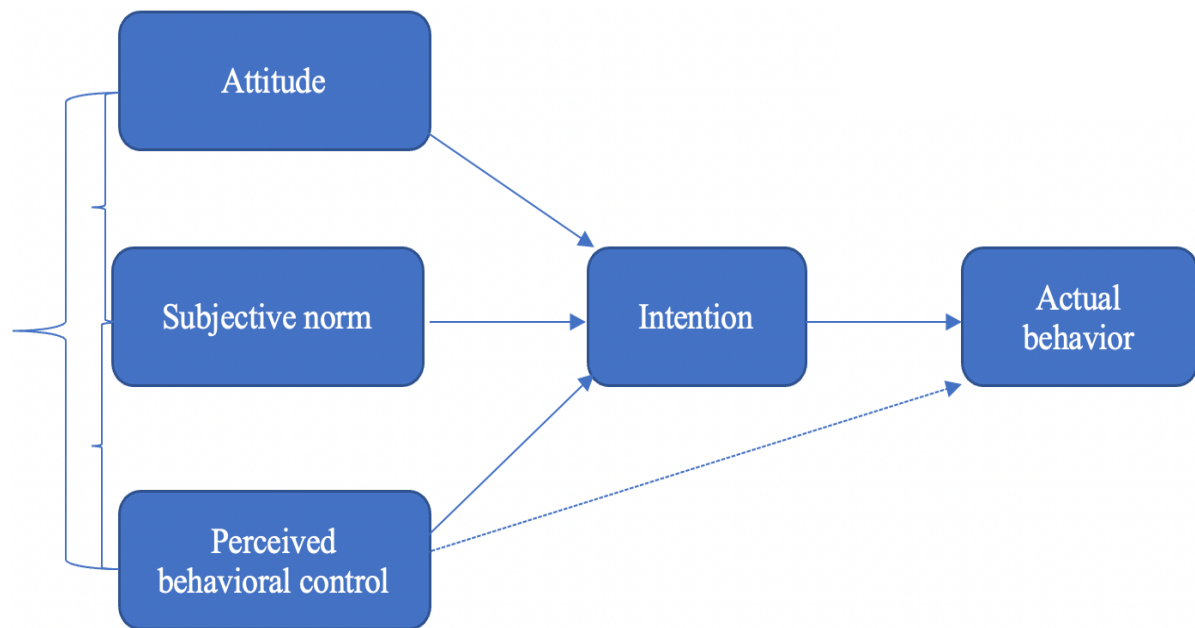


Figure 2 Theory of Planned Behavior Scheme

2.4.2) Recent developments of the Theory of planned Behavior and the Reasoned Action Approach

The Theory of Planned Behavior has been developed more than thirty years ago, but in spite of this this theory continue to provide an important contribution to behavioral sciences (Bosnjak, 2020). The basic structure of the theory remains the same, but it has been clarified and modified during the years, including by Ajzen himself (Conner, & Armitage, 1998; Ajzen & Fishbein, 2000; Ajzen, 2020).

Studies using nowadays the Theory of Planned Behavior as theoretical foundation has added additional variables to the model to increase the degree of precision of prediction (Conner & Armitage, 1998; Peng et al., 2014). Other research has defined more specifically the three key variables attitude, subjective norm and perceived behavioral control (Wang & Zheng., 2020). Intention remains the factor that affects the actualization of specific goals and behaviors (Lihua, 2022).

Recent developments of the theory have focused more specifically on the transition from intention to execution (Lihua, 2022). People has difficulties in translating intentions into actions. A possible solution could be associate in advance possible solutions to every critical situation, in order to anticipate possible signs of a lack of motivation (Gollwitzer, 1999). Another study focuses on social capital and effective behavior (Tatarko & Schmidt, 2016). The

social capital has the function to influence the perceived behavioral control and consequently to be a facilitator for the actual behavior (Tatarko & Schmidt, 2016).

In any case, there are many papers written in recent years that still use and test the validity of the Theory of Planned Behavior, a sign that the theory is still valid (Dewberry & Jackson, 2018; Si et al., 2019; Holdsworth et al., 2020).

The latest version of the Theory of Reasoned Action (1967) and the Theory of Planned Behavior (1985) is the Reasoned Action Approach, developed by Fishbein and Ajzen at the beginning of the century (Fishbein & Ajzen, 2010). According to this new version of the theory, some background factors such as individual, social and informational background influences the behavioral beliefs, the normative beliefs and the control beliefs. These, in turn, influences attitude towards behavior, perceived norm and perceived behavioral control. As usual, these three variables predict intention that predict the actual behavior. A new addition of this theory is the presence of the actual control that determines if the intention will really lead to the behavior. The actual control is represented by the skills of the person and by environmental factors. The predictors of the intention can take on different weights (Fishbein & Ajzen, 2010). This theory tries to overcome the limitations of the two previous theories. It attempts to explain a behavior considering potential determinants, trying to give a uniform theoretical framework that can possibly be applied to every kind of behavior (Fishbein & Ajzen, 2010).

2.4.3) The use of the Theory of Planned Behavior inside the research

These three theories have been reviewed in this chapter because they will be used in this thesis to construct the questionnaire used in the pre-test phase. The main goal of this survey is to identify some of the key-drivers that will support households in the change towards a more efficient waste separation. The Theory of Reasoned Action (Ajzen, 1967) and the Theory of Planned Behavior (Ajzen, 1985), that is an evolution of the Theory of Reasoned Action, describes the mental underpinnings of behavior. In particular, the survey will investigate whether attitude, subjective norm and perceived behavioral control impacted on the purpose for households to do a better pre-sorting of wastes and whether intention predicted households' behavior. According to the Theory of Planned Behavior, the possibility that a behavior will be executed, in our case an improvement in waste sorting, increases with the strength of the individual's intention to engage in it. Intention is determined by the feelings that people perceive on the importance of waste separation (attitude), by the importance that people around

them give to waste separation (subjective norm) and finally by the confidence that they have about the fact that they will succeed in the task or not (perceived behavioral control).

The Theory a Planned Behavior has been applied many times to sustainability-related topic, such as water conservation (Trumbo & O’Keefe, 2001), recycling (Boldero, 1995; Taylor & Todd, 1995), reducing energy consumption (Sparks et al., 2014) and sustainable food choices (Han & Hansen, 2012; Graham-Rowe & Sparks 2015). Despite this, since the Theory of Planned Behavior is a rather old theory, other variables can be added to the model to enhance his capacity to predict behaviors (Ajzan, 2020). The variables that have been added in the questionnaire are user engagement in recycling behaviors, environmental concerns, and pro-environmental self-identity (Hsu, 2022).

3. Literature Review

The papers reviewed in this exposé have been mainly found with Publish or Perish on Google Scholar. Other papers have been found on other online databases such as ResearchGate, Elsevier, ScienceDirect and JSTOR. Once the key papers for this dissertation were identified, additional useful papers were discovered by reading the bibliography in or at the end of their text.

The research queries used to find the papers have been multiple. Some of the most used keywords are “Gamification”, “Sustainability”, “Recycling”, “App”, “Education”, “Gamified Learning Theory”, “Waste Management”. Usually in the research two or three of these keywords were linked in the query by the word AND. Exclusion criteria were not used in this research.

The final number of paper analyzed from the beginning of the writing of this thesis is equal to approximately 150 papers. The papers actually used in the writing of this exposé are 93.

The following table contains the 10 most important articles for this thesis, together with a brief description of their content.

Table 1 Literature Review

	Reference	Content

1	Hsu, C., Chen, M. (2021), Advocating recycling and encouraging environmentally friendly habits through gamification: An Empirical investigation. <i>Technology in Society</i> , 66, DOI: 10.1016/j.techsoc.2021.101621	This paper is the one from which it has been taken the research gap on which is based all this thesis. Since resource recycling strictly depends on people behavior, this paper studies if gamification can be a useful tool to encourage sustainable habits, analyzing the behavior of 457 participants that use the website Recyclebank.
2	Landers, R. (2015). Developing a Theory of Gamified Learning. <i>Simulation & Gaming</i> . 10.1177/1046878114563660.	In this paper, the Gamified Learning Theory is defined and discussed. This is a psychological theory where gamification is considered as the application of game features outside of the context of a game. The purpose of gamification is to influence behaviors or attitudes towards learning through a moderating process and/or a mediating process.
3	Krath, J., Schürmann, L., von Korflesch, H. F. O. (2021), Revealing the theoretical basis of gamification: A systematic review and analysis of theory in research on gamification, serious games and game-based learning, <i>Computers in Human Behavior</i> , 125, https://doi.org/10.1016/j.chb.2021.106963 .	A systematic meta-review of theoretical foundations of gamification is performed in this article. The review shows 118 theories used to explain gamification. These theories are grouped according to the outcome (behavioral, cognitive or motivational) and interrelated to each other.

4	<p>Douglas, B. D., Brauer M. (2021), Gamification to prevent climate change: a review of games and apps for sustainability. <i>Current Opinion in Psychology.</i>, 42, 89-94. doi: 10.1016/j.copsyc.2021.04.008</p>	<p>Gamification is useful to incentivize pro-environmental behaviors. There are many fields where gamification have been implemented such as boardgames, team competitions, electronic games, and smartphone apps to improve sustainability education. The aims can be grouped into four categories: energy reduction, more sustainable transportation/air quality, improvements in waste management, and water conservation. This article reviews the games and apps that have been evaluated in empirical research in the last five years and provides a list of apps and games that have yet to be tested. Gamification results to be an efficient system for preventing climate change.</p>
5	<p>Hsu, C. (2022), Applying cognitive evaluation theory to analyze the impact of gamification mechanics on user engagement in resource recycling, <i>Information & Management</i>, 59, Issue 2, https://doi.org/10.1016/j.im.2022.103602.</p>	<p>This study investigates how gamification mechanics on a website affect users' intrinsic incentives, needs satisfaction, and participation in resource recycling. It also investigates how environmental issues affect the connections between user engagement and intrinsic motives. According to research, gamification encourages intrinsic motivation and is likely to satisfy psychological needs thanks to characteristics like self-expression, point rewards, and other incentives.</p>

6	<p>Ajzen, I. (1991), The theory of planned behavior, <i>Organizational Behavior and Human Decision Processes</i>, 50, 2, 179-211, https://doi.org/10.1016/0749-5978(91)90020-T</p>	<p>This research is an extension of the other two papers about the Theory of Planned Behavior by Ajzen (Ajzen, 1985, Ajzen, 1987). Some unresolved issues are discussed. Empirical evidence is also presented. The theory states that attitudes toward the behavior, subjective norms, and perceived behavioral predict the intention to perform the behavior; substantial variation in actual behavior is accounted for both attitudes and subjective norms as well as perceptions of behavioral control. The results show that expectancy-value formulations are only partially successful in managing these relations, but it is demonstrated that the theory can predict behavior successfully.</p>
7	<p>Graham-Rowe, E., Jessop, D. C. & Sparks, P. (2015) "Predicting household food waste reduction using an extended theory of planned behaviour," <i>Resources, Conservation & Recycling, Elsevier</i>, vol. 101©, pages 194-202.</p>	<p>This study tests the efficacy of applying an extended Theory of Planned Behaviour model to an investigation about the reduction of family food waste. 279 participants completed a questionnaire designed to measure intention, attitude, subjective norm, perceived behavioral control, self-identity, anticipated regret, moral norm and descriptive norm. Results demonstrate that the Theory of Planned Behavior can predict motivation and behaviors, in the</p>

		context fruit and vegetable waste reduction for families.
8	Aguiar-Castillo, L.; Clavijo-Rodriguez, A.; De Saa-Perez, P.; Perez-Jimenez, R. (2019), Gamification as An Approach to Promote Tourist Recycling Behavior. <i>Sustainability</i> , 11, 2201. https://doi.org/10.3390/su11082201	UrbanWaste is a project developed by the European Union that try to find a solution for urban wastes. The article is about an experiment made in several European cities thanks to the app WasteApp. WasteApp has been used to encourage the recycling behavior of tourists and to test if it can be a good method for pushing recycling and improve the reputation of the city. According to this study, the results show that a gamified application can contribute to the recycling behavior of tourists and improve the image of the destination that adopts it, provided that the satisfaction of the user about the app and his usability. will influence the recycling behavior.
9	Cechella, F., Abbad, G., Wagner, R. (2021), Leveraging learning with gamification: An experimental case study with bank managers, <i>Computers in Human Behavior Reports</i> , 3, https://doi.org/10.1016/j.chbr.2020.100044 .	Despite this paper relates to a different field than sustainability, because it tests the impact of gamification on bank managers, it has been useful to develop the methodology and the hypothesis. This research investigates the effects of gamification on cognitive learning. Instructions are gamified. The design of the experiments involves three groups: a group with gamified instructions, a group with no gamified instructions

		and a control group. The skills of the groups are assessed before and after the treatment. Results show that the effects on learning of both groups that used or not used gamification are similar, even if the use of gamification allowed people to learn in less time.
10	Kassim, S. M. (2012). The importance of recycling in solid waste management. <i>Macromolecular Symposia</i> , 320, 1, 43-50. DOI: 10.1002/masy.201251005	This paper focuses on the necessity of a proper Solid waste Management, and especially shows the relevance of recycling processes and the technology required. As well as clearly explaining why it is important to recycle and what are the steps in the recycling process, the article also explain the needs of the market for the recycling process and a general overview about the reasons

4. Research Model and Hypotheses (or Research Propositions)

The chapter “Research model and hypothesis” of this thesis is divided into two sections because the two sets of hypotheses relate to two research objectives. The first group refers to the behavior that the people composing the sample should show during the various phases of the experiment according to the Theory of Planned Behavior. The second group refers to the assumption that should predict the different degrees of learning in the three different groups.

4.1) Research methods hypothesis

The Theory of Planned Behavior states that attitudes toward the behavior, subjective norms, and perceived behavioral control can be good predictor of the intention to execute the behavior and, consequently, good predictors of the actual behavior (Ajzen, 1991). Despite the length of time passed since the theory was developed for the first time, much recent research has used it as theoretical foundation (Dewberry & Jackson, 2018; Si et al., 2019; Holdsworth et al., 2020).

The theory was also modified by Ajzen himself to try to overcome the limitations (Ajzen & Fishbein, 2000; Fishbein & Ajzen, 2010; Ajzen, 2020).

The behavior considered in this thesis is the waste separation and the Theory of Planned behavior should predict the level of improvement of each participant from the beginning to the end experiment according to the three variables attitude, subjective norms and perceived behavioral control. The variables engagement in recycling behavior (Tucker, 2001), environmental concern (Eccleston, 2010) and pro-environmental self-identity (Kuswati et al., 2021) have been added to the model to increase the reliability of the prediction (Ajzen, 2020).

Hypothesis will be listed in the next paragraphs:

Hypothesis 1. The intention to improve waste separation behavior will be predicted *attitude*.

The variable *attitude towards behavior* implies that the intention to perform the behavior depends on what people think about a certain behavior (Ajzen & Fishbein, 1975). Positive personal beliefs about the consequences of the behavior will lead to the effectiveness of the proposed behavior while negative personal beliefs will reduce the possibility to succeed (Hox et al., 1995). Attitudes are not innate, but they are gleaned during the course of life, and they are shaped by the experience and the personal background (Ajzen, 1988). Some attitudes are durable over-time, but the experiences can change others had during the course of life (Ajzen, 1988). Cognitive and motivational processes can also wrongly influence attitudes (Ajzen, 1988). More recent theories define the variable attitude as the tendency, that can also be latent, to react to an input with a certain degree of positivity or negativity (Fishbein & Ajzen, 2010).

Hypothesis 2. The intention to improve waste separation behavior will be predicted by the variable *subjective norms*.

The variable *subjective norms* refer to a self-assessed opinion about what others think that should be done (Hox et al., 1995). Subjective norms are influenced by normative beliefs, that are ideas that a person develops based on moral expectations of significant others (Ajzen, 2006). Subjective norm can also be defined as a social pressure for doing or not doing something (Fishbein & Ajzen, 2010).

Hypothesis 3. The intention to improve waste separation behavior will be predicted by the variable *perceived behavioral control*.

The variable *perceived behavioral control* is related to people's perception and ability to control the outcome of their behavior or, in other words, to the probability they can obtain success in performing a given action (Wallston, 2001). The greater is the perceived control, the more likely the individual will be prone to accomplish the behavior considered (Ajzen, 2006). The variable perceived behavioral control is also about to the *actual* control, but it is not limited to that. The crucial part is the *perceived* behavioral control. This refers to the individual's ability to believe that it is possible to succeed in accomplishing a certain behavior (Fishbein & Ajzen, 2010).

The dependent variable *intention* is essential in the Theory of Planned Behavior because it is the factor that determines whether the individual will achieve what they set out to do. The word intention in this sense encompasses all the motivational factors that will lead the individual to perform the given behavior. The intention depends on how much effort individuals will take to succeed in what they planned to do, and it is fundamental to assess how likely is it that the performance will be successfully completed (Ajzen, 1991). The variable intention can be read also as “readiness to perform the behavior” (Fishbein & Ajzen, 2010). The stronger the three variables attitudes, subjective norms and perceived behavioral control will be, the more decisive will be the intention to perform the behavior (Fishbein & Ajzen, 2010).

Hypothesis 4. The intention to improve waste separation behavior will be predicted by the variable *engagement in recycling behaviors*.

The Theory of Planned Behavior is a theory that is always valid and effective, but despite that it is not a recent theory. In fact, it was first developed officially in the 1991, even if the researcher Icek Ajzen was already working on that since many years. For this reason, Dr. Ajzen himself stated that it is possible to add other predictor variables to the original Theory of Planned Behavior (Ajzen, 2020). For this reason, the variables added to the model are engagement in the recycling behavior, environmental concern, and pro-environmental self-identity (Hsu, 2022).

The *engagement in recycling behavior* refers to the willingness of individuals to perform a correct waste separation and maintain it over time (Tucker, 2001).

Hypothesis 5. The intention to improve waste separation behavior will be predicted by the variable *environmental concern*.

The *environmental concern* can be defined as the concern that some people have about the health of planet earth and its marine and terrestrial inhabitants (Eccleston, 2010).

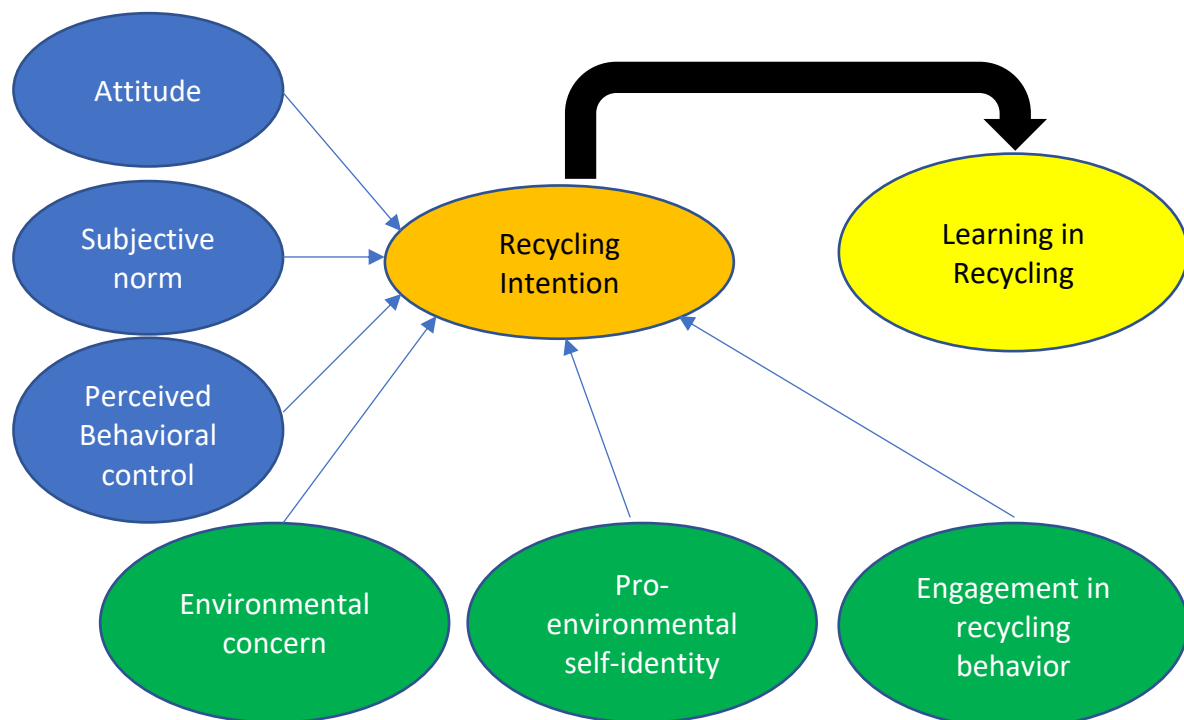
Hypothesis 6. The intention to improve waste separation behavior will be predicted by the variable *pro-environmental self-identity*.

The *pro-environmental self-identity* is the “individual’s tendency to see himself as an individual who has a pro-environment perspective and action” (Kuswati et al., 2021).

All these variables will be investigated into the pre-test survey with specific questions and the purpose of their addition to this model is to test whether the self-consideration about sustainable issues affect the successful completion of the experiment.

Hypothesis 7. *Intention predicts waste separation learning behavior* about recycling.

The intention leads to the actual learning behavior about recycling. The three variables of the Theory of Planned Behavior and the other three variables about sustainability added to improve the capacity of the model are not only supposed to predict the intention but also the actual waste separation learning behavior of the people participating to the experiment. They include all the motivational factors that will lead the individual to perform the given behavior. The strength of intention is directly proportional to the probability with which the behavior will be enacted.



4.2) Experimental hypothesis

The second section of this chapter is about the assumptions related to the treatment of the experiment. In fact, the following hypothesis are about the consequences that the various treatments forming the experiment should have on the people composing the sample. Since the design of the experiment has been based on the model developed by Cechella, Abbada and Wagner (2021) to test the learning outcome of gamification on bank managers, the assumptions are the same of those stated in the cited paper.

Hypothesis 8. Training with gamification increases correct recycling waste separation (experimental group 1).

It is assumed that the part of the sample that uses the gamified app (experimental group 1) will learn new rules about separate collection. This will lead to greater motivation for recycling and also toward greater awareness of avoiding common mistakes in waste separation and consciousness about the correct waste separate collection.

Hypothesis 9. Training without gamification increases correct recycling waste separation (experimental group 2).

This assumption is about the training with brochure and flyers for the group that does not use gamification (experimental group 2). It is assumed that brochure and flyers about recycling and waste separation will improve the knowledge of participants about separate collection and correct recycling habits.

Hypothesis 10. No progress will be made by participants belonging to control group (experimental group 3).

Experimental group 3 do not undergo a treatment between the pre-test and the post-test phase. For this reason, it is assumed that no improvement will be found in the control group during interviews compared with the results obtained in the survey.

Hypothesis 11. The learning outcome of the participants belonging to the group with gamified treatment will have a higher learning outcome than the participants without the gamified treatment.

It is hypothesized that the learning outcome of experimental group 1, made by the people receiving the gamified treatment, will incur in a learning outcome superior to the experimental group 2, made by the people who will receive a not gamified treatment. This hypothesis stems from the fact that gamification, thanks to game elements such as challenges, points and scores, should evoke feelings like fun, competition and desire to keep learning. All these emotions cause better self-motivation and engagement in sustainable activities and waste separation compared to the only cognitive aspects generated by learning with a flyer about recycling. For this reasons, it is assumed that people training with gamification will obtain better results compared to people training without gamification.

5. Methodology

5.1) Research design

This thesis uses a mixed-method experimental study to fill the gap proposed in the paper written by Hsu in 2021, i.e. to investigate users' actual behavior when they start to use the app GreenApes to improve their recycling habits. This choice has been made because the experiment was the only methodology that allowed the researcher to have a clear picture of people recycling skills before and after the treatment.

The experiment run will not be a traditional experiment, but it will have a quasi-experimental design. The quasi-experiment design is similar to the traditional experiment design but there is no random assignment to treatment and control group (Dinardo, 2008). This type of design was necessary because people were not chosen randomly, but on the basis of voluntary participation.

The design of the experiment is the following. There will be three groups participating to the experiment:

Group 1: this group will receive the gamified treatment. In other words, this group will use the gamified app GreenApes for 4 days.

Group 2: this group will receive a not-gamified treatment. In other words, they will have access to the same information of Group 1, but they will not be gamified.

Group 3: this is the control group, so it will not receive any treatment.

The treatment for Group 1 is represented by the use of the app GreenApes for four days. This app helps users doing separate waste collection correctly.

The treatment for Group 2 is made by a printed series of rules that reflects the same information given to group one, but without gamification.

The Group 3 is the control group, and they will not receive any treatment.

The same dependent variables are measured before (pre-test) and after (post-test) the treatment is administered. At the end of the experiment the results of the post-test are compared with the results of the pre-test and the different improvements in each group are compared to each other and analyzed.

The variable considered in our experiment is users' ability to do a proper waste separation. The effect of the intervention is measured by comparing the pre- and post-intervention measurements among the three groups. If the intervention has no effect, the two measurements will be equal.

5.2) Application Domain

The domain of application of the experiment is represented by the population of the Italian town Pistoia. Italy has been chosen as the country where to test the app because Italy is the third country in Europe on the waste recycling front and in the circular economy (data Eurostat, 2021). Every town in Italy has different waste separation rules. For this reason, it has been necessary to choose one city where to implement the experiment. The city chosen has been Pistoia, a municipality in Tuscany, a region in the center of Italy. The central Italy has the worst performance about recycling in 2021, compared with the North and South (Comuni Ricicloni, 2022).

5.3) Sample

The sample is composed by people over 18 years old that lives in Pistoia and that do separate collection. The sample consists of 18 people, six people per group. The characteristics of the sample give a good overview about Italian population in 2022, according to ISTAT statistics.

The youngest person is 19 years old and the oldest one is 80 years old. The sample is made by nine males and nine females, because half of the Italian population is made by women and half by men. People participating in the experiment are chosen on voluntary basis and not in a random way.

5.4) Data collection procedures

Data are collected with an online experiment that uses a mixed-method approach. The phase of the pre-test uses a quantitative approach. Participants to the experiment will be asked to fill a questionnaire in with questions designed to understand people intentions when they do separate collection and the mistakes they do when they separate wastes. This method has been chosen to speed the phase of pre-test, instead of doing a double interview per person. In addition, since the people will be asked to answer to some questions about how the separate wastes, this solution has been chosen to let them do the test without the pressure of judgment. After using the apps Junker and Green Apes for about four days, users will be asked to participate in a qualitative interview. The interview will investigate if there have been improvements in the separation of wastes, repeating the same questions of the pre-test phase slightly changed, and how the people participating to the experiment perceived the use of the apps, especially the feelings that created engagement or repulsion. The qualitative method has been chosen for the phase of the post-test because it can investigate deeply view and perceptions of the respondents. The researcher has the opportunity to follow the answers given by the respondents in real time and to adjust the conversation around the subject. In addition, since the people interviews are also over 60 years old, this kind of conversation can be managed better than a survey where there could be some bias in their answer, such as the tendency to answer “yes” at every question or to click random answers.

5.5) Data analysis

Since the sample is composed by 18 people, it is not possible to do a t-test, that requires that people are normally distributed. A Multigroup analysis will be made to test if the data of the groups have significant differences in their group-specific parameter estimates. A factor analysis will be made to test if there are differences between the factor scores of the pre-test and the post-test. A Kruskal–Wallis test will be done to test whether samples originate from the same distribution. In fact, this test is generally used to compare more independent samples

of equal size. In addition, it will be made a Wilcoxon Rangsummentest, i.e. a nonparametric test of the null hypothesis. After these two tests, the Bonferroni correction will be used to counteract the multiple comparison problem.

The qualitative answers from the interview will be analyzed with a lexical analysis.

6. Expected Contributions

6.1) Scholarly Contributions

This thesis aims to improve the knowledge of how gamification can be applied to the field of sustainability, particularly to the field of waste management. Given the experimental design of the research, this thesis could be particularly useful because it does not only investigate intentions about waste collection but also it attempts to test with practical questions the real attitudes of people when they separate wastes.

The research gap on which this research is based is the following (Hsu & Chen, 2021):

While this study examines users' behavioral intentions, it does not investigate the impact of gamification on users' actual behaviors. This could be the focus of future research, which would reduce the likelihood of skewed results.

In order to satisfy this gap, the experiment run by Hsu and Chen (2021) was taken as the basis for developing the experiment run in this thesis, but instead of asking to the users of RecycleBank their intention about waste separation, the skills about recycling of people are analysed before and after the use of the app GreenApes. This design is not as effective as directly observing while differentiate wastes in their homes, that would obviously have been the most optimal design. Unfortunately, this design is impossible to apply in practice due to privacy. In fact, most people start to behave in a different way when they are observed. The solution of having people of the sample using the App GreenApes on recycling for four days and seeing progress through a final interview can give an acceptable degree of efficiency to test the research gap addressed by Hsu and Chen in 2021, considering to not being able to observe people in their homes quite effectively.

The topic has already been addresses in others research (Hsu & Chen, 2021; Aguiar-Castillo et al., 2019). The main difference between this research and other studies in the same field lies in the fact that this thesis does not simply investigates people intention when they differentiate

wastes but investigates the progress between the initial phase without the use of gamification and the final phase with the use of gamification. In addition, the experiment will take place in the Italian town Pistoia. Pistoia is a medium-sized city that does not particularly excel in the level of recycling. In the case of the paper written by Aguiar-Castillo (2019), the cities where the experiment has been run were European capitals. Finally, this experiment considers a sample made by people living permanently in Pistoia. In the case of the paper written by Aguiar-Castillo (2019), the sample was composed by tourists.

6.2) Implications for Business and Society

6.2.1) Contributions to the society

The need for a more sustainable way of living and making optimal use of resources is now a change that is addressed in multiple ways in the society. The European Union together with the United Nations have developed a series of common goals about sustainable development and they should be reached within 2030 (European Union official website, 2022). Many of these goals can be connected with the topic of waste management. The most relevant ones are reviewed below:

Goal N. 11: *Sustainable cities and community*

Goal N. 12: *Responsible consumption and production*

Goal N. 13: *Climate Action*

Goal N. 14 and 15: *Life below water and on land.*

The aim of this thesis is strictly connected with Goal N. 11, namely this thesis has the purpose to test if gamification can be used as a new tool to educate people in doing a better recycling. If the hypothesis stated in this thesis will be confirmed by the results of the experiment gamification could be increasingly used in the field of sustainability-learning, also in medium-small European cities. The other goals listed are not directly related to the study made in this thesis, but the effects of this successful experiment could also be found in goals N. 13 and 14 because a bad waste management affects the life of all the creatures that lives on the earth and under the water and it also risk affecting the climate due to the difficult disposal of waste that pollutes the environment. This experiment could also have a positive impact on Goal N.12 because it is proved that encouraging sustainable practices such as recycling, or waste separation people are also more engaged in sustainable thinking and responsible consumption (Hsu & Chen, 2021).

In addition to being a pressing need for the planet, a proper recycling collection also has positive practical implications for the lives of citizens.

Circular economy implies the transition of the society towards an economy that can regenerate itself and consequently the goods involved must be reused, repaired, or recycled (CONAI, 2022). This involves a teamwork made by all the forces that are parts of the economy and the households are not excluded.

Socio-economic consequences of a well-managed waste management are massive and tangible. According to the Green Economy Report made in 2020 by CONAI, the benefits of a correct recycling behavior are multiple. In 2019, have been avoided through proper recycling of waste 4.469 kt of primary material saved, 4.306 kt of carbon dioxide equivalent, 22,8 TWh of primary energy. The economic value of the CO₂ saved thanks to recycling was equal to 124 millions of euros and is equal to 402 millions of euros the economic value of the material recovered from recycling (Data from Green Economy Report CONAI, 2020). Therefore, increasing the quality of the recycling process in people's houses could lead to further enhancement of these benefits

6.2.2) Contributions for the Italian society, with particular reference to the city of Pistoia

European union is trying to push recycling behavior in all the states that are part of it since many years. In 2019, recycling of municipal waste in the EU27, involved about 68 million tons of garbage (ISPRA, Rapporto Rifiuti Urbani, 2021). It has been registered an increase of 3.2% compared to 2017. The top three countries that are distinguished by the amount of waste sent for recycling in Europe are Germany in the first place, followed by France and by Italy (Data ISPRA, elaborated on Eurostat data). France and Italy show the largest increases in quantity over the three-year period; an increasing equal to 10.3% for France and one equal to 10.1% for Italy. Per capita amounts of municipal waste sent for recycling increase over the three-year period from 148 to 152 kg/inhabitant per year. Italy is in line with the EU average with 151 kg/inhabitant per year. From what can be deduced from this data, Italy ranks among the best countries in Europe in terms of recycling activities. Nonetheless, the recycling situation in Italy is not homogeneous. 590 "waste free" municipalities were counted in Italy in 2022, equal to the 7,5% of the total municipalities in Italy. A municipality can be classified as "waste free" if "the per capita output of waste sent for disposal is inferior to 75 kg" (Comuni Ricicloni, 2022). 66.3 % of recycled municipalities are located in the north of Italy, 23,3 % is located in the south of Italy and only 5,4% is located in the center of Italy (Comuni Ricicloni, 2022).

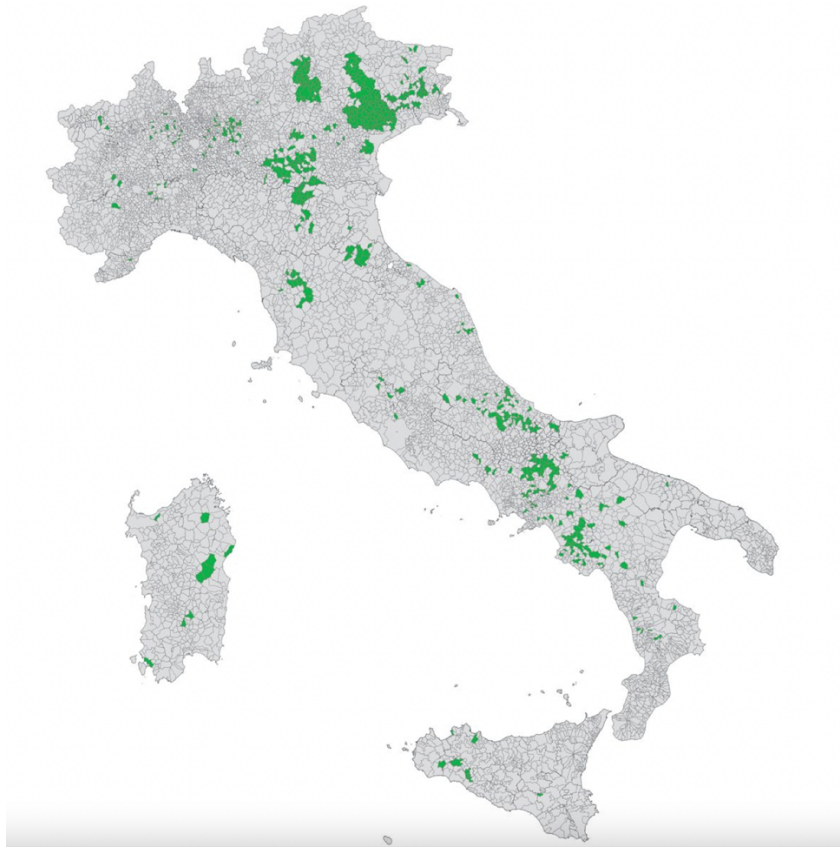


Figure 4 Map of free-waste municipalities in Italy

This data reporting on the low performance of the municipalities in the center of Italy with regard to recycling collection stimulated the search for the causes of this performance. Therefore, this thesis focuses on the performance about recycling of the city of Pistoia, located in Tuscany, a region of central Italy. Tuscany has some municipalities that excel in recycling collection and some of those are in the province of Pistoia, such as Serravalle Pistoiese, Lamporecchio, Pieve a Nievole, Uzzano, Buggiano or Monsummano Terme (Comuni Ricicloni, 2022). Nevertheless, the municipality of Pistoia does not appear among these, and the quantity of wastes selected for recycling could improve. In fact, only the 38,52% of waste per capita is sorted for recycling (Catasto Rifiuti ISPRA, 2020). This data is not completely depraved but improvable. For this reason, this research try to explain why the level of recycling could be improved in Pistoia and if gamification can be considered a successful tool to improve sustainable habits of citizens. If this research produces a positive outcome, the effects of gamification could be tested on a larger scale and in other Italian cities. If these results are also favorable, gamification applied to environmental issues could help all of society both in Italy and Europe toward the transition to the circular economy.

7. Chapters Overview

Table 2 Thesis chapters overview

i	Abstract
ii	List of abbreviations
iii	List of figures
iv	List of tables
Chapter 1	Introduction
Chapter 2	Theoretical Framing
Chapter 3	Literature Review
Chapter 4	Research Model and Hypothesis (or Research Preposition)
Chapter 5	Methodology
Chapter 6	Results
Chapter 7	Discussion
Chapter 8	Conclusion
Chapter 9	References

8. Work Plan

8.1) Workplan of the following weeks before the submission of the Master Thesis

Table 3 Work plan of the following weeks

24-28 October	Pre-Planning Experiment
1-9 November	Experiment (Questionnaire + Interviews)
10-27 November	Transcription of the 18 interviews
28-28-30 November	Coding + Review
1-15 December	Data Analysis
15-22 December	Writing the rest, formatting, revision
9-13 January	Final Revision
13 January	Deadline for thesis submission

8.2) Workplan of the experiment

Table 4 Work plan of the experiment

1-2 November	Distribution of the survey (all groups)
3-4-5-6 November	Group 1: use of the gamified app GreenApes Group 2: reading of the same instruction contained in GreenApes but without gamification
3-4 November	Group 3: Interviews
7-8-9 November	Group 1 and 2: Interviews

9. References

- Aguiar-Castillo, L.; Clavijo-Rodriguez, A.; De Saa-Perez, P.; Perez-Jimenez, R. (2019) Gamification as An Approach to Promote Tourist Recycling Behavior. *Sustainability*, 11, 2201. <https://doi.org/10.3390/su11082201>
- Ajzen, I.; Fishbein, M. (1975). "A Bayesian analysis of attribution processes". *Psychological Bulletin*. 82 (2): 261. [doi:10.1037/h0076477](https://doi.org/10.1037/h0076477).
- Ajzen, I. (1985). From intentions to actions: A theory of planned behavior, 11-39, *Ina J. Kuhl & J. Beckmann (Eds.), Action control: From cognition to behavior. Berlin, Heidelberg, New York: Springer-Verlag.*
- Ajzen, I. (1988). *Attitudes, personality, and behavior*. Chicago: The Dorsey Press.
- Ajzen, I. (1991), The theory of planned behavior, *Organizational Behavior and Human Decision Processes*, 50, 2, 179-211, [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T).
- Ajzen, I. & Fishbein, M. (2000). Attitudes and the Attitude-Behavior Relation: Reasoned and Automatic Processes. *European Review of Social Psychology* - EUR REV SOC PSYCHOL. 11. 1-33. 10.1080/14792779943000116.
- Ajzen, I. (2006). Constructing a theory of planned behavior questionnaire.
- Ajzen, I. (2020) The theory of planned behavior: Frequently asked questions. *Hum Behav & Emerg Tech*, 2, 314–324. <https://doi.org/10.1002/hbe2.195>
- "American Psychological Association (2013). *Glossary of psychological terms*". *Apa.org*. Retrieved 2014-08-13.
- Bai, S., Hew, K. F., Huang, B. (2020), Does gamification improve student learning outcome? Evidence from a meta-analysis and synthesis of qualitative data in educational contexts, *Educational Research Review*, 30, <https://doi.org/10.1016/j.edurev.2020.100322>.
- Bardus, M., Massoud M. A. (2022), Predicting the Intention to Sort Waste at Home in Rural Communities in Lebanon: An Application of the Theory of Planned Behaviour. *Int J Environ Res Public Health*. 19(15). doi: [10.3390/ijerph19159383](https://doi.org/10.3390/ijerph19159383)
- Behnamnia, N., Kamsin, A., & Ismail, M. A. B. (2020). The landscape of research on the use of digital game-based learning apps to nurture creativity among young children: A review. *Thinking Skills and Creativity*, 37. <https://doi.org/10.1016/j.tsc.2020.100666>

- Bernstad, A. (2014), Household food waste separation behavior and the importance of convenience, *Waste Management*, 34, 7, 1317-1323, <https://doi.org/10.1016/j.wasman.2014.03.013>.
- Boldero, J., 1995. The prediction of household recycling of newspapers: the role of attitudes, intentions and situational factors. *J. Appl. Soc. Psychol.* 25 (5), 440–462, <http://dx.doi.org/10.1111/j.1559-1816.1995.tb01598.x>
- Bosnjak, M., Ajzen, I., Schmidt, P. (2020), The Theory of Planned Behavior: Selected Recent Advances and Applications. *Eur J Psychol.*, 16(3), 352-356. doi: [10.5964/ejop.v16i3.3107](https://doi.org/10.5964/ejop.v16i3.3107).
- Campbell, J. P., & Kuncel, N. R. (2002). Individual and team training. In N. Anderson & D. S. Ones (Eds.), *Handbook of industrial, work and organizational psychology* (pp. 278-312). Thousand Oaks, CA: SAGE.
- Catasto Rifiuti ISPRA (2020). <https://www.catasto-rifiuti.isprambiente.it/index.php?pg=comune&aa=2018®id=09047&p=1&width=1440&height=900&advice=si>
- Cechella, F., Abbad, G., Wagner, R. (2021), Leveraging learning with gamification: An experimental case study with bank managers, *Computers in Human Behavior Reports*, 3, <https://doi.org/10.1016/j.chbr.2020.100044>.
- Chappin, E. J., Bijvoet X., Oei A. (2017) Teaching sustainability to a broad audience through an entertainment game The effect of Catan: oil Springs. *Journal of Cleaner Production*, 156, 556–568, <https://doi.org/10.1016/j.jclepro.2017.04.069>.
- Chauhan, S., Akhtar, A., & Gupta, A. (2021). Gamification in banking: a review, synthesis and setting research agenda. *Young Consumers*. [10.1108/YC-10-2020-1229](https://doi.org/10.1108/YC-10-2020-1229).
- Comuni Ricicloni (2022), Periodico di Legambiente sull'Economia Circolare, 31, 1.
- CONAI-Consortio nazionale Imballaggi (2022). Studi e ricerche. <https://www.conai.org/prevenzione-eco-design/studi-e-ricerche/>
- CONAI – Green Economy Report (2020), <https://www.conai.org/notizie/presentato-il-green-economy-report-del-sistema-conai/>
- Connolly, T. M., Boyle, E. A., MacArthur, E., Hainey, T., & Boyle, J. M. (2012). A systematic literature review of empirical evidence on computer games and serious games. *Computers & Education*, 59(2), 661–686. <https://doi.org/10.1016/j.compedu.2012.03.004>

- Conner, M., & Armitage, C. J. (1998). Extending the theory of planned behavior: A review and avenues for further research. *Journal of applied social psychology*, 28(15), 1429-1464.
- Deci E. L., Ryan R. M (1985), *Intrinsic Motivation and Self-Determination in Human Behavior*, *Perspectives in Social Psychology*, Springer New York, NY, <https://doi.org/10.1007/978-1-4899-2271-7>
- Deci, E. L., & Ryan, R. M. (2012). Self-determination theory. In P. A. M. Van Lange, A. W. Kruglanski, & E. T. Higgins (Eds.), *Handbook of theories of social psychology* (pp. 416–436). Sage Publications Ltd. <https://doi.org/10.4135/9781446249215.n21>
- Derksen, L., & Gartrell, J. (1993). The social context of recycling. *American sociological review*, 434-442. <https://doi.org/10.2307/2095910>
- Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: defining “gamification”. In A. Lugmayr (Ed.), *Proceedings of the 15th International Academic Mindtrek Conference: Envisioning Future Media Environments*, 9–15, <https://doi.org/10.1145/2181037.2181040>.
- Deterding, S., Sicart, M., Nacke, L., O’Hara, K., Dixon, D. (2011), Gamification: Using Game Design Elements in Non-Gaming Contexts, *Conference: Proceedings of the International Conference on Human Factors in Computing Systems*, [10.1145/1979742.1979575](https://doi.org/10.1145/1979742.1979575)
- Dewberry, C., & Jackson, D. J. (2018). An application of the theory of planned behavior to student retention. *Journal of Vocational Behavior*, 107, 100-110. <https://doi.org/10.1016/j.jvb.2018.03.005>
- Dichev, C., & Dicheva, D. (2017). Gamifying education: What is known, what is believed and what remains uncertain: A critical review. In *International journal of educational technology in higher education*, 14, Springer Netherlands. <https://doi.org/10.1186/s41239-017-0042-5>.
- Dinardo, J. (2008). Natural experiments and quasi-natural experiments. *The New Palgrave Dictionary of Economics*. 856–859. [doi:10.1057/9780230226203.1162](https://doi.org/10.1057/9780230226203.1162).
- Doswell, W., Braxter, B., Cha, E., Kim, K. (2011). Testing the Theory of Reasoned Action in Explaining Sexual Behavior Among African American Young Teen Girls. *Journal of Pediatric Nursing*, 26(6), 45-54. [doi:10.1016/j.pedn.2011.03.007](https://doi.org/10.1016/j.pedn.2011.03.007)

- Douglas, B. D., Brauer M. (2021), Gamification to prevent climate change: a review of games and apps for sustainability. *Current Opinion in Psychology*, 42, 89-94. [doi: 10.1016/j.copsyc.2021.04.008](https://doi.org/10.1016/j.copsyc.2021.04.008)
- Eccleston, C. H. (2010). *Global Environmental Policy: Concepts, Principles, and Practice*. Chapter 7. ISBN 978-1439847664.
- Ekici, M. (2021), A systematic review of the use of gamification in flipped learning. *Educ Inf Technol* 26, 3327–3346. <https://doi.org/10.1007/s10639-020-10394-y>
- Europa data Eurostat <http://ec.europa.eu/eurostat/web/waste>
- European Union official website, 2022, https://ec.europa.eu/info/strategy/international-strategies/sustainable-development-goals_en
- Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley.
- Fishbein & Ajzen (2010). *Predicting and changing behavior: The Reasoned Action Approach*. New York: Taylor & Francis.
- Fox, S. (1997) Situated learning theory versus traditional cognitive learning theory: Why management education should not ignore management learning. *Systems Practice*, 10, 727–747. <https://doi.org/10.1007/BF02557922>
- Galeote, D. F., Rajanen, M., Rajanen, D., Legaki, N-Z., Langley, D., & Hamari, J. (2021). Gamification for climate change engagement: review of corpus and future agenda. *Environmental Research Letters*, 16, <https://doi.org/10.1088/1748-9326/abec05>
- Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). A review on circular economy : the expected transition to a balanced interplay of environmental and economic systems. *Journal of Cleaner Production*, 114, 11–32. <https://doi.org/10.1016/j.jclepro.2015.09.007>
- Gollwitzer, P. M. (1999). Implementation intentions: Strong effects of simple plans. *American Psychologist*, 54(7), 493–503. <https://doi.org/10.1037/0003-066X.54.7.493>
- Graham-Rowe, E., Jessop, D. C., & Sparks, P. (2015). Predicting household food waste reduction using an extended theory of planned behaviour. *Resources, Conservation and Recycling*, 101, 194-202. <https://doi.org/10.1016/j.resconrec.2015.05.020>
- Grazhdani, D. (2016), Assessing the variables affecting on the rate of solid waste generation and recycling: An empirical analysis in Prespa Park, *Waste Management*, 48, 3-13, <https://doi.org/10.1016/j.wasman.2015.09.028>.

- Gwangndi, M. I., Muhammad, Y. A., & Tagi, S. M. (2016). The impact of environmental degradation on human health and its relevance to the right to health under international law. *European scientific journal*, 12(10). <https://doi.org/10.19044/esj.2016.v12n10p485>
- Han, Y., Hansen, H., 2012. Determinants of sustainable food consumption: a meta-analysis using a traditional and a structural equation modelling approach. *Int. J. Psychol. Stud.* 4 (1), 22–45, <http://dx.doi.org/10.5539/ijps.v4n1p22>
- Haseena, M., Malik, M. F., Javed, A., Arshad, S., Asif, N., Zulfiqar, S., & Hanif, J. (2017). Water pollution and human health. *Environmental Risk Assessment and Remediation*, 1(3). <http://www.alliedacademies.org/environmental-risk-assessment-and-remediation/>
- Hattie, J., Biggs, J., & Purdie, N. (1996). Effects of learning skills interventions on student learning: A meta-analysis. *Review of Educational Research*, 66, 99-136. <https://doi.org/10.2307/1170605>
- Holdsworth, S., Sandri, O., Thomas, I., Wong, P., Chester, A., & McLaughlin, P. (2020). The use of the theory of planned behaviour to assess graduate attributes for sustainability. *Environmental Education Research*, 26(2), 275-295. <https://doi.org/10.1080/13504622.2019.1700218>
- Hox, J., de Leeuw, E., Vorst, H. (1995), Survey Participation as Reasoned Action; A Behavioral Paradigm for Survey Nonresponse?, *Bulletin de Méthodologie Sociologique*, 48, 52-67. <https://www.jstor.org/stable/23891661>
- Hsu, C., Chen, M. (2021), Advocating recycling and encouraging environmentally friendly habits through gamification: An Empirical investigation. *Technology in Society*, 66, DOI: 10.1016/j.techsoc.2021.101621
- Hsu, C. (2022), Applying cognitive evaluation theory to analyze the impact of gamification mechanics on user engagement in resource recycling, *Information & Management*, 59, Issue 2, <https://doi.org/10.1016/j.im.2022.103602>.
- Illeris, Knud (2004). The three dimensions of learning. *Malabar, Fla: Krieger Pub. Co ISBN 9781575242583*.
- Islam, M. D. R. & Mazumder, T. (2010). Mobile application and its global impact. *International Journal of Engineering & Technology*. 10. 6. 72-78.
- Ispra, rapporto rifiuti urbani (2021).
- Jesson, J. K., Pocock, R.L., Stone, I. (2014), Barriers to Recycling: A Review of Evidence since 2008, Waste & Resources Action Programme (WRAP),

<http://www.wrap.org.uk/sites/files/wrap/WRAP%20Barriers%20Synthesis%20Full%20Report%20final%20121214%20PUBLISHED%20-%20PDF.pdf>

- Johnson, D., Deterding, S., Kuhn K. A., Staneva, A., Stoyanov S., Hides L. (2016), Gamification for health and wellbeing: A systematic review of the literature. *Internet Interentions*, 6, 89-106, doi: [10.1016/j.invent.2016.10.002](https://doi.org/10.1016/j.invent.2016.10.002).
- Kassim, S. M. (2012). The importance of recycling in solid waste management. *Macromolecular Symposia*, 320, 1, 43-50. DOI: [10.1002/masy.201251005](https://doi.org/10.1002/masy.201251005)
- Kim, J., & Yu, E. A. (2016). The holistic brand experience of branded mobile applications affects brand loyalty. *Social Behavior and Personality*, 44, 1, 77–88. <https://doi.org/10.2224/sbp.2016.44.1.77>
- Krath, J., Schürmann, L., von Korfflesch, H. F. O. (2021), Revealing the theoretical basis of gamification: A systematic review and analysis of theory in research on gamification, serious games and game-based learning, *Computers in Human Behavior*, 125, <https://doi.org/10.1016/j.chb.2021.106963>.
- Kordaki, M., & Gousiou, A. (2017). Digital card games in education: A ten year systematic review. *Computers & Education*, 109, 122–161. <https://doi.org/10.1016/j.compedu.2017.02.011>
- Kuswati, R., Purwanto, B., Sutikno, B., Aritejo, B. (2021). Pro-Environmental Self-Identity: Scale Purification in the Context of Sustainable Consumption Behavior. [10.1007/978-3-030-65147-3_12](https://doi.org/10.1007/978-3-030-65147-3_12).
- LaCaille, L. (2013). Theory of Reasoned Action. In: Gellman, M.D., Turner, J.R. (eds) *Encyclopedia of Behavioral Medicine*. Springer, New York, NY. https://doi.org/10.1007/978-1-4419-1005-9_1619
- Landers, R. (2015). Developing a Theory of Gamified Learning. *Simulation & Gaming*. [10.1177/1046878114563660](https://doi.org/10.1177/1046878114563660).
- Landers, R. N., Auer, E. M., Collmus, A. B., & Armstrong, M. B. (2018). Gamification science, its history and future: definitions and a research agenda, *Simulation & Gaming*, 49(3), 315–337. <https://doi.org/10.1177/1046878118774385>.
- Lihua, D. (2022), An Extended Model of the Theory of Planned Behavior: An Empirical Study of Entrepreneurial Intention and Entrepreneurial Behavior in College Students, *Sec. Educational Psychology*, <https://doi.org/10.3389/fpsyg.2021.627818>

- Lister, C., West, J., Cannon, B., Sax, T., & Brodegard, D. (2014). Just a Fad? Gamification in Health and Fitness Apps. *JMIR serious games*, 2, e9. [10.2196/games.3413](https://doi.org/10.2196/games.3413).
- Low S. T., Tee S. Y., Choong W. W. (2016), Preferred Attributes of Waste Separation Behaviour: An Empirical Study, *Procedia Engineering*, 145, 738-745, <https://doi.org/10.1016/j.proeng.2016.04.094>.
- Martí-Parreño, J., Méndez-Ibáñez, E., and Alonso-Arroyo, A. (2016) The use of gamification in education: a bibliometric and text mining analysis. *Journal of Computer Assisted Learning*, 32: 663– 676. doi: [10.1111/jcal.12161](https://doi.org/10.1111/jcal.12161).
- Minelgaitė, A., Liobikienė, G. (2019), Waste problem in European Union and its influence on waste management behaviours, *Science of The Total Environment*, 667, 86-93. <https://doi.org/10.1016/j.scitotenv.2019.02.313>
- Nah, F. F. H., Zeng, Q., Telaprolu, V.R., Ayyappa, A.P., Eschenbrenner, B. (2014). Gamification of Education: A Review of Literature. *International Conference on HCI in Business. Lecture Notes in Computer Science*, 8527, 401-409, https://doi.org/10.1007/978-3-319-07293-7_39
- Negrușă, A.L.; Toader, V.; Sofică, A.; Tutunea, M.F., Rus, R.V. (2015), Exploring Gamification Techniques and Applications for Sustainable Tourism. *Sustainability*, 7, 11160-11189. <https://doi.org/10.3390/su70811160>
- Ordóñez, I., Harder, R., Rahe, U. (2015), Waste sorting in apartments: integrating the perspective of the user, *Journal of Cleaner Production*, 106, 669–679. doi:[10.1016/j.jclepro.2014.09.100](https://doi.org/10.1016/j.jclepro.2014.09.100)
- Passafaro, P., Livi, S., & Kosic, A. (2019). Local norms and the theory of planned behavior: Understanding the effects of spatial proximity on recycling intentions and self-reported behavior. *Frontiers in psychology*, 10, 744. <https://doi.org/10.3389/fpsyg.2019.00744>
- Peng, J., Zhi-cai, J., Lin-jie, G. (2014). Application of the Expanded Theory of Planned Behavior in Intercity Travel Behavior. *Discrete Dynamics in Nature and Society*. [10.1155/2014/308674](https://doi.org/10.1155/2014/308674).
- Qian, M., & Clark, K. R. (2016). Game-based learning and 21st century skills: A review of recent research. *Computers in Human Behavior*, 63, 50–58. <https://doi.org/10.1016/j.chb.2016.05.023>
- Rotter. V. S. (2009), Material Recycling; Teaching Materials IHE Netherlands.

- Ryan, R. M., Deci E. L. (2020), Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions, *Contemporary Educational Psychology*, 61, <https://doi.org/10.1016/j.cedpsych.2020.101860>.
- Sailer, M., Hense, J. H., Mayr, S. K., Mandl, H. (2017). How gamification motivates: An experimental study of the effects of specific game design elements on psychological need satisfaction, *Computers in Human Behavior*, 69, 371-380, <https://doi.org/10.1016/j.chb.2016.12.033>
- Sailer, M., Homner, L. (2020) The Gamification of Learning: a Meta-analysis. *Educ Psychol Rev* 32, 77–112, <https://doi.org/10.1007/s10648-019-09498-w>
- Seaborn, K., Fels, D. I. (2015), Gamification in theory and action: A survey, *Int. J. Human-Computer Studies*, 74, 14-31, [10.1016/j.ijhcs.2014.09.006](https://doi.org/10.1016/j.ijhcs.2014.09.006)
- Sheau-Ting, L., Sin-Yee, T., Weng-Wai, C. (2016), Preferred Attributes of Waste Separation Behaviour: An Empirical Study, *Procedia Engineering*, 145, 738-745, <https://doi.org/10.1016/j.proeng.2016.04.094>.
- Si, H., Shi, J. G., Tang, D., Wen, S., Miao, W., & Duan, K. (2019). Application of the theory of planned behavior in environmental science: a comprehensive bibliometric analysis. *International journal of environmental research and public health*, 16(15), 2788. <https://doi.org/10.3390/ijerph16152788>
- Stocchi, L., Pourazad, N., Michaelidou, N. et al. (2022), Marketing research on Mobile apps: past, present and future. *J. of the Acad. Mark. Sci.* 50, 195–225. <https://doi.org/10.1007/s11747-021-00815-w>
- Stoeva, K., Alriksson, S. (2017), Influence of recycling programmes on waste separation behaviour, *Waste Management*, 68, 732-741, <https://doi.org/10.1016/j.wasman.2017.06.005>.
- Sparks, P., Hinds, J., Curnock, S., Pavey, L.J., (2014). Connectedness and its consequences: a study of relationships with the natural environment. *J. Appl. Soc. Psychol.* 44 (3), 166–174. <https://doi.org/10.1111/jasp.12206>
- Sukholthaman, P., Sharp, A. (2016), A system dynamics model to evaluate effects of source separation of municipal solid waste management: A case of Bangkok, Thailand, *Waste Management*, 52, 50-61, <https://doi.org/10.1016/j.wasman.2016.03.026>.

- Taylor, S., Todd, P., 1995. An integrated model of waste management behavior. A test of household recycling and composting intentions. *Environ. Behav.* 27 (5), 603–630, <http://dx.doi.org/10.1177/0013916595275001>
- Tatarko, A., Schmidt, P. (2016) Individual social capital and the implementation of entrepreneurial intentions: The case of Russia. *Asian J Soc Psychol*, 19: 76– 85. [doi: 10.1111/ajsp.12113](https://doi.org/10.1111/ajsp.12113).
- Thomas, C. (2001), Public understanding and its effect on recycling performance in Hampshire and Milton Keynes, *Resources, Conservation and Recycling*, 32, 259-274, [https://doi.org/10.1016/S0921-3449\(01\)00065-9](https://doi.org/10.1016/S0921-3449(01)00065-9).
- Trumbo, C.W., O’Keefe, G.J., 2001. Intention to conserve water: environmental values, planned behavior, and information effects. A comparison of three communities sharing a watershed. *Soc. Nat. Resour.* 14 (10), 889–899, <http://dx.doi.org/10.1080/089419201753242797>
- Tucker, P. (2001). Understanding recycling behaviour. *Paper Technol.* 42, 51–54. 12. <https://doi.org/10.3390/su11226496>
- Van Benthem, J. (2002), Extensive Games as Process Models. *Journal of Logic, Language and Information*, 11, 289–313. <https://doi.org/10.1023/A:1015534111901>
- Vlachopoulos, D., & Makri, A. (2017). The effect of games and simulations on higher education: A systematic literature review. *International Journal of Educational Technology in Higher Education*, 14(1), 22. <https://doi.org/10.1186/s41239-017-0062-1>
- Wade, C., Tavris, C. (1997), *Psychology in Perspectives* (2nd edition), New York, Longman, [ISBN 978-0-673-98314-5](https://doi.org/10.1007/978-0-673-98314-5).
- Wallston, K. (2001), *International Encyclopedia of the Social & Behavioral Sciences*
- Wang, L., Zheng, D. (2020), Associations Among Habitual Behavior, Implementation Intention and Physical Activity of Adolescents: Application of Model of Extended Theory of Planned Behavior. *Journal of Shanghai University of Sport*, 44(2): 22-32. doi: 10.16099/j.sus.2020.02.003
- Wang, Y., Long, X., Li, L. et al. (2021), Extending theory of planned behavior in household waste sorting in China: the moderating effect of knowledge, personal involvement, and moral responsibility. *Environ Dev Sustain*, 23, 7230–7250. <https://doi.org/10.1007/s10668-020-00913-9>

- Wasserman T., Wasserman L. (2020). "Motivation: State, Trait, or Both". Motivation, Effort, and the Neural Network Model. pp. 93–101. [doi:10.1007/978-3-030-58724-6_8](https://doi.org/10.1007/978-3-030-58724-6_8). ISBN 978-3-030-58724-6. S2CID 229258237.
- Whittaker, L., Mulcahy, R., Russell-Bennett, R. (2021), ‘Go with the flow’ for gamification and sustainability marketing, *International Journal of Information Management*, 61, <https://doi.org/10.1016/j.ijinfomgt.2020.102305>.
- World Bank Data (2020), What a Waste 2.0, <https://datatopics.worldbank.org/what-a-waste/>
- World bank Data (2022), Solid waste management, <https://www.worldbank.org/en/topic/urbandevelopment/brief/solid-waste-management>
- Wouters, P., van Nimwegen, C., van Oostendorp, H., & van der Spek, E. D. (2013). A meta-analysis of the cognitive and motivational effects of serious games. *Journal of Educational Psychology*, 105(2), 249–265. <https://doi.org/10.1037/a0031311>.
- Zaric, N., Lukarov, V., Schroeder, U., (2020), The Empirical Investigation of the Gamified Learning Theory. *Games and Learning Alliance* Marfisi-Schottman et al., Springer Nature Switzerland AG. [10.1007/978-3-030-63464-3_13](https://doi.org/10.1007/978-3-030-63464-3_13).
- Zhuang, Y., Wu, S.W., Wang, Y.L., Wu, W.X. and Chen, Y.X. (2008), “Source separation of household waste: a case study in China”, *Waste Management*, 28, 10, 2022-2030. DOI: [10.1016/j.wasman.2007.08.012](https://doi.org/10.1016/j.wasman.2007.08.012)