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For a good selfie. Enhancing mobile phone recycling through simulated exposure to cobalt mining

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Abstract

Mobile phones and other electronic equipment need elements like cobalt that are obtained with enormous tolls of human rights and environmental health. In the Democratic Republic of Congo cobalt mining involves child labour. The principles of R-framework like refusing to buy and recycling post-first-life mobiles help to improve the sustainability of this and other minerals through waste management; however, current rates of mobile phone recycling are very low. Here we have designed an intervention for educational settings. We exposed students of different ages (271 of secondary and 266 of higher education) to the situation of child miners through an intervention called *For a Good Selfie*. Participants put themselves in the place of children working in cobalt mines. Significant increase of the intention of refusing-to-buy (between 11.6% and 45.5%) and recycling behaviour were found in students of different ages and disciplines after playing *For a Good Selfie*. Role-play was significantly more efficient than non-role play interventions; the first one involves a higher psychological proximity with child miners. Higher rates of recycling were found in engineering (57.7%) than in social sciences (9.6%) students. Interventions based on role-playing could be recommended for improving sustainable behaviours in the sector of mobile phones.

Key words: Empathy; Mobile phones; Recycling; Refusing to buy; Role-play; WEEE

1.Introduction

1.1. Social issues behind mobile phones' batteries

Today it is difficult to imagine modern life without electronic devices like smartphones and tablets. Amongst the elements employed to construct these devices the cobalt occupies a central place because it is used in the battery. It is classified as a critical mineral in the European Union because it is almost absent in the EU territory and must be imported (European Commission, 2011).

The source of the majority of cobalt employed in the world today, 90,000 over a total of 140,000 metric tons of mine production in 2018, is the Democratic Republic of Congo (DRC) (Shedd, 2019). Today, cobalt mining in the DRC encompasses child labour (e.g. Amnesty International, 2016; Faber et al., 2017), accidents and occupational hazards, even violent conflict and death (e.g. Sovacool, 2019). Child miner's salary in DRC is no higher than 2$/day according to Amnesty International research, and children working in cobalt mining are exposed to abuses and violence (Amnesty International, 2016).

Cobalt mining also encompasses an enormous environmental deterioration that threatens human health in the regions due to increased concentrations of this mineral in water, soil and fish (Banza et al., 2009, 2018). Children are especially vulnerable to environmental exposure since they exhibit a higher level of cobalt concentration in urine than adults do in polluted areas nearby mines (Cheyns et al., 2014).

1.2. Mobile phone recycling in Europe

The principles of circular economy, promoted from all instances for increasing sustainability of non-renewable primary products used in smartphones, emphasize the R-imperatives that Reike et al. (2018) synthesize in 10RO framework (for 10 value retention options): Refuse (buying), Reduce, Re-sell/reuse, Repair, Refurbish, Re-manufacture, Re-purpose (rethink; use old components for new uses), Recycle, Recover (buy and use energy), Re-mine (landfilled material; buy and use secondary materials). Other authors follow Circular Economy 4R scheme of Reduce, Reuse, Remanufacture and Recycle (Bressanelli et al., 2020). Old or obsolete electronic products (Waste Electric and Electronic Equipment, WEEE) should be recycled after their first life for reusing their components; however, current estimates of end-of-life recycling rate of the cobalt are not higher than 32% (OECD, 2019). Main barriers to recycling battery components are inefficient WEEE collection, technological challenges in recycling operations, and low demand of recycled products that may be seen as "used" (Church and Wuennenberg, 2019). The lack of public awareness about WEEE recycling has been identified as one of the main barriers that make WEEE management implementation difficult (Kumar and Dixit, 2018). For Church and Wuennenberg (2019), inefficient collection of post-first-life products is also due to the lack of infrastructure for dropping off those products, but the lack of awareness seems to be the most important cause.

Hibernation, or the period of time when a product is kept after it has been used, can be very long or permanent for electronic devices. As an example, Danish consumers keep as many as 2.9 (Penners et al., 2018) to 5 (Tanskanen, 2013) used cell phones at home in average, as spare phones or fearing privacy disclosures (Penners et al., 2018). In the UK about 33% of mobile phones are returned for recycling (Wilson et al., 2017). The percentage is much lower in Spain, with more than 90% of appliances and devices unavailable for reuse and recycling (Bovea et al, 2018). Mobile phones are by far the most kept category, and the main reason stated for device hibernation is to have it as spare parts; less than 10% are taken to a civic amenity site for adequate management as electronic waste (Bovea et al., 2018).

Application of financial incentives for encouraging consumers to recycle has been proposed (Abila and Kantola, 2019; Shevchenko et al., 2019). Alternatively, increasing population awareness about sustainability is a widely employed strategy for increased recycling of different materials like glass, metal, paper, plastic, textile (Hole and Hole, 2020). Accordingly, education for sustainability often focuses on recycling (e.g. Cheung et al., 2018; Hofverberg and Maivorsdotter, 2018; Buil et al, 2019). Considering also other R-imperatives is desirable. In a recent review, Bressanelli et al. (2020) found that Circular Economy in the WEEE industry needs to explore how all the R-imperatives can create value to end-users, and establish the right incentives for take-back systems, amongst others. In this study we will look for incentives to Reduce and Recycle. Specifically, we will design an intervention to be applied in educational contexts.

1.3. Empathy for sustainable behaviours

Sustainability empathy has been defined as one's ability to establish an emotional connection with the surrounding people and environment (Font et al., 2016, and cites therein). If a tourist feels positive emotions and empathy towards a place and people living there, they will care about and exhibit sustainable behaviour (Font et al., 2016). Batson et al. (2002) found that empathy with a stigmatized individual increased positive attitudes and action on behalf of stigmatized groups, that is, altruist behaviour. This can be expanded to pro-environmental and sustainable behaviours. Here we will use that model and the interaction of social affect and cognition (Preckel et al., 2018). Preckel et al. (2018) showed that, although socio-affective and socio-cognitive routes to understanding others are separated in the brain, they are jointly required for adaptive social behaviour. On the other hand, Decety and Cowell (2015) described affective sharing (automatic mirroring of other's emotions), empathic concern (motivation of caring), and perspective-taking (capacity of putting oneself in the other's skin, which is the cognitive aspect of empathy) as empathy components. Pro-social behaviour is mediated, also in non-human animals, from different components of empathy like affective sharing and empathic concern (Decety et al., 2016). Individual differences in cognitive empathy and empathic concern predict sensitivity to justice for others (Decety & Yoder, 2016); affective sharing alone is not sufficient because the distress caused by other´s pain can be avoided simply looking the other way.

From the theories above, the emotional connection with children working in DRC mines will be stronger activating multiple empathy components. This may be achieved using interventions that contain different amounts of empathy components. Sharing affective states with another person and feeling concern for another are also separated at conceptual and neural levels (Preckel et al., 2018). Batson (2009) described "Imagine-self" (imagining oneself in the other's situation) and "Imagine-other" instructions (imagining how the other person feels) as efficient techniques to induce perspective-taking, although they do not activate exactly the same emotional empathy components. "Imagine-self" instructions activate both empathic concern and the sense of self-other overlap (feeling like the other feels), while “Imagine-other” activates empathic concern but not so much the sense of self-other overlap (Myers et al., 2013). Thus, interventions based on putting oneself in the other’s situation would induce empathy using more emotional aspects, and for equal cognitive empathy would be more efficient than “Imagine-other” interventions at promoting sustainable behaviours.

1.4. Role-play

Role-play is a type of game that has been widely and successfully employed for varied purposes, such as reducing students’ racial prejudices (e.g. McGregor, 1993), decreasing persistent stereotypes of scientists (Howes and Cruz, 2009), engaging university students in understanding the impacts of climate change in their cities and lives (Kluver et al., 2018), learning therapeutic skills in Master training programs for clinical psychologists (Ruiz Rodriguez et al., 2018), developing environmental values in children (Lithoxoidou et al., 2017) and many others. Based on their effective contribution to behaviour change, role-playing games have been also proposed out of educational contexts, as a way of public engagement in so-called “Serious games”. Examples are the creation of spaces for mutual understanding in controversial issues like housing development (Doberstein, 2020); to reduce stigma of the homeless (Schrier, 2018); to support interventions for the reduction of household carbon emissions (Agusdinata and Lukosh, 2019); to educate and engage communities in adaptation to climate change (Rumore et al., 2016), and others.

Role-play simulation pushes participants to engage with issues from a different perspective (Rumore et al., 2016). In this sense, role-play could be considered a way of “Imagining-self”, but it is more than that because it contains more psychological elements that contribute to behaviour changes. During the game the player adopts not only the perspective but also the behavior expected from a particular role (Peng et al., 2010). Player enjoyment also explains part of the success of educational games, because it motivates the player to learn from the game (Fjællingsdal and Klöckner, 2017). A pleasurable gameplay experience is related with positive learning outcomes and motivates to learning from it (Bisson and Luckner, 1996; Fjællingsdal and Klöckner, 2017). Another important element is the degree of perceived behavioural control; a behaviour perceived as easy will be adopted with higher probability (Ajzen, 2002), and role-play creates a safe space for participants to openly engage with others' viewpoints (Rumore et al., 2016). A game that helps to understand issues and proposes clear, manageable behaviours to change them will likely keep learners' motivation high. This is especially important in role-play games aimed at learning socio-environmental issues that are naturally complex (Fjællingsdal and Klöckner, 2017).

However, the mere exposure of the audience to a simulated situation is insufficient for a strong behavioural change. Motivation and opportunities to think about a cause will make the change of attitude durable, since judgments based on thinking persist more over time (Briñol and Petty, 2015). Referring specifically to game play, Ke (2016) identified meta-reflective moments as one of the five key themes necessary for purposeful learning through playing. In this sense, Foster et al. (2019) successfully achieved pro-environmental changes in learners' identity through a virtual game where high school students role-played to be environmentalists, using projective reflection methodology. Allowing a time to think, reflect about the message received and discuss it will reinforce the persuasion about the social and environmental benefits of recycling electronic devices.

On the other hand, for efficient behavioural engagement two-way is better than one-way communication. The audience is easily engaged when it is directly involved in the persuasion process, like in classes, seminars or meetings (Djordjevic and Cotton, 2011). In contrast, one-way communications like newspapers, blogs, flyers or research articles may lead to misunderstanding of the message (e.g. Cornell and Randall, 2011). For these reasons, in this study we opted for face-to-face intervention with a time for thinking.

1.5. Objectives and expectations

In this study we aimed at developing an intervention in educational settings to change behaviour in two imperatives of 10RO framework, Refusing (to buy) and Recycling mobile phones, through the exposure to current practices employed to obtain cobalt. The intervention was assayed in groups of students of different disciplines and academic levels. Depending on the discipline, students may be differentially aware and motivated about sustainability. Students from humanistic disciplines and educational sciences would give more support to sustainable actions than engineering students, (Kukkonen et al., 2018). Students from some business courses are not concerned about sustainability (e.g. Palma et al., 2011), and seem to have limited awareness about environmental issues (Cezarino et al., 2018). Regarding academic levels –generally of different age-, younger undergraduate students tend to be less concerned about sustainability than older graduate students. Examples are Greek undergraduate students unconcerned about sustainable food behaviour (Kamenidou et al., 2019), or Italian young undergraduate students being grouped as unconcerned about environmental values and protection of natural spaces (Forleo et al., 2019).

The vulnerability of children rights in DRC mines was the base of the intervention, called "*For a Good Selfie*" (FOGS thereafter). Expectedly, the conscious knowledge of the implications of cobalt mining coupled with empathy for miner children should promote behaviours favourable to R-imperatives regarding mobile phones. Here we have tested this intervention in 271 students of secondary education and 266 of higher education from Asturias, a region of Spain, where the WEEE returning rate is quite low in comparison with other European countries (Bovea et al., 2018). The behavioural intention "Refusing to buy", and the behaviour "Recycling" (mobile phones), were measured. Similar interventions based on role-play and no-role play ("Imagine-other"), were assayed in student groups of similar age and discipline, and role-play interventions tested in different age and formation background. Differences between role-play and no-role play, and the effects of student age and formation background were determined.

1.6. Departure hypotheses

a) Playing FOGS, which is based on empathy induced through perspective-taking (Batson, 2002, 2009) will increase sustainable behaviour (Recycling and Refusing-to-buy) in treated groups (Font et al., 2016), in comparison with non-treated students.

b) From the efficiency of easily understandable, pleasurable role-play to rise awareness about socio-environmental issues (Rumore et al., 2016; Fjællingsdal and Klöckner, 2017; Lithoxoidou et al., 2017), role-playing with FOGS will improve sustainable behaviours in comparison with a similar intervention based solely on perspective taking without role-play.

c) From different awareness about sustainability in different disciplines (e.g. Cezarino et al., 2018; Kukkonen et al., 2018), the efficiency of FOGS to improve sustainable behaviours will be higher in students of educational science and humanistic disciplines than in engineering students.

d) Following Forleo et al. (2019) and Kamenidou et al. (2019), younger students are less sensitive to sustainability values. Pre-university students will thus be less sensitive to

FOGS than older graduate students, changing less their behaviour –or intention of behaviour- towards sustainability.

2.Methodology

2.1. Ethic statement

The competent Committee of Research Ethics of Asturias Principality approved this study with reference 166/19. Students were informed about the use of the data for research purposes only, signed informed consent and anonymity and confidentiality of personal data was ensured. This study aligns with the Declaration of Helsinki.

2.2. Educational and regional contexts and participants

The study was carried out in the Spanish region of Asturias, which according to the Spanish Institute of Statistics (INE, 2019) had in 2018 a population of 1,028,244 persons (52.27% females); 37,753 (3.67%) of age 15-19, most of them in secondary education, and 38,442 (3.74%) in the age range 19-24.

The activities described below took place in four centres of secondary education (n = 271) and in seven classes of higher education (HE) within the public university in the region (n = 266). The participants are described in Table 1.

2.3. Overview of studies using FOGS

Three studies with different purposes were carried out. To test Hypothesis *b*, in the first study the efficiency of role-play versus no-role play –classic perspective-taking- interventions for stopping mobile phone hibernation (*Recycling* in R-imperatives) was measured in two groups of students of similar background treated either with role-play or no-role play interventions. The results of treated groups were compared with the spontaneous rate of mobile dropping in the same school to test Hypothesis *a*.

The second study aimed at testing the possible differences in mobile phone recycling between students of different disciplines and background, to test Hypothesis *c*.

In the third study we investigated the effect of the assayed interventions on the acquisition of new mobile phones (*Refuse buying* in R-imperatives), to test Hypothesis *b* for that behavioural intention. To test Hypotheses *c* and *d* the samples of the other two studies and younger students of pre-university education were considered.

2.4. FOGS intervention design and development

Two versions of FOGS ("*Por un buen selfie*" into Spanish) were prepared: role-play and no role-play ("Imagine-other"). The intervention was composed of three consecutive parts with a total duration of 50 minutes. It allows to developing it within an ordinary class.

Before starting, researchers introduced themselves briefly. Then they asked participants about the number of post-first-life cell phones stored at home, how long they have been using the current mobile phone, and if they had any intention to buy a new one within the next twelve months (answer: yes/not). This question was posed again after the intervention. The answers were recorded in writing. The questionnaire is presented in Supplementary Information (Supplementary Table 1).

2.4.1. Part 1. Sensitization.

FOGS started with a short description of the problem for 10 (secondary education) to 15 (higher education) minutes. This first part aimed at informing about the environmental and social issues involved in the production of an element constituent of clean batteries. Cobalt demand, producer countries and the production chain of electronic goods, human rights violations and environmental threats associated to cobalt mining in DRC were succinctly explained with a visual support (by PowerPoint presentation).

2.4.2. Part 2. Perspective-taking induction treatments.

This part of FOGS (20 minutes or a little bit longer in secondary education) aims at facilitating the participants to "imagine-other" (without role-play) or to role-play in child miners' situation, to elicit perspective-taking and empathic concern (Batson, 2009).

In the role-play version students were informed that they could abandon the game at any moment if they felt uncomfortable with it or disinterested. Then the class was divided in small groups as asked to play the role of DRC children. Each group got a bag with sand and small stones, some of them blue mocking cobalt-rich pebbles. Researchers dressed themselves as military with some game elements (an army cap, a machine gun) and played intimidating roles, urging the students to hurry up and not to steal or lose a single tiny pebble of "cobalt". Students playing the role of child miners sifted the sand with small sieves looking for "cobalt" nuggets. Then each group took their "cobalt" for weighting and receiving the scarce "payment" in play money.

In the version without the role-play, students were asked to imagine the feelings of a child working in a mine, following researcher's instructions: to approach the foreman, to enter the mine, to shoulder ore sacks, to wash the ore in the river. A new topic was introduced approximately every three to five minutes. Exposures to abuses, environmental risks, weight of the ore sacks up to 50 kg etc., were recalled.

2.4.3. Part 3. Thinking.

The last 15 minutes of FOGS were employed for a collective reflection about the two previous parts. Researchers guided and encouraged a discussion where some crucial aspects were tackled: the impact of cobalt production on Sustainable Development

Goals and human rights, and possible alternatives to keep buying unsustainable minerals. Recycling was discussed as an action that can be done at individual level, allowing mobile phone owners to do something to solve (or not worsen) the problem. This part makes the participants thinking and was planned to consolidate the previous ones and induce a more durable behaviour change (Briñol and Petty, 2015).

After the intervention, students were asked again if they had intention to buy a new mobile phone within the following 12 months. Answers were recorded in writing.

2.4. Evaluation of the intervention effects

The outcome of FOGS was tested using objective indicators of refusing-to-buy and recycling behaviour. Behavioural non-buying intention was measured by [1-proportion of students manifesting the intention of buying a new mobile phone within the year] (refusing to buy), higher values indicating higher adhesion to this 10RO imperative. The change [After – Before FOGS] of behavioural intention indicates the immediate effect of the intervention.

Recycling behaviour was measured from the rate of return of Post-First-Life (PFL) mobiles in three weeks following the intervention. For this, after the interventions we left boxes for collecting PFL mobile phones for recycling in the classes, informing students about the deadline. The boxes were opened after three weeks, mobiles were counted and taken to civic amenities for reuse or recycling. The variable employed to measure the efficiency of the intervention in recycling behaviour was the number of mobile phones deposited in the box divided by the number of students in a class.

2.5. Statistics

Sample size was estimated taking into account the indicators used for measuring the success of the activity designed. In a recent survey in Spain, 74% participants disused permanently small electronic devices at home, and only 9% of this small ICT equipment was disposed for proper management –recycling, repairing or reusing (Bovea et al., 2018). This was our reference to calculate sample size according to Bartlett, Kotrlik, and Higgins (2001), using the formula:

$n = t^2 * P_o * (1-P_o)/d^2$,

n being the sample size, t the value for a selected alpha level in each tail (normal typified distribution), P_o the proportion of participants who brought a mobile phone for recycling, and d the margin of error. In this case, we assumed: $t = 1.96$ as the value for a selected alpha of 0.05 (the level of risk taken by the researcher); a proportion of persons recycling cell phones of 9% ($P_o = 0.09$; Bovea et al., 2018); a 5% margin of error ($d = 0.05$). The same calculation was done for a maximum proportion of 32% ($P_o = 0.32$) of mobile phones' recycling (OECD, 2019). This gives a range of $n = 125.9$ - 334.4 extracted from the two investigations.

For comparison of the proportion of PFL mobile return between groups (i.e. control versus treated groups or between different treated group) risk-odds analysis was done. Risk is the probability of occurrence of an outcome, in this case the proportion of mobile phone returns or proportion of students wanting to buy a new phone. Odds is the probability of occurrence of an outcome divided by the probability of the outcome not occurring. While for rare events the two measures have similar values, for more frequent events there are differences being odds > risk. Risk (or odds) ratio is the ratio of risk (or odds) in treated versus the risk (or odds) in the non-treated or differently treated group. Odd ratio is used in case-control studies when the total number of exposed or non-exposed people is not available (Ranganathan et al., 2015). In our study, this was the case of the exposure to emails informing about the box for mobile recycling (baseline), since we cannot be sure about how many students read the email. z-test was employed to determine the statistical significance of risk difference, risk ratio or odds ratio, with H_0 being no difference, ratio = 1.

Intervention effectiveness on behavioural intention (Refusing Buying) was tested using two-sample paired t-tests for the variable "Proportion of students refusing to buy" measured before and after playing FOGS in the groups of students considered.

Comparisons between the samples of this study and published references i.e. proportion of recycled mobile phones in Spain (reference: Bovea et al., 2018) and worldwide (OECD, 2019) was made using *z* statistics, with the formula:

$z_o = (p_o - P_o)/\sqrt{(P_o * Q_o)}/n$,

p_o and P_o being the proportions of recycled phones in the sample and the reference population respectively, $Q_o = 1 - P_o$, and *n* the sample size.

Statistics was performed with SPSS software version macOS 10.15. Significance threshold of $p = 0.05$ was used.

3.Results

3.1. Samples, their consumer profile and FOGS overview

The total number of 537 students that participated in the interventions in this study (Table 1) was larger than the superior sample size estimate (125.9 – 334.4) and can be considered powerful.

Of the university students participating in interventions 9.8% were of Engineering disciplines (Informatics, Mining, Industrial) and the rest of social sciences (Law, Education Sciences). The majority of non-university students were in the second cycle of secondary education (73.8%, age 14-15), 9.6% in the last course of primary education (age 11-12) and 16.6% in high school (*Bachillerato*, age 16-17).

FOGS was successfully implemented in the groups of students targeted. Indicators of the role-play effectiveness for attracting the attention of the involved students were the following: 0% abandon rate –all the students that started playing continued involved in the role play until the end of the game. Intense and lively discussions happened in the third part of the activity, with spontaneous participation of at least one half of the students in all the groups, without differences between role-play and no-role play interventions.

Regarding participants' profile as mobile consumers, the majority of university students of this study owned mobile phones of one or less years (Figure 1). The mean age of participants' mobile phones was 1.33 (*SD* = 0.89) for social sciences students and 1.05 (*SD* = 0.99) for engineering students. The number of hibernating, or post-first-life mobiles, ranged between none (22% participants) to 5 or more (3.1%), although the majority of participants had one, two or three at home (Figure 1). The average number of hibernating mobile phones was 1.66 (*SD* = 1.36).

In secondary education, answers about the number of hibernating mobiles were vague. Considering that these students are not responsible for electronic device disposal, we discarded this question. The mean age of current mobiles of secondary education students was 0.74 years (*SD* = 0.81), the majority owning mobiles bought in the year (Figure 1). The difference with university students was highly significant ($t = 8.03$, $p < 0.001$)

3.2. Study 1. FOGS and recycling. Role-play versus no-role play intervention

3.2.1. Methods

The effect of role-play versus no-role play interventions on mobile phone hibernation was tested in two groups of students of the Faculty of Teacher Formation and Education (Education Sciences department). In a first stage, three weeks before the interventions we left a box in the lobby of the Faculty labelled "Mobile Phones for Recycling". All the students of the Faculty (N = 1200) received a message in their e-mail announcing that a box was available for recycling obsolete mobile phones and explained its location, with no other information. The box was removed the day before the interventions and the mobiles inside were counted and provided us with a proxy of spontaneous mobile phones recycling without FOGS intervention (recycling behaviour in untreated students).

Then volunteer students were convoked through the Board of the Faculty and were randomly assigned to each treatment. In one group the intervention included role-play (N = 74) and in the other group no-role play intervention was applied (N = 166). The groups were unbalanced because some students dropped out before starting.

3.2.2. Results

Both interventions increased the rate of mobile phones dropped for recycling after the intervention (see Figure 2), compared with the low spontaneous return rate of untreated students (only two in three weeks, although the box availability had been annouced via email). Furthermore, the increase was much higher in role-playing (12.2%) than in no role playing or *imagine-other* intervention (2.1%) improving baseline odds ratio. Odds ratios were highly significant for both baseline *vs* imagine-self (OR = 12.479, z = 2.75, p = 0.006) and baseline *vs*. imagine-other- comparisons (OR = 82.938, z = 5.578, with $p < 0.001$; see Table 2).

Supporting Hypothesis *b*, the proportion of mobiles phones donated for recycling after role-play intervention was indeed significantly higher than that obtained after the intervention without role-play (Table 2), for all the measures considered: difference between intervention, risk ratio and odds ratio ($z = 3.134$, $p = 0.002$, z = 2.431, $p = .015$, and z =2.772, $p = 0.006$, respectively).

3.3. Study 2. Effect of role-playing in mobile returns in different disciplines

3.3.1. Methods

To test the efficiency of the designed intervention in students of different disciplines, we called for volunteers in four university Faculties randomly selected, $N = 46$ in total from engineering and law schools (Table 1), and administrated role-play FOGS. The results were compared with the role-play group of students of Education Science.

3.3.2. Results

Role-play intervention in groups of students of other disciplines was followed by a donation of mobile phones quite varied among groups (Table 3). In Computer Engineering and in the Master of Protection of Vulnerable Persons & Groups there were no donations by three weeks after the interventions, while in Mining Technology Engineering (small group of 4 students) one mobile was donated and in the group of 18 students of Industrial Engineering 14 mobiles were donated. The comparison between the results in Engineering profiles (total $N = 26$, 15 mobiles dropped) and the two groups of social sciences (Law and Education Sciences students, total $N = 94$, 9 mobiles dropped) was highly significant (risk ratio 0.468 [0.297 – 0.736], $z = 3.282$, $p = 0.001$), but the heterogeneity of results among groups and the different group sizes does not allow to obtaining robust conclusions.

Considering the total number of mobile phones donations in the experimental samples with role-play intervention (N = 120), the proportion of mobiles donated (24) was 20%. It was significantly higher than the percent of 10% of civic recycling found in Bovea et al. (2018) study on general population in Spain ($z_o = 3.651$, $p < 0.001$).

3.4. Study 3. FOGS and Refusing-to-buy. Effect of role-playing, student background and age.

3.4.1. Methods

Students of Secondary education were contacted through the teacher boards of four education centres of Asturias region, with N = 271 (Table 1) and played the role-play version of FOGS. In secondary school (Study 3) only behavioural intention was evaluated, because the students are below the legal age of majority (18 years in Spain) and we assumed that the parents (not the children) are responsible for disposing PFL mobile phones. The results for this variable were compared with those of university students.

3.4.2. Results

In both university and secondary education students, FOGS produced a change in the intention to buy a new mobile (Figure 3), using either role-play or no-role play intervention. We did sum all the students of Engineering because the groups of Mining and Computer Engineering were very small (N = 4, Table 1). Using the version without role-play (imagine-other) the proportion of students intending to buy a new mobile changed from 16.4% before the intervention to 2.7% after, equivalent respectively to 83.6% and 97.3% of students refusing to buy. In the role-play intervention the increase was from 87.8% to 98% in Education Sciences, from 73.1% to 92.3% in Engineering and 0% in Laws where no one wanted to change the mobile before FOGS (Figure 3, columns in the middle). In secondary education role-play intervention the improvement was from 85.7% to 97.1% (Figure 3, columns at right). To test the effect of the treatment a paired t-test was done (before versus after playing FOGS) for the proportion of students refusing to buy a new mobile phone within the year in the four groups represented in Figure 3. That proportion was significantly higher after (mean $M = 0.96$) than before ($M = 0.82$) the treatment ($t = 6.82$, $p = 0.006 << 0.05$).

In summary, the proportion of students that changed their recycling behavioural intention after playing FOGS was 13.7% in the group of no role-play and 15.1% in the whole groups treated with role-play. In the groups of students where the comparison was possible, the change in behavioural intention was not correlated with the behaviour of recycling measured from recycling rate (in Secondary Education recycling rate was not measured). In those six groups rank correlation gave $\tau = 0.46$, $p = 0.19 > 0.05$, not significant. This result should be taken with caution considering small sample sizes in Mining and Computer Engineering. Reuniting the three groups of Engineering the result did not change very much ($\tau = 0.67$, $p = 0.17 > 0.05$). The main discrepancy between the two sets of results occurred in the group treated with no role-play (Imagine-other) FOGS, where the change was much greater in the behavioral intention than in the recycling behaviour.

4. Discussion

4.1. Assessment of *For a Good Selfie* effects on e-waste recycling

Supporting Hypothesis *a* about empathy promoting sustainable behaviours (Font et al., 2016), this study provided strong evidence of the exposure to harsh conditions of child miners serving to increase pro-environmental behaviours aligned with R-imperatives. It served to decrease the intention to buy and to increase mobile dropping (donation) for recycling. The global rates of recycling achieved from FOGS, being relatively small, were higher than the spontaneous return by untreated students and also than other reference data in Spain (Bovea et al., 2018). This is important and opens a wide field for application of empathy to the specific improvement of sustainable behaviour regarding WEEE, at least in young citizens.

The lack of infrastructure for discarding post-first-life electronic devices was one of the causes identified by Church and Wuennenberg (2019) as a reason for not recycling. It is true that in our study we provided a box for recycling mobile phones, but it is unlikely that easy dropping was the main cause of the significant increase since before FOGS (untreated students) they had the same box available, in the same building. Although the presence of the box in the class after the intervention could perhaps serve as a reminder of prompt of the intervention, the results would suggest that playing FOGS was at least partially the cause.

4.2. Psychological interpretation of FOGS effects

Our results supported Hypothesis *b* about the efficiency of role-playing promoting perspective-taking in easy, pleasurable ways that help to engage in environmental issues (Rumore et al., 2016; Fjællingsdal and Klöckner, 2017; Lithoxoidou et al., 2017). Differences in recycling behaviour between the interventions of FOGS with and without role-play suggest that role-play is more efficient in enhancing proactive mobile dropping behaviour (behaviour change), Studies 1 and 2 in 3.2 and 3.3. Considering the “imagine-self” aspect of role-play simulation, this difference could be explained from the respective effects of imagine-self and imagine-other instructions (Batson, 2009; Myers et al., 2013); imagine-self instructions activate the sense of self-other overlapping that boosts empathic concern (Todd and Galinsky, 2014). Since imagine-self implies cognitive empathy plus self-other overlapping while imagine-other is mainly focused on cognitive empathy, double psychological motivation to help (Preckel et al., 2018) would explain more action-taking in the role-play FOGS version. In addition to this, likely other psychological components of role play simulation have contributed to the higher behavioural change promoted from role-play FOGS. We could mention at least player enjoyment (Fjællingsdal and Klöckner, 2017), safe environment while adopting others' perspective (Rumore et al., 2016), and adopting really their behaviour while living the experiences of miner children (Peng et al., 2010).

Although the imagine-other intervention does not promote empathic concern at the same level that role-play, an increase in recycling behaviour was observed anyway – less efficient than the role-play, but significant, as expected from literature (Laurent and Myers, 2011). However, the two interventions produced similar changes in behavioural intentions (refusing-to-buy, see Study 3, section 3.4). Cognitive empathy and the level of empathic concern induced with imagine-other perspective-taking are probably sufficient to induce intention changes, because the emotional components of empathy are not necessary to activate the sensitivity to social justice (Decety and Yoder, 2016). The results of our study would suggest differences between the effect of FOGS on behavioural intention and on behaviour change.

4.3. Interpretation of differences among groups of students

Hypothesis *c* was not supported from our results, since, opposite to the expected from Kukkonen et al. (2018), the effect of FOGS on recycling behaviour was significantly lower in social sciences than in engineering (Study 2, section 3.3). The source of the message could explain this unexpected result. Regarding social injustices, Pinazo-Calatayud et al. (2020) demonstrated that strong messages from a source favourable to a cause have little impact on the behaviour of people already sensitized for that cause. The whole issue around abuses and violence on miner children is very strong. It can be logically assumed that students enrolled in Education Sciences and those studying Legal Protection of Vulnerable Groups (Laws School) will be more sensitive to messages related with injustices to children than students from other disciplines. Although it was not explicit, since the beginning of Part 1 it was clear that FOGS researchers were favourable to the cause of social and environmental sustainability. It is possible that the same action organized by a neutral source had a greater effect on electronic waste return than when it is organized from researchers committed about sustainability.

Without excluding a possible effect of the message source, the apparent lower impact of FOGS on students supposedly more sensitive to children suffering could also be explained from higher pro-environmental behaviour in these groups. Kim et al. (2018) demonstrated that increasing awareness about sustainability may have small effect on actions when the audience is already taking pro-environmental actions. In our case, these students exhibited a higher refuse-to-buy behaviour than engineering students before playing FOGS (Figure 3), having older appliances (Figure 1), and this could be taken as a signal of higher environmental awareness - assuming a similar interest for communication technology. It is possible that they were already recycling mobile phones using other channels.

On the other hand, the credibility of a message is not always related with behaviour change. Sustainability campaigns may even decrease pro-environmental actions, something that can be partially explained from the disconnection between the science in the message and individual subjective concepts of sustainability (Godfrey and Feng, 2017). This does not seem to be the case in our study, where more emphasis was put on child miners than on science, and both refusing-to-buy, and recycling behaviour changed significantly.

Finally, Hypothesis *d* could not be demonstrated from our data. Secondary and higher education students increased their intention of refusing-to-buy in a similar level (Study 3, section 3.4), although the expectation was that younger students were less sensitive to FOGS from their lower sensitivity to sustainable values (Forleo et al., 2019; Kamenidou et al., 2019). Their actual behaviour as mobile phone consumers, however, was consistent with Forleo et al. (2019) and Kamenidou et al. (2019) results: secondary education students owned significantly newer devices than university students (Section 3.1). It is possible that the strong message conveyed by FOGS serves to overcome this difference, at least intentionally.

4.4. Limitations of this study

Although the study was largely based on generating empathy with child miners, here we haven't measured empathy traits but changes in behavioural intention and behaviour that were the real objective of the intervention. We did assume that empathy increased as a consequence of a higher self-other overlap, and that such increase was a reason for the change, but it is possible that role-play activated, alternatively or concomitantly, other psychological entities like the sense of justice that, although can be activated through empathy, is an independent characteristics of our species. For example, Taylor (2009) defined justice as a basic psychological human need. In education contexts, the sense of justice is directly related with civic attitudes, and the moral sense of justice can promote pro-environmental actions (Resh and Sabbagh, 2014; Sweetman and Witmarsh, 2016). Perhaps role-play activated directly the sense of justice, although from differences between FOGS versions it seems more probable that empathy was a mediator of behaviour change. Future studies could tackle this issue measuring situational empathy traits after FOGS interventions.

Another limitation was that, despite large sample size of the study as a whole, samples of university students were unequally distributed across disciplines, with small groups in Computer and Mining engineering. Recruitment was made from a call for volunteers; it is possible that in those disciplines students are more motivated for technical than for social issues. Perhaps an intervention encompassing a reflection about technological challenges in cobalt recycling would attract more volunteers there. Further developments could explore the issue of differences between formation background using larger samples of engineering and extending the background to health and natural sciences. If the differences found in this study were confirmed from larger samples and more specialties, interventions should take into account the previous formation of target groups and design ad-hoc activities.

As a technical detail commented in the section 4.2, in similar experiments the proxy to the spontaneous return rate of mobile phones could be improved depositing boxes for recycling in all the classes, instead of centralizing recycling in the lobby before the intervention.

5. Conclusions and potential applications

To conclude, our study demonstrates that the intention of refuse-to-buy mobile phones and recycling behaviour can be induced through the exposure to socially and environmentally unfair situations related with cobalt production. Role-play enhanced more recycling behaviour. Shevchenko et al. (2019) proposed new electronic bonuses as alternatives to existing consumer incentives to increase collection rates of post-first-life electronic devices. However, other incentives, being empathy, the sense of justice and/or moral satisfaction, could be facilitated using FOGS and other similar interventions based on role-play approaches.

FOGS was assayed in Spain, where increasing the rate of WEEE recycling is much needed given current figures. Other countries with higher recycling rates would also benefit from behaviour changes, until reaching 100% recycling objective as desirable for fully sustainable electronic goods. The message of current mobile phones implying violations of the Convention of the Rights of the Child is strong. Spreading it across societies could help to change consumer's behavior towards a better WEEE recycling, especially if R-imperatives are presented as more sustainable alternatives.

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The authors declare that this study has no conflict of interest.

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Figure legends

Figure 1. Mobile consumer profile. PLF, post-first-life. Mobile phone age, age of current mobiles in years.

Figure 2. Effect of the intervention in post-first-life mobile recycling, as proportion of recycled mobiles over number of students.

Figure 3. Change in Refusing-to-buy in university and secondary education students, measured from the proportion of participants not intending to buy a new mobile before and after playing “For a good selfie”. HE, higher education.

Table 1. Student samples, by education level and specialty. N = sample size.

Specialty	Education level (age)	*N*	% females	Intervention
Education Sciences	HE (>18)	1200	75.9%	None
Education Sciences	HE (>18)	146	68.5%	No role play
Education Sciences	HE (>18)	74	86.5%	Role play
Legal Protection of Vulnerable Persons and Groups (Laws School)	HE (>18)	20	60%	Role play
Mining Technology Engineering	HE (>18)	4	75%	Role play
Computer Engineering	HE (>18)	4	25%	Role play
Industrial Engineering	HE (>18)	18	44%	Role play
School A	Primary (11-12)	26	46.2%	Role play
School B	Secondary (14-15)	200	50%	Role play
School C	High School (15-16)	16	56.3%	Role play
School D	High School (15-16)	29	51.7%	Role play

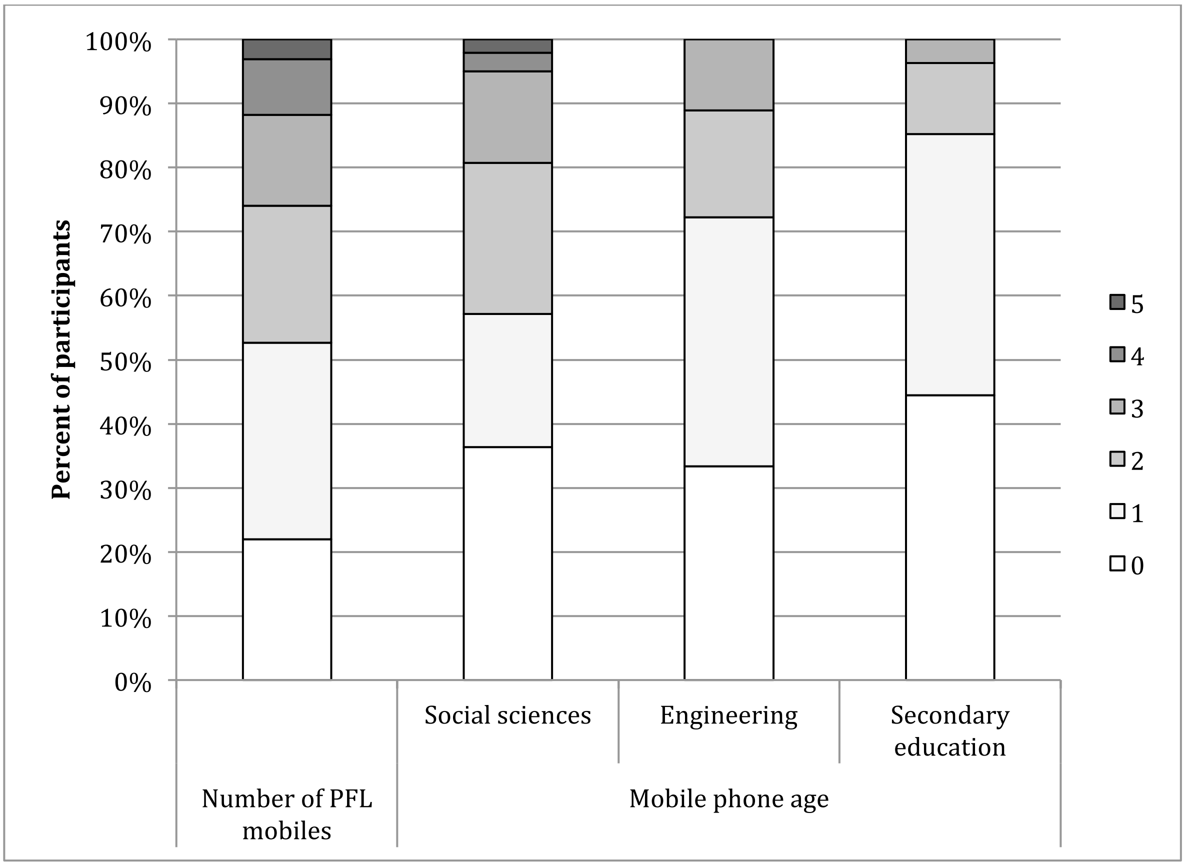
Table 2. Risk-odds analysis of the interventions in educational sciences students.

	Parameter	Value	95% confidence	z	p
Untreated vs. no role-play	Risk difference:	0.019	[0.004 - 0.042]	3.527	.0004
	Risk ratio:	1.019	[0.959 - 1.043]	1.584	.113
	Odds ratio:	12.479	[2.068 - 75.31]	2.75	.006
Untreated vs. role-play	Risk difference:	0.119	[0.045 - 0.195]	10.825	<< .0001
	Risk ratio:	1.137	[1.044 - 1.237]	2.958	.003
	Odds ratio:	82.938	[17.56 - 391.7]	5.578	<< .0001
No role-play vs. role-play	Risk difference:	0.101	[0.023 - 0.179]	3.134	.002
	Risk ratio:	1.115	[1.021 - 1.218]	2.431	.015
	Odds ratio:	6.646	[1.742 - 25.36]	2.772	.006

Table 3. Mobile recycling rate as donations in three weeks after role-play intervention in different university disciplines.

Discipline	Students	Recycling rate
Education Sciences	74	0.12
Industrial Engineering	18	0.78
Mining & Materials Engineering	4	0.25
Computer Sciences	4	0
Law Sciences	20	0

Figure 1. Mobile consumer profile. PLF, post-first-life. Mobile phone age, age of current mobiles in years.



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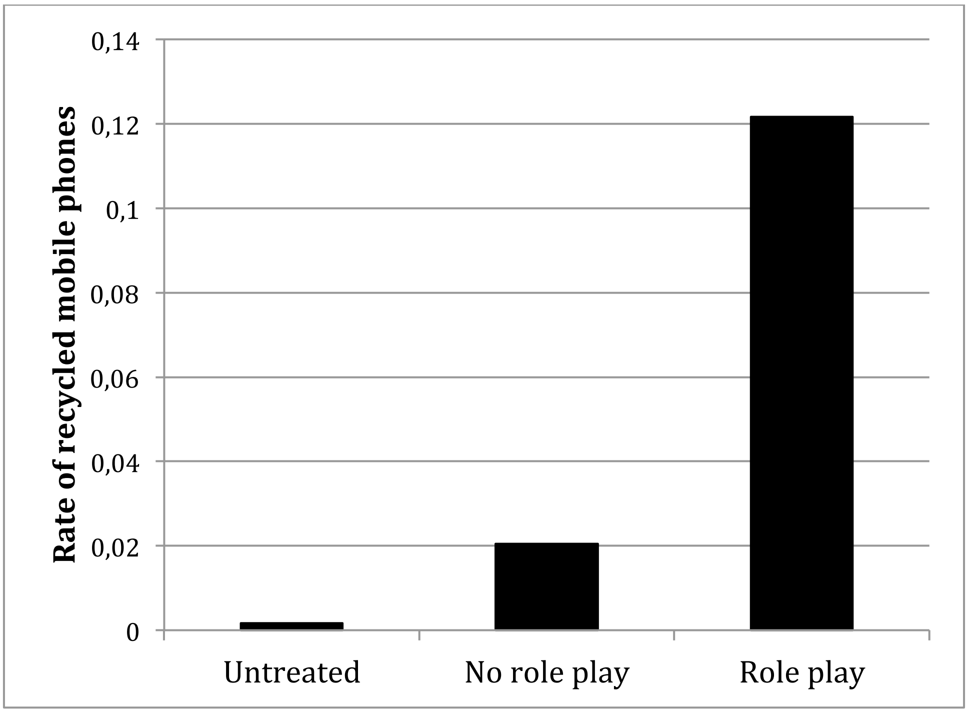
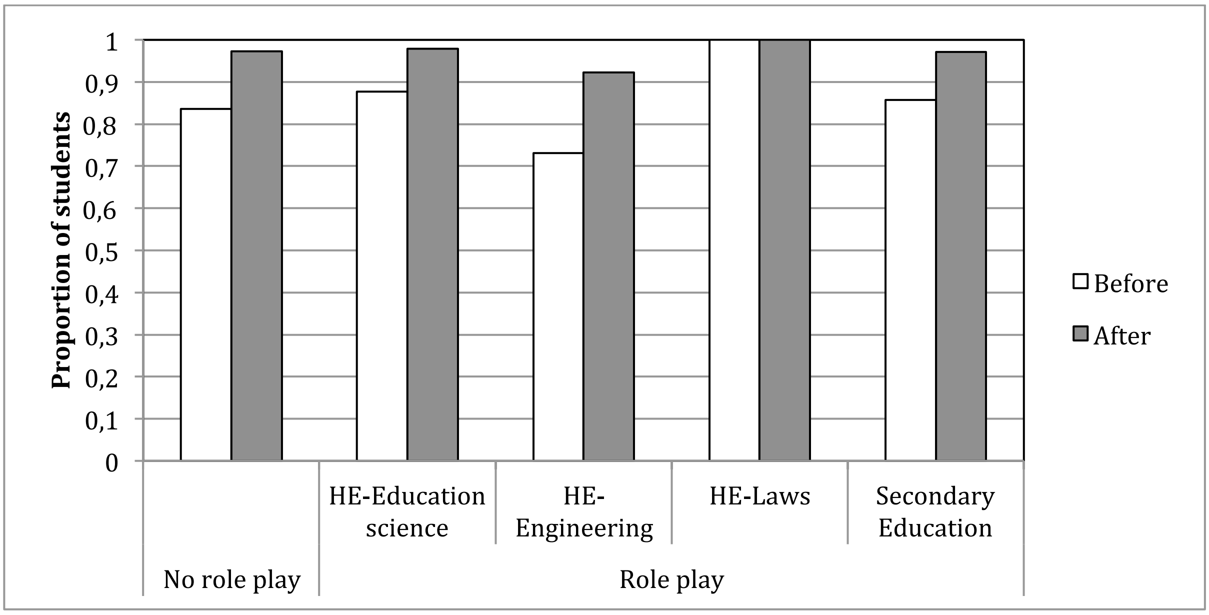


Figure 3. Change in Refusing-to-buy in university and secondary education students, measured from the proportion of participants not intending to buy a new mobile before and after playing "For a good selfie". HE, higher education.



Supplementary Information

Supplementary Table 1. Questionnaire employed in this study (English version). The original language was Spanish because the study was carried out in Spain.

We are interested in the consumption behaviour about mobiles phones. Could you please answer the following questions?
1) How old is your current mobile phone, in years?
2) How many old mobile phones that you no longer use have you at home?
3) Do you plan to buy a new cell phone within the next year? *

* This question was posed again after playing FOGS