



KNOWLEDGE AND BEHAVIOUR OF GERMAN STUDENTS REGARDING RECYCLING AND WASTE REDUCTION

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ABSTRACT

Through the various activities of waste reduction, re-use, recycling and composting, energy and resources can be saved for future generations. To help achieve sustainable waste management, waste producers must be aware of potential advantages, disadvantages, benefits and problems of different waste management options. Education for sustainable development can help to achieve this. In the current paper, questionnaires were designed and distributed to students to find out what knowledge they had about waste management options and recycling possibilities, how important they rated different waste management approaches, whether they recycled on a regular basis and what they thought about waste reduction. The results illustrate that knowledge about waste management options is high while knowledge of recycling possibilities, participation in recycling behaviour and the importance of waste reduction is lower than in similar surveys that were conducted in other countries.

Keywords: Waste management, recycling, source reduction, waste hierarchy, education for sustainable development

INTRODUCTION

Waste management is one aspect of sustainable development which influences societies in a range of different ways. Waste production leads to resources and energy being lost, landfill can be a nuisance in terms of smell and lost space, recycling and composting still uses energy and requires the participation of the public (Edgerton, McKechnie, & Dunleavy, 2009; Samakovlis, 2004). Any waste which is produced has to be transported, handled and managed in one way or another. From the viewpoint of sustainable development, it is therefore best to not produce waste at all (Oskamp, 1995; King, Burgess, Ijomah, & McMahon, 2006). If waste production is inevitable, materials should be chosen which are easily recyclable or compostable and which burden the environment as little as possible.

The overall population plays a major role regarding sustainable waste management (Bekin, Carrigan, & Szmigin, 2007). In particular students are good recipients of education initiatives because they act as "multipliers". What they learn at school or from peers will be transported into their families and can help to change behaviour of the whole family (Larsson, Andersson, & Osbeck, 2010; Vaughan, Gack, Solorazano, & Ray, 2003). It is therefore important to understand what students currently know about waste management options, what their attitudes to waste management are, whether they realize the importance of different waste management approaches and whether or not they participate in recycling behaviour. The current paper analyses this for students in Germany. It is assessed for the first time as to how students' attitudes and behaviour is reflected in the national waste statistics and national legislation. Germany was chosen for the current study since it has an advanced waste management system with strict regulations regarding landfill, as well as high recycling rates. Similar studies have been undertaken in countries where higher amounts of waste are landfilled and less waste is recycled, namely Romania (Kolbe, 2014) and England (Kolbe, 2015).

WASTE MANAGEMENT IN GERMANY

Since 2005, landfill of untreated waste is prohibited in Germany. Since then, waste has to be treated mechanically and/or biologically before it can be landfilled which means that only inert materials are allowed to be landfilled (Umweltbundesamt, 2006). This has increased the cost for landfill from around 20-30 Euros per ton before 2005 to around 150 Euros per ton of waste after 2005 (Giern, 2007). Consequently, landfill is minimised wherever possible. Recycling and composting rates have increased - which is seen as an environmental benefit for the country. At the same time, high costs for landfill



also resulted in the frequent use of incineration technologies which is sometimes criticised as not being in accordance with sustainable development (NABU,2009). Development of recycling and incineration rates can be seen in Figure 1.

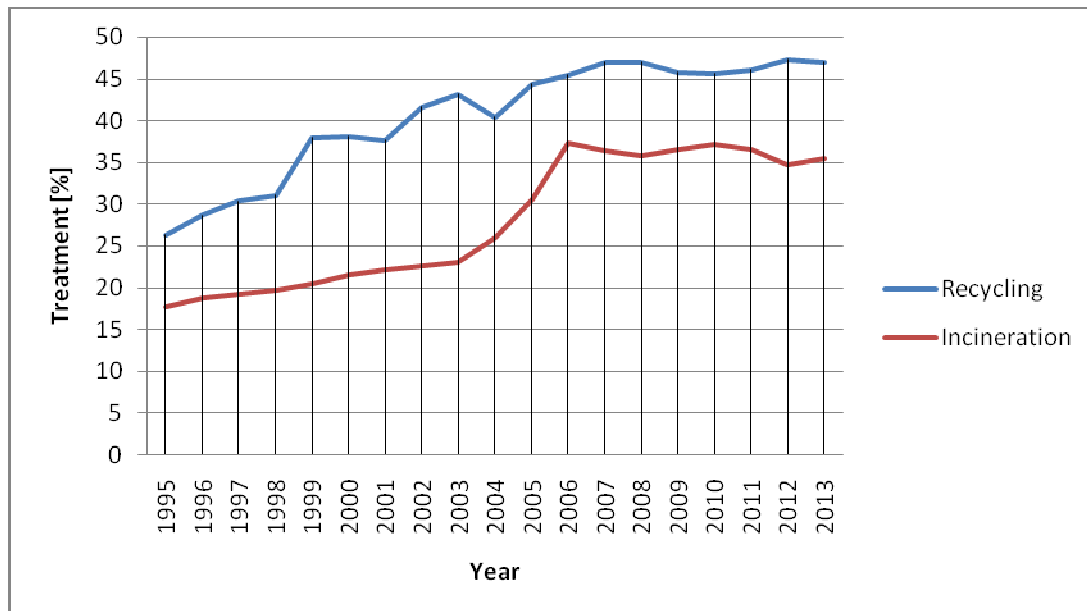


Figure 1. Percentage of municipal waste which was recycled and incinerated in Germany between 1995 and 2013 (Eurostat 2015).

The responsibility for packaging waste management was shifted to the producers in 1991 through the German packaging ordinance (Bundesministerium der Justiz 98). As a result, the Duales System Deutschland was established which took over the responsibility from packaging manufacturers, to take care of the end-of-life management process. Packaging materials which are managed through this system are marked with the Green Dot symbol and are collected separately from the rest of the waste stream. Packaging producers pay a licensing fee for the Green Dot and thereby pay for the management, recycling and/or disposal of their packaging materials (Rousso & Shvetank, 1994; Hillebrand, 2009). Therefore, compared to other European countries such as the United Kingdom or Romania, where only a limited number of recyclable materials are collected through kerbside collection services, all packaging materials are collected in most areas in Germany (Vehlow, 1996). Next to recycling, incineration is a common method of waste management in Germany (Eurostat 15).

As a result of these regulations, Germany's landfilling rate is among the lowest in Europe. In 2012, Germany only landfilled around 3 kg of waste per capita. Only Sweden (3 kg) and Switzerland (less than 1 kg) landfilled equally little or less. The EU average is 160 kg per capita. However, in 2012, around 213 kg were treated through incineration. Germany thereby belongs to those countries within Europe that incinerate large quantities of its waste. Only Denmark (349 kg), Luxembourg (237 kg), Sweden (239 kg) and Norway (268 kg) incinerate more municipal waste per person. In 2012, the EU average was 115 kg per capita (Eurostat 2015).

At the same time waste reduction, is only partly reflected in the national waste statistics, as can be seen in Figure 2. Since 2006, the amount of municipal waste produced per capita has increased with only a small decrease between 2011 and 2012. This is in contrast to the development in the EU, where waste decreased since 2007. On average, every German citizen produced around 611 kg of waste in 2012. Only in Denmark (668 kg), Cyprus (663 kg), Luxembourg (662 kg) and Switzerland (694 kg) is more municipal waste produced per person. Germany's waste production per capita is therefore among the highest in Europe and is not compatible with sustainable waste management.

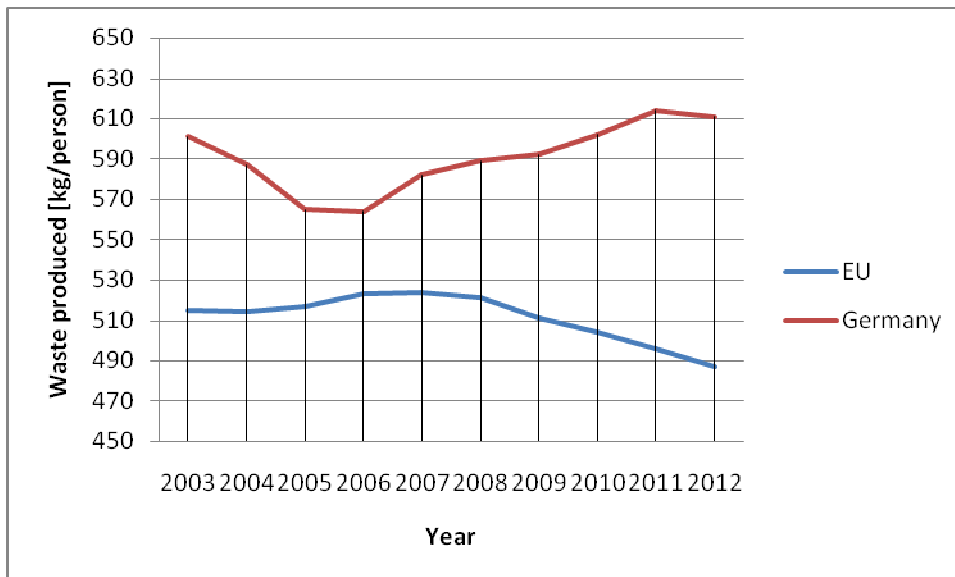


Figure2. Waste production between 2003 and 2012 in Germany and the EU (Eurostat 2015).

Germany has the reputation of being a very green country with an environmentally conscious population. A popular travel guide points out that “to recycle a teabag” it is necessary to use “all but one of the five rubbish bins found in German homes” and that “Germans are Europe’s biggest recyclers” (Schulte-Peevers, 2013: 97). However, research showed that people who recycle do not necessarily also perform waste reduction (Ebreo & Vining, 2001). Waste reduction has not yet received the same level of scholarly or public interest as has recycling in Germany.

RESEARCH QUESTION

As has been shown, Germany’s current waste situation is only partly compatible with sustainable waste management. While the country has high recycling rates, waste production is excessive and a large fraction of the waste that is produced is treated via incineration. Moreover, the current legislation leads to high recycling and low landfill rates even if many citizens are not inclined to participate in recycling schemes.

To increase sustainable development in the area of waste management, it is of importance to find out in how far German students participate in waste management approaches and what they know and feel about the different options used to treat waste. The current questionnaire therefore tries to find out what students know about waste management and how they behave.

Considering the legislative background, the following hypotheses were developed and tested through the questionnaire:

- (1) German students live in a country with an advanced waste management system. It is therefore suspected that they have high levels of knowledge regarding waste management techniques.
- (2) Since recycling rates are high in Germany, it is suspected that German students are generally supportive of recycling and try to recycle whenever possible.
- (3) Incineration is a technology which is widely used in Germany. Since a large percentage of municipal waste is treated in this manner it is suspected that German students tend to support this technology, and consider it a good option for the treatment of waste.
- (4) The average German citizen produces a lot of waste and this has not decreased significantly during recent years. It is therefore suspected that waste reduction is not seen as being of high importance, possibly because waste is currently managed efficiently.



Similar questionnaires were divided in schools in Romania (Kolbe, 2014) and England (Kolbe, 2015). Whether German students showed a higher or a lower awareness for waste related issues and whether they more actively contributed to recycling schemes and waste reduction was of interest considering that Germany is currently producing more waste but landfilling less and recycling more than Romania or the UK.

METHOD

An explorative approach was chosen to analyse knowledge, perceptions and behaviour in respect to waste management. Questionnaires were designed and distributed in 2009 in a comprehensive school in a small city in Germany with a population of 40,000. The questionnaires were filled out anonymously in class. A total of 165 students between 13 and 14 years of age completed the questionnaires. The questionnaire had been piloted previously through handing it out to differently aged students. Students from the age of 13 onwards understood the questions well, while students younger than 11 years often had problems understanding some of the questions.

Multiple choice and open ended questions on knowledge about waste management, attitudes regarding waste management options and behaviour in the area of waste recycling were part of the questionnaire.

Specifically, the part of the questionnaire which is analysed in this paper consisted of the following questions:

Question 1: Knowledge about waste management concepts/multiple choice question. A list of concepts was provided (Recycling of paper, kerbside collection, composting, incineration and landfill). Students could choose between the answer options “I have never heard of it”, “I have heard of it but I don’t know what it means” and “I have heard of it and I know what it means”.

Question 2: Importance of waste management options/multiple choice question. Students were asked how important different mostly waste related issues (reducing the amount of waste, recycling waste, composting organic waste, re-using waste, earning lots of money and reducing global warming) appear to them on a scale from “1” (very unimportant) to “10” (very important).

Question 3: Impression about incineration/multiple-choice and open ended question. Students were asked “if you know what incineration is, please tell us if you think that it is a good way of treating waste”. The answer options were “Yes it is, because...”, “No, it isn’t, because...”, “It can be, if...” and “I don’t know”. Students could then explain their viewpoint.

Question 4: Knowledge about recycling potentials. A list of 7 materials was provided (paper, glass, Fruit juice cartons (Tetra Paks), Plastic bottles (PET bottles), drink cans, cardboard and aluminium foil). Students were asked to circle the materials of which they thought that they could be recycled.

Question 5: Recycling behaviour/multiple choice question. Students were asked how often they recycled paper, Green-Dot products and glass bottles. They also had the option to name other materials which they recycled besides the three named ones. Students could choose between “whenever possible”, “at least once every month”, “at least twice a year”, “almost never” and “other (please specify)”. For the purpose of the analysis, “at least once every month” and “at least twice a year” were summarised as one category which is called “sometimes”.

Question 6: Reasons for not recycling/open ended question. If students did not recycle, they were asked to provide reasons for this.

Question 7: Importance of waste reduction/open ended question. Students were asked “Do you think that waste should be reduced? Please provide reasons why you think waste should or should not be reduced”.

The analysis was carried out using the SPSS statistical software package and Excel. The answers to multiple choice questions were compiled into groups. The groups were checked by another researcher.



Discrepancies were discussed. Answers which were only given by one students were compiled in a specific section which is called “other”.

RESULTS

Different concepts which are related to waste management were provided to the students. The answers which were given by the students can be seen in Table 1. Most students had heard of the named concepts and understood what they meant. Only very few students claimed to have never heard about the concepts.

Table 1.
Knowledge Of Students

Concept	<i>Have never heard of it</i>	<i>Have heard of it / don't know what it means</i>	<i>Have heard of it / know what it means</i>	<i>Missing answer</i>
Recycling of paper	0.6	4.2	94.5	0.7
Kerbside collection services	1.2	0.6	97.6	0.6
Composting of garden and kitchen waste	6.0	15.8	78.2	0.0
Incineration	1.2	4.8	92.7	1.3
Landfill of waste	1.8	18.2	79.4	0.6

Students were asked how important different waste management options appeared to them on a scale ranging from 1 (very unimportant) to 10 (very important). The mean values can be seen in Table 2. The order of importance is given in brackets. In addition, “earning lots of money” and “reduce global warming” were equally provided as options to the students.

Table 2.
Importance Of Waste Management Options

Concept	Importance
Reduce the amount of waste	6.33 (4)
Recycle our waste	6.88 (1)
Compost organic waste	5.36 (6)
Re-use waste	5.76 (5)
Earn lots of money	8.21 (2)
Reduce global warming	8.06 (3)

Note. Students could choose between “1” (very unimportant) and “10” (very important).

As can be seen in Table 2, German students rated recycling as most important, followed by “earn lots of money” and “reduce global warming”. Other waste management options were seen as being of less importance. However, waste reduction was seen as more important than re-use and re-use as more important than composting. Still, with the exception of recycling, German students thereby rated personal benefits (earning lots of money) and the reduction of a global environmental problem (reduce global warming) as more important than reduction of waste, re-use or composting. This is particularly interesting since waste-reduction, waste re-use and composting are potential actions that everybody can participate in and that can help to reduce global warming (Ackerman, 2000).

Students were asked what they thought about incineration, a technology which is widely used in Germany. Students were also asked to provide reasons for their judgement. The answer options can be



seen in Table 3. Slightly less than 20% of the students considered it a good technology, around 35% stated that it could potentially be a good technology if certain criteria are met while 32% of the students stated that it is not a good technology for the treatment of waste. The almost 20% of students who considered it a good technology named the reduction of landfill as reasons and the production of energy from waste. Students who thought that it could potentially be a good technology named efficient filtration technologies as precondition, the use of techniques which produce energy while the waste is burned and the limitation to specific materials, e.g. materials which cannot (easily) be recycled. Reasons given by students who did not consider it a good technology encompassed the impact of exhaust fumes and toxic substances that might be left in filters and ashes.

Overall, students who considered incineration “a good technology” were not less likely to recycle paper, green-dot products or glass.

Table 3.
Perception About Incineration

Impression of incineration	Answer of students [%]
<i>A good technology</i>	19.4
<i>Not a good technology</i>	32.0
<i>A potentially good technology if certain criteria are met</i>	35.5
<i>Do not know whether it is a good technology</i>	13.1
<i>Missing answer</i>	0.0

A list of materials was provided to the students and they were asked whether they thought that these could be recycled or not. The percentage of students who classified the materials correctly can be seen in Table 4. Almost 100% of the students knew that paper is recyclable while almost 90% of the students classified glass, pet bottles and cardboard correctly. However, only around two-third classified Tetra Paks correctly and slightly less than two-third of the students classified drink cans correctly. Finally, only one quarter of the students were aware that aluminium foil can be recycled. Knowledge about the recycling potential of standard materials (paper, glass, plastic bottles) was therefore relatively high, while other materials were often classified incorrectly.

Table 4.
Knowledge About Recycling Possibilities

Material	Correct answer [%]
Paper	99
Glass	86
Fruit juice cartons (Tetra Paks)	62
Plastic bottles (PET bottles)	89
Drink cans	57
Cardboard	89
Aluminium Foil	25

Students were asked about their recycling behaviour. The results can be seen in Table 5. Over 50% of the students stated that they did not recycle any of the named materials “whenever possible”. This is particularly surprising if one considers the high recycling rates in Germany and the general opinion that Germany is a very recycling-eager country. Moreover, in theory students rated recycling as very important, as can be seen in Table 2. Considering this, it is particularly surprising that not even half of



the students recycled “whenever possible”. Around one quarter even recycled paper and Green-Dot products “almost never”, over 20% claimed that they recycled glass bottles almost never.¹ Students who recycled “whenever possible” overall rated recycling as more important than students who recycled only sometimes or almost never. This indicates that the importance which is felt by students is also translated into behavioural change. This finding thereby supports similar findings by other authors who conclude that environmental awareness and personal values are vital for environmental behaviour (Maloney & Ward, 1973; Grob, 1991: 199).

Table 5.
Recycling Frequency

Material	Whenever possible	Sometimes	Almost never	Missing answer
Paper	43.9	18.3	26.2	11.6
Green-Dot products	40	23.6	25.5	10.9
Glass	47.3	18.8	21.9	12

Students were asked to provide reasons why they did not recycle. 25% of the students provided reasons. These can be seen in Table 6. With over 35%, the reason most often named was that it takes too much work or time to recycle, followed by a lack of knowledge and interest. The majority of the students thereby named internal/personal issues. Only a minority named external issues such as “other people” or “parents” do it, a “lack of containers at home” or the feeling that “waste gets incinerated anyway”.

Table 6.
Reasons For Not Recycling

Reasons	Answers of students [%]
It takes too much work/time	35.4
Lack of knowledge	16.7
Not interested	14.6
Other people are paid to do it	8.3
Parents do it for me	6.3
Too complicated	6.3
Because parents do not do it	4.2
Lack of containers at home	4.2
It gets incinerated anyway	2.1
Other	1.9

Students were asked whether they thought that it is necessary to reduce the amount of produced waste. The students could choose between “yes, waste should be reduced” or “no, it is not necessary to reduce waste”. The results can be seen in Table 7. As can be seen, over 8% thought that a reduction of waste is not necessary and another 15% left the answer blank which might indicate that they were unsure on whether waste should be reduced. Consequently, only three quarters of the students clearly stated that they did consider a reduction of waste important. While this is still the majority of the students, it is more than surprising that in a country where over 600 kg of municipal waste are produced per capita, every fourth students did not clearly support a reduction of waste.

Table 7.
Perception About Waste Reduction

¹Gamba and Oskamp(1994) found, that self-reported recycling behaviour was higher than observed recycling behaviour. Consequently, reported frequencies might be biased by social desirability or selective remembrance. While self-reported behaviour is a common method in social sciences, the frequencies reported in this paper might show a bias towards higher reporting of recycling frequency.



Impression of incineration	Answer of students [%]
Yes, waste should be reduced	75.8
No, it is not necessary to reduce waste	8.5
Missing answer	15.7

Students were also asked to provide reasons for their judgment. Students who thought that waste should be reduced normally named environmental reasons for it such as a reduction of environmental pollution, nature protection, to reduce global warming and to reduce the amount of waste for future generations. It was also considered healthier by over 5% of the students who said that waste should be reduced. Reasons such as resource use, money savings and animal protection were also named by a few students.

Students who stated that they did not consider waste reduction important rated all of the waste management options which are named in Table 2 as less important than students who considered waste reduction important. They were significantly more likely to consider “earn lots of money” important ($p \leq 0.1$). They are also less likely to recycle any of the materials which are listed in Table 5. At the same time, they were more likely to consider incineration “a good technology” to treat waste.

Students who stated that it was not necessary to reduce waste named the reasons given in Table 8.

Table 8.
Reasons Given By Students For Why Waste Reduction Is Not Necessary

Reasons	Answer of students [%]
It can get recycled	21.4
A change of lifestyle is needed	21.4
Jobs depend on it	14.3
It is not possible	14.3
It is not important/I do not care	14.3
It can be burned	7.1
Not specified	7.1

The answers “It can get recycled” and “it can be burned” might indicate, that the high recycling/incineration rate in Germany led some students to believe that waste reduction is not necessary despite the fact that waste reduction is the environmentally best option regarding waste management. However, students also named lifestyle changes, job security and disinterest as reasons. 28.6% of the students also generally stated that “it is not possible”, “it is not important” or that they did “not care”. Unfortunately, more specific reasons were not named by these students.

DISCUSSION

The results illustrate that despite Germany’s advanced waste management system, students often showed a surprising lack of knowledge regarding recycling potentials and disinterest regarding recycling and waste reduction.



While factual knowledge regarding waste management options is relatively high, with over 90% of the students stating that they knew what recycling of paper, kerbside collection services and incineration meant, the same cannot be said about the students' knowledge regarding recycling potentials. Only slightly over 60% of the students knew that Tetra Paks could be recycled, drink cans were judged as recyclable by only 75% of the students and aluminium foil by as few as 25%. Some of the findings can assumedly be explained by looking at the current waste management system in operation. Aluminium foil is not part of the Green Dot scheme in Germany and pupils might therefore get the impression that it is not recyclable. Equally, drink cans are not part of the Green Dot scheme but are instead part of a one-way deposit scheme. They can be returned to shops for a small refund. Students might have believed that this system was introduced because cans cannot be recycled. However, Tetra Paks do carry a Green Dot and are normally advertised as environmentally friendly alternative to one-way plastic bottles. Potentially, the current system in which all packaging materials, including Tetra Paks, are collected together in bins or bags for collection compared to paper or glass, which is collected separately in bins or through bring banks, might lead to the students not realising that these packaging materials are recyclable. Hypotheses 1 is therefore only partly confirmed. While factual knowledge is high, actual knowledge about recycling potentials is in many cases not well developed.

There is a clear discrepancy between what students consider important and what they actually do. While students in theory considered recycling very important (even more important than "to earn lots of money" or to "reduce global warming"), they often did not recycle themselves "whenever possible". Many even recycled "almost never". This is in accordance with other authors who found that attitudes and knowledge are in many cases not sufficient to alter behavioural change (Fietkau & Kessel, 1981: 11; Grob, 1991: 119). At the same time, recycling rates in Germany are very high. However, it is important to note that these high recycling rates are not in all cases a result of society's behaviour to recycle their waste. Instead, the German government relatively early transferred the responsibility to fulfil certain recycling rates to packaging waste producers. Therefore, recycling targets have to be fulfilled even if the population is not willing to participate. Moreover, the government banned landfilling of untreated waste, which resulted in a steep increase of costs for landfilling materials. Therefore, landfill is normally avoided whenever alternatives such as composting, recycling or incineration exist. Recycling rates have to be fulfilled and landfill is minimised even where the population is unwilling to participate in waste sorting activities. Hypothesis 2 was therefore only partly confirmed: While recycling was judged as being important in theory, actual behaviour was not in accordance with this. Many students did not recycle regularly -although every household in Germany has the option to do so.

Incineration, a widely used technology in Germany, was regarded sceptically by over 30% of the students. Another 13% did not know whether it is a good technology or not. Hypotheses 3 was therefore proven incorrectly. A large proportion of the student population are not supportive of incineration. This is surprising considering that incineration is widely used in Germany. It raises the question whether students who disapprove of incineration are aware that it is used to such a large extent. Otherwise one would assume that the use of a technology which is seen sceptically by a large part of the population will trigger protest and opposition.

Only three-fourth of the surveyed students clearly stated that they considered waste reduction necessary. This is in contrast to results from similar questionnaires in Romania (Kolbe, 2014) and England (Kolbe, 2015) where almost all students considered a reduction of waste important. Hypotheses 4 was therefore confirmed. It might be that in a country where waste is no longer a clearly visible problem as it is in other countries, students might get the feeling that waste per se is not a problem anymore. As a result of strict legislation, the problems associated with landfill are no longer visible in Germany. However, the problems which cannot be seen directly, such as a loss of energy, resources and the release of exhaust fumes, are still environmental problems which can be reduced through waste reduction.



Overall, the findings of the current study confirmed findings in the area of consumer psychology. Catlin and Wang (2012) showed through psychological experiments that people produce more waste when the option to recycle waste exists. This also seems to apply to the level of society. Once a country or a society reaches a level where most materials are recyclable, waste reduction is seen as being of less importance.

To minimise this environmentally unfortunate behaviour, teachers need to highlight the need for – in particular – waste reduction. The excessive use of resources and energy through waste that is produced is unnecessary and everybody can easily help to produce less waste through some easy behavioural changes. However, this will only be successful if students are aware of the benefits of waste reduction.

CONCLUSION AND FUTURE RESEARCH

The current paper for the first time showed the connection between Germany's waste production, management statistics, national laws regarding waste management and students' attitudes towards waste management. The results in particular show that Germany's advanced waste management system might have led to students having the feeling that recycling and waste reduction is no longer necessary. Compared to similar questionnaires which were undertaken in Romania and England, the results from the German school are therefore disillusioning - and perhaps bode ill for the future.

Education for sustainable development is vital in this area. Students do not only need to know how to recycle but need to understand why it is still important even in a country where waste is no longer a visible problem. The environmental, economic and social benefits must be highlighted. Moreover, the benefits of waste reduction in comparison to recycling need to be addressed so as to save a maximum of resources and energy.

Future research should assess whether the tendencies which are described in this paper also exist in other countries with advanced waste management systems. In a further step, initiatives need to be developed and tested to increase students' willingness to participate in waste reduction so as to help the world live in a more sustainable manner.



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