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A comparison of waste education in schools and colleges across five European cities

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ABSTRACT

The European Union produces over 200 million tonnes of municipal waste each year with 47% being recycled or composted. With the EU reuse and recycling targets set at 55% by 2025 and the introduction of the EU's Circular Economy Action Plan there has never been more importance placed on waste and recycling education. A three-year transnational project 'An Erasmus + Waste Education Initiative' set out to investigate the level of waste and recycling education (WE) that is currently being delivered in five European cities with a view to develop a range of materials to be used in the classroom extracting the best practice from each. This paper highlights the responses from a questionnaire sent to schools and colleges to determine the baseline of WE currently being delivered in Bucharest, Hamburg, Manchester, Tallinn and Zagreb. Factors such as the local waste and recycling infrastructure and population density were also considered to determine the extent of their influence on the type and availability of WE in the classroom. The findings indicate a wide variation in the amount of WE currently being delivered in the five cities. Increased recycling rates and level of infrastructure have an inverse effect on the level of teacher engagement and involvement in waste management projects does not have an impact on the amount of WE that is present in the curriculum or number of registered Eco-Schools. Time constraints due to other curriculum topics, awareness and lack of resources were the main reasons for not including WE in the classroom.

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1. Introduction

The reduction of waste generation through prevention, reuse and recycling are part of the Sustainable Development Goals (Nations 2021) and fundamental to a Circular Economy. The EU produces approximately 200 million tonnes of municipal waste each year with 47% currently recycled (Eurostat 2021); however, the target for 2025 is 55%. In order to meet these goals, behaviour change and education is vital to produce a waste aware and motivated generation of young people who will improve the quality and quantity of valuable resources available for recycling. This will also prepare them for 'green' sector opportunities resulting from the decoupling of economic growth from material consumption central to the Circular Economy principles (Stahel 2016). It is estimated that the expansion of the Circular Economy has the potential to create 1.2 to 3 million jobs and reduce unemployment by 520,000 in the EU member states by 2030 (WRAP 2015b).

To design teaching resources that include waste management and introduce concepts such as the Circular Economy and the Waste Hierarchy it is important to understand the baseline of material currently used in the classroom. This paper presents the findings

of a questionnaire sent to teachers in schools and colleges across five European cities; Bucharest, Romania; Hamburg, Germany; Manchester, UK; Tallinn, Estonia; and Zagreb, Croatia. Combining these empirical data with factors that influence recycling performance within each region, an analysis of available waste education, materials used and factors that influence Waste Education (WE) uptake in the classroom are presented.

Integrating sustainability education (SE) in schools has attracted significant academic research over the years, for example, teacher knowledge (Green and Somerville 2015), integrating SE in to the school day (Meersdom and Vandelacluze 2018; Pereira da Silva et al. 2020) and evaluating SE present in primary textbooks (Andersen Katja, 2018). However, few studies are specifically concerned with WE in schools and colleges. This finding was echoed by a study based on Danish schools seeking to overcome shortcomings of habitual behaviour (Jørgensen et al. 2018). Those that do involve WE tend to examine a single project or initiative in one school or class (Cunningham-Scott 2005; Maddox et al. 2011; Stöckert and Bogner 2020). This paper

contributes to the literature by providing a comparison of WE across five European cities and examining the influence of the local waste management infrastructure (Butler and Hooper 1999) and population density (Rispo et al. 2015) on the WE provided in junior and secondary schools and colleges.

Before analysing the results of the questionnaire sent to teachers, it is first important to understand the impact of waste education and the role it has played in the five regions.

1.1. Waste education

Factors such as policy and availability of recycling facilities all influence the variation in recycling rates; however, along with access to facilities, education and ongoing environmental awareness campaigns are found to be one of the biggest influences on recycling rates within the control of Local Authorities (Starr and Nicolson 2015). Schultz et al. (1995) carried out a literature review of studies into the determinants of environmental behaviour. They concluded that awareness and attitude were fundamental factors in whether a person will recycle or not. Their review found it was specific knowledge of the recycling scheme available, rather than general environmental knowledge that was the predictor of positive recycling behaviour. Further to this, a study carried out on five deprived high-rise estates in the London Borough of Haringey concluded that continued communication to change behaviour over time is required to increase recycling performance (Rispo et al. 2015).

The idea of continual communication and education was echoed in a study carried out in Texas, USA where the LA, waste contractor and a primary school worked in partnership to determine the effects of recycling education (Cunningham-Scott 2005). The study found that recycling rates increased during the term time and fell dramatically during the summer months, increasing again once the children had returned to school and to the recycling education. The Taking Home Action on Waste (THAW) project was conducted in Rotherham, United Kingdom to determine the effects of intensive education in infant and primary schools (Maddox et al. 2011). The project centred around the 3'R's (Reduce, Reuse and Recycle) and involved assemblies, workshops and homework to complete with parents. The results were overwhelmingly positive with residual wastes falling by 4.5%, paper recycling increasing by 4.3% and glass, cans and textiles by 8.7%. The project concluded that as well as producing a waste aware cohort of children there was also evidence that intergenerational influence can have substantial effects on waste and recycling rates.

Environmental Education has been building importance on the global stage for many years. In 1994 'Eco-Schools' was set up by the Foundation for Environmental Education. This voluntary, pupil led programme empowers young people to develop an environmentally conscious world (FEE 2020). This seven-stage programme guides young people through forming an eco-committee, carrying out Environmental Reviews, making action plans linking to the curriculum and producing an eco-code for the school. Initially, Eco-Schools were European based but the scheme now has over 59,000 schools in 68 countries around the world (EcoSchools 2020).

Although schemes such as Eco-Schools are available, in this case, to all five cities, not all schools become an Eco-School. The influence of socio-economic factors (Valenzuela-Levi 2019) and population density on a school's propensity to arrange extra-curricular activities is varied within a country and certainly between countries.

1.1.1. United Kingdom

The education system in the United Kingdom has incorporated environmental education (EE) at certain points over the years. It was introduced as a cross-curriculum topic 'the built and natural environment' in 1990 but was removed from classrooms in 1994. In 2000 the Education for Sustainable Development introduced environmental education as a non-statutory topic, this was updated in 2006 by the Sustainable Schools Strategy which included a 'Purchasing and Waste' module, but again this was removed in 2010 (NAEE(UK) 2015). Since 2014 there has been little formal environmental education and specifically waste and recycling education in schools although it is mentioned as a small element within the Science subject in Key Stage 3 (DfE 2014). Organisations such as the National Association for Environmental Education, a UK-based charity, and Waste Watch who later merged with Keep Britain Tidy, provide support to teachers wanting to teach EE in their classrooms, this heavily relies on the interests of teachers and their willingness to incorporate EE into their classroom activities.

1.1.2. Romania

In Romania, waste education is not adopted as a topic in the basic curriculum in schools, colleges or universities. Only environmental disciplines teach waste topics in higher education, and only since 1997. Pilot educational activities related to waste started in 2000 in schools and are often supported by environmental associations and NGOs. In primary and secondary schools, only dedicated teachers are introducing the waste topic within environmental education, this is done voluntarily with not too much interest from the authorities. Today, these educational activities do not

have continuity and only occasionally involve waste contractors for marketing purposes or public authorities to reach the legal recycling targets. Without public policy and legal constraints for waste educational activities included in the national curriculum, combined with the awareness for Circular Economy, the Romanian waste challenge will continue preponderantly targeting landfilling or incineration.

1.1.3. Germany

In Germany, schools in different states are starting to incorporate the subject of sustainability into their syllabus. A committee of stakeholders from the political arena, academia and non-governmental organisations is responsible for advising Germany's education ministers on the inclusion of sustainability in the curricula. The environmental movements of the 1970s played a major role in the development of the current approaches. In the 1980s, numerous concepts with very different orientations and objectives were developed in the German-speaking countries, for which various designations were introduced, such as environmental education, ecological learning, and ecopedagogy. Since the late 1980s, environmental education actors have existed in all educational sectors, from early childhood education, school, university, vocational and general (further) education to informal learning. Following Agenda 21 at the 1992 World Conference in Rio de Janeiro, environmental education developed further in the context of the Education for Sustainable Development (ESD) campaign (UNESCO 2013). Without the guiding principle of sustainable development, environmental education is now obsolete. This model not only applies to ecology, the environment and nature but also integrates other dimensions such as social and economic issues and often also to politics/participation and culture. This has now been accepted by nearly all actors in the former environmental education field, in all areas of education and in science and politics.

1.1.4. Estonia

Environment education is one of the priorities for Estonia and traditionally it has focused on biodiversity, natural heritage and species conservation. Starting from 2000, Environmental education has been incorporated in the wider topic of Education for Sustainable Development (ESD), being implemented in Estonian schools' curriculum. According to the National Curricula, sustainable development was recognized at all school levels as a cross-curricular objective in 2002. Based on sustainable development requirements, study programmes have been developed which included topics such as waste management, mining of mineral resources, and other economic and cultural aspects affecting the state of the environment. With support of Estonian government and European

Structural Funds the EDS got a new leap, especially during the financial period from 2007 to 2013. During this time two measures were supported: 'Development of the infrastructure of environmental education' with 22.3 million euros by the European Regional Development Fund and 'Development of Environmental Education' with 3.2 million euros by the European Union Social Fund (Henno 2016). Today ESD in Estonia covers formal and informal learning.

1.1.5. Croatia

The national body responsible for the education system in Croatia is the Ministry of Science and Education (MSE). The Croatian education system provides education services at four different levels: pre-school, primary school, high-school and higher education levels, as well as for adult education. They are trying to enable every user to develop his/her potential optimally, aiming at their personal development and entry into the labour market, including their preparedness for lifelong learning. Environmental education (EE) is not separately enrolled in the Curriculum, but it is touched within cross-curriculum topics as sustainable development (MSES 2019). Sustainable development encompasses all three dimensions of sustainability – environmental, social and economic sustainability and their interdependence; these topics prepare students to act appropriately in society for personal and general well-being. According to the provisions of the Environmental Protection Act, in 2004 an Environmental Protection and Energy Efficiency Fund was established to secure additional resources for the financing of projects, programs and similar activities in the field of conservation, sustainable use, protection and improvement of the environment. The Fund provides funding and organizes events for different levels of education and communities at the local, regional or national level can participate in various projects to develop an awareness of the application of waste management principles, 3 R concepts, our environmental footprint and sustainable use of resources among others. Whether or not the Curriculum has this type of education or it is provided by the Fund or other sources, the main goal of environmental education (EE) is to implement awareness among communities as early as possible that waste, if adequately managed, can bring economic and ecological benefits.

The last two decades have seen schools in all five regions introduce Environmental Education and, to an extent, Waste Education (WE), whether this is through the formal curriculum or via extra-curricular activities.

2. Methodology

Figure 1 provides an overview of the framework used for the study.



Figure 1. Study framework.

Table 1. Number of questionnaire responses.

City	Primary School	High School (College)	Total
Manchester	11	5	16
Hamburg	7	12	19
Tallinn	13	10	23
Bucharest	16	6	22
Zagreb	17	13	30

To determine the baseline of waste education being delivered in the schools and colleges within the five cities; Bucharest, Hamburg, Greater Manchester (Manchester), Tallinn, and Zagreb, a questionnaire containing open and closed questions was developed and sent to all schools in the local areas, the number of responses received is shown in Table 1. During the development of the survey further education providers were identified including local authorities, waste contractors, and universities, the responses from these are not included in the scope of this paper. Although it is worth noting that the education they provide to schools and colleges should be picked up in the survey results from the schools and colleges, however this is not guaranteed.

The questionnaire had two foci; the first to gather information on the waste facilities/infrastructure within the school such as whether there is a recycling system, material segregation and whether the school is a registered Eco-School. The second was on the amount of WE provided in the school and if it is taught as part of the curriculum or whether it is a voluntary extra. If WE is provided, information was sought on the

type of materials used, how often and who supplies the resources. The teachers were also consulted about where and how they felt WE could be improved.

The five regions, although all European, have varying socio-economic profiles. Population density and the availability of a waste and recycling infrastructure can influence the topics taught in the classroom. Relevance and interest significantly increases long-term learning (Stöckert and Bogner 2020) so material separation, for instance, is not appropriate in a country that does not have a recycling infrastructure. A desk study and informal consultation with the local waste authority for each city to determine the local collections offered to residents and limitations to increasing their recycling performance was carried out to provide a picture of each local area and how they compare with each other.

3. Results and discussion

3.1. The five cities

The five regions included in this project and the project partners are shown in Figure 2, the cities were chosen based on the broader project with which this study lies, the consortium that made up the members of the Erasmus+ Waste Education Initiative (Thewastecitizen 2020). The diverse locations promoted transnational cooperation when sharing best practice and aimed to increase regional development whilst tackling common environmental issues.

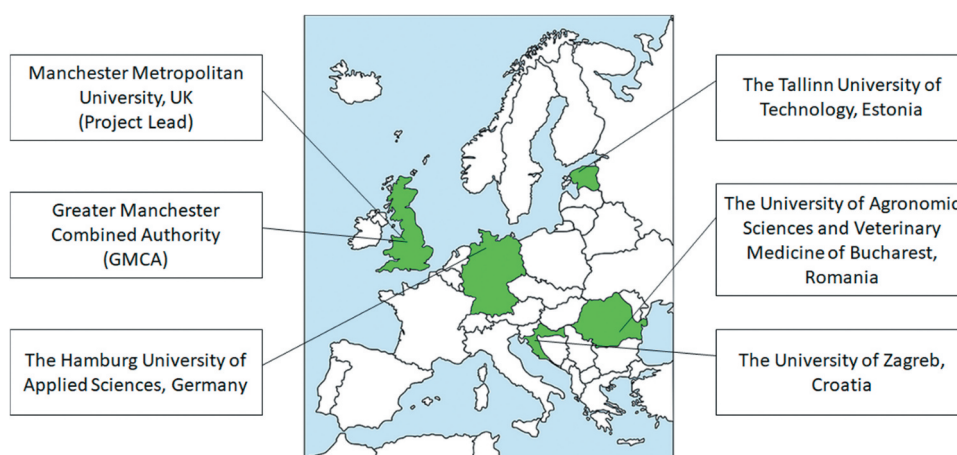


Figure 2. Map of regions in study.

The regions covered by the partnership represent approximately 7 million residents and 5 million tonnes per annum of Municipal Solid Waste (MSW), with varying approaches to waste management.

Figure 3 summarises the population size and geographical area of each region for comparison. It is well documented that these two factors have an impact on the way waste and recycling is collected and treated (Rispo et al. 2015). For instance, whilst Greater Manchester has the largest population at 2.79 million with a geographical area of 1,277 km², Bucharest has a population of 2.12 million in a geographical area of just 238 km², or in other words there are 2.2 people/m² in Greater Manchester and 8.9 people/m² in Bucharest. Tallinn and Hamburg have 2.8 and 2.4 people/m² respectively and Zagreb has the least with 1.3 people/m². A large majority of the population of Bucharest reside in high-density housing such as apartments in high-rise buildings. High-density housing can have significant impacts on recycling levels and can hinder kerbside recycling schemes (Rispo et al. 2015). Rispo et al.'s study concluded that residents in highly populated areas require intensive and ongoing recycling services and awareness campaigns to promote material segregation, resources that most Local Authorities are lacking.

Kerbside collections of recyclate consistently capture larger tonnages of material than alternative schemes such as bring sites in local recycling centres or supermarket car parks (Butler and Hooper 1999). Table 2 provides a summary of the kerbside waste infrastructure provided to residents in each region. Hamburg and Greater Manchester both have recycling rates of 47%, see Figure 4, and have a similar kerbside waste infrastructure with containers for green waste, food, bottles, glass, cans, paper and card. They both have fortnightly and monthly residual waste collections.

Tallinn also has a kerbside waste collection scheme and has a slightly lower recycling rate of 44%. The residual collection in Tallinn is collected once or twice a week; this could be an obstacle to increasing the recycling rate as there is little incentive for residents to recycle. Abbott et al. (2011) found that there is an inverse relationship between recycling participation and the frequency of the residual waste collection; that is, many Local Authorities saw an increased recycling rate when changing from a weekly to a fortnightly residual waste collection (Abbott et al. 2011).

Tallinn has a Deposit Return Scheme (DRS) for plastic and glass bottles and Hamburg has one for glass and cans, which runs alongside its kerbside collection.

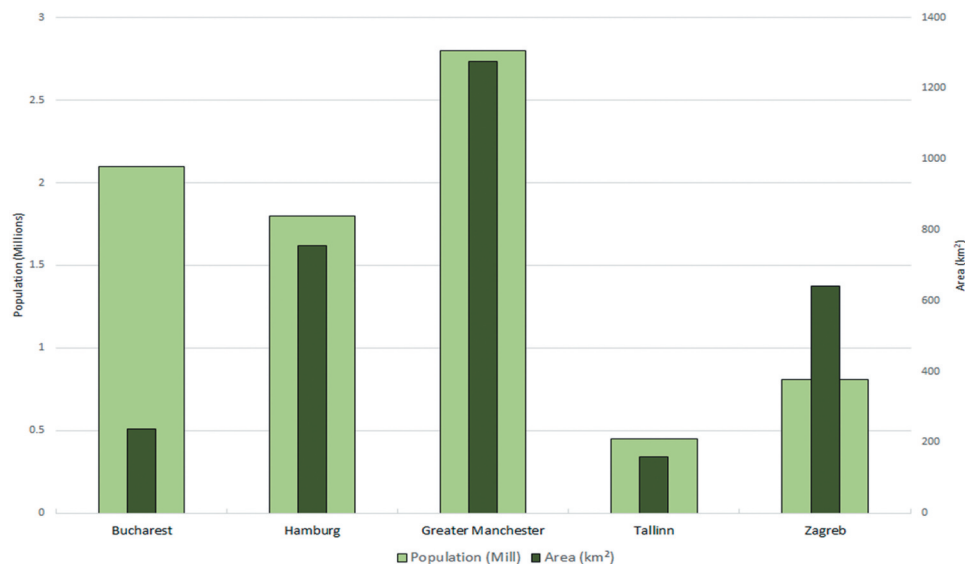


Figure 3. Population and geographical area each city.

Table 2. Summary of kerbside waste collection frequency in each partner region.

	Bucharest	Hamburg	Manchester	Tallinn	Zagreb
Residual	2 to 3/week	Fortnightly	Fortnightly	1 to 2/week	2/week
Paper/card	-	Monthly	Fortnightly	1 to 2/week	-
Metal/plastic	-	Fortnightly	Fortnightly	-	-
Glass*	-	Monthly	Fortnightly	-	-
Bio waste	-	Fortnightly	Weekly	1 to 2/week	-

*Glass is collected with metal and plastic in Manchester

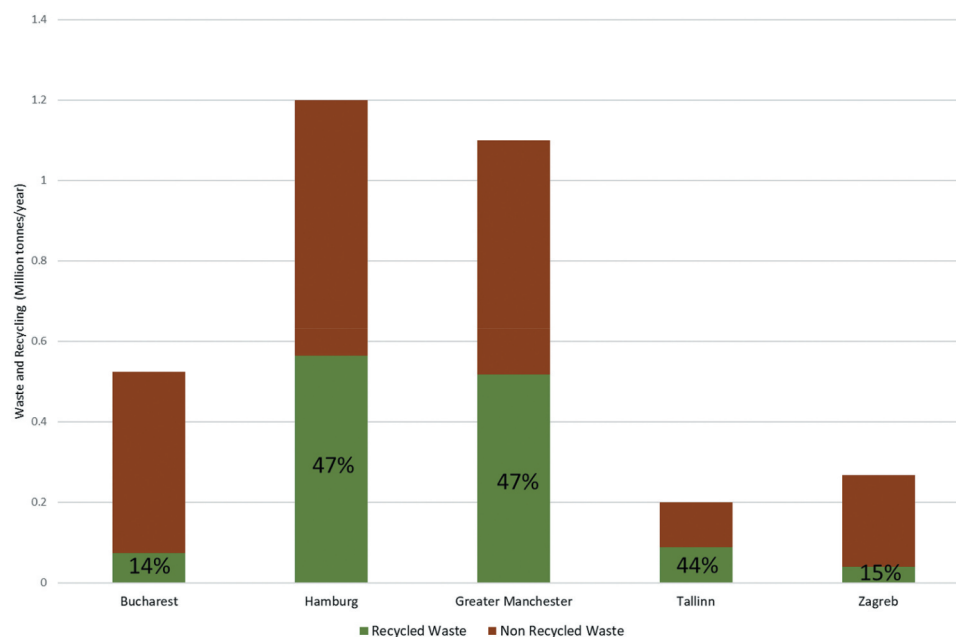


Figure 4. Quantity of waste collected and recycled in each region.

A DRS is due to be introduced to the UK in 2023 (DEFRA 2019); however, the cost of implementation has come under criticism due to the already comprehensive kerbside collection offered and that the estimated €1.1 billion set up costs could be better used to reduce the litter associated with the on-the-go bottles (Snowden 2019).

Zagreb has a similar recycling rate as Bucharest at approximately 15%. Both of these countries currently have little to no downstream processors for recycling materials and the majority of waste is landfilled, though both countries are currently investigating energy from waste plants. Zagreb is also in the early stages of implementing a kerbside recycling scheme, however there are no plans for Bucharest to implement one at the time of writing this paper.

When Local Authorities were asked about obstacles to current recycling performance, contamination was mentioned in the three regions offering a kerbside scheme. Contamination presents issues from the point of collection by taking up space in the vehicles, to damaging machinery leading to costly repairs and downtime. A local authority in England reports to spending €276,000 annually on rejected material due to contamination (WRAP 2015a). Lack of infrastructure and a reliance on overseas markets were noted as being major obstacles to current performance with Greater Manchester collecting only plastic bottles and Hamburg finding the adaption of the Circular Economy, especially WEEE, lacking. Manchester also highlighted the need for disposal routes for compostable and biodegradable alternatives to plastics as residents are incorrectly placing them in the plastic recycling bins. As already discussed, Tallinn highlights

frequency of collections and size of residual bins to be an issue and that packaging waste is not a kerbside collection, but collected via bring sites. Bring sites tend to contain high levels of contamination and tend to capture far less material than with kerbside collections (Butler and Hooper 1999).

The five regions show different approaches to managing their waste and recycling, to understand the influence these differences have on the WE provided in schools it is first important to understand the waste infrastructure within schools.

3.2. Waste infrastructure within schools

A separate waste infrastructure within schools can promote recycling behaviour and cement learning by using a real-life experience (Meersdom and Vandelacluze 2018). Noticeably, the two cities with the highest recycling rates, Manchester and Hamburg, had fewer schools with separate waste collections than Zagreb (44%) and Tallinn (44%) at 19% and 11%, respectively. Bucharest had the least with no schools having a separate waste infrastructure, which would be expected as there is minimal recycling infrastructure in the city.

The schools that did not have a separate waste collection scheme were asked if they would like to organise one. The majority of respondents, see Table 3, from Manchester and Hamburg did not want to participate with 63% from Manchester and 79% from Hamburg saying no. The majority of teachers in Bucharest, Zagreb and Tallinn said that they would be interested in organising separate waste collections in their schools. Bucharest, having no schools with

Table 3. % of respondents interested in organising separate waste collection at their school.

	Yes	No	Already in place
Manchester	19	63	19
Hamburg	10	79	11
Tallinn	35	9	44
Bucharest	82	18	0
Zagreb	37	0	63

separate collections were the most likely to want to organise the schemes with 82% of respondents saying yes, indicating that the lower the recycling rate of a region the more interested the teachers are at implementing a separate waste collection.

Financial support, permits from school administrations and active support from colleagues were factors highlighted to promote the organisation of a recycling scheme. All cities, especially Bucharest and Zagreb, indicated that material support such as separate containers were required to set up the schemes, although this would also indicate a need for downstream processors of the collected recycle.

When asked what could improve waste collection, prevention, reuse or recycling rates at their school the most popular answer from Manchester, Hamburg and Zagreb was more awareness of the topic. Tallinn also found awareness important being the second most popular answer after provision of appropriate containers, however Bucharest found awareness the least popular answer. Bucharest felt the biggest improvement could be made by the responsible handling of waste in the classroom, indicating that a separate waste collection scheme in the classrooms would improve the waste collection and recycling rates, less so the prevention or reuse of waste materials.

Less than half of teachers surveyed in all five cities had been involved in a waste management project with Manchester and Hamburg responding only 6% and 5%, respectively, responding positively. 17% of teachers in Tallinn had, 37% in Zagreb and 46% in Bucharest. The teachers were asked if they would like to be involved in a recycling or a circular economy project or hub in the future and a similar pattern is seen with 19% of Manchester teachers being interested, 26% in Hamburg, 44% in Tallinn, 73% in Bucharest and 80% in Zagreb. Once again indicating that the lower the recycling rate of a city the more likely a teacher had been involved in a waste management project or would like to be involved in one.

This emerging pattern of teachers in areas with higher recycling rates being less inclined to organise separate waste collections and be involved in waste management or circular economy projects could be explained by the presence of a robust waste and recycling infrastructure and therefore waste is not seen as a priority. Unlike a city with lower recycling rates where the majority of waste is being sent to landfill, the urgency to divert waste from

landfill is clearly apparent and therefore requiring immediate action. Waste infrastructure within schools and the teacher's propensity to be involved in waste and circular economy projects will have an impact on the waste education that a child receives. It is therefore necessary to determine how much waste education is delivered as part of the curriculum or whether it is an extra-curricular component of school life.

3.3. Curriculum or extra-curricular

Teachers are required to cover all topics on the curriculum set by their governments. It is therefore clear that if waste education (WE) is included as a topic on the curriculum it will be taught by teachers. However, it is worth noting that not all topics are covered every year and therefore some teachers who teach certain age groups may not be aware of the curriculum for other age groups they do not teach, especially if waste education is covered as a sub topic of a broader subject such as environmental education. Figure 5 shows the percentage of respondents that have WE as part of the curriculum at their school. Bucharest (27%) and Manchester (31%) have the lowest rates of WE on the curriculum, Hamburg has just over half at 53%, and Tallinn has 70% with Zagreb having the most at 83% of schools.

These results could be explained by the reason already highlighted that the teachers who responded to the questionnaire did not teach the age group where WE is found on the curriculum and therefore produced a negative image of the current curriculum in some regions. Alternatively, if these results are indicative of the general level of WE in the curriculum, Manchester and Bucharest have the lowest formal WE; however, their recycling rates and infrastructure are polar opposites therefore finding an explanation for a lack of WE must go beyond infrastructure.

Zagreb and Bucharest have similar recycling rates, yet their level of WE are at opposite ends of the scale, again indicating that infrastructure has little influence over whether a curriculum contains WE. A presumption could be that a government's propensity to install recycling infrastructure would indicate their inclination to incorporate WE in the curriculum, but these results show this not to be the case. There are many reasons for a lack of infrastructure that are often complex and out of the control of an authority, however the ability to add WE to the curriculum may be something the authority has autonomy over.

Figure 3.21 also shows the number of schools who responded to the questionnaire that are certified Eco-Schools. Bucharest, Hamburg, Manchester and Tallinn all have between 23% and 35% of schools that are running the Eco-School scheme with Manchester equalling the number of schools that have WE on the curriculum. The other regions have less Eco-Schools

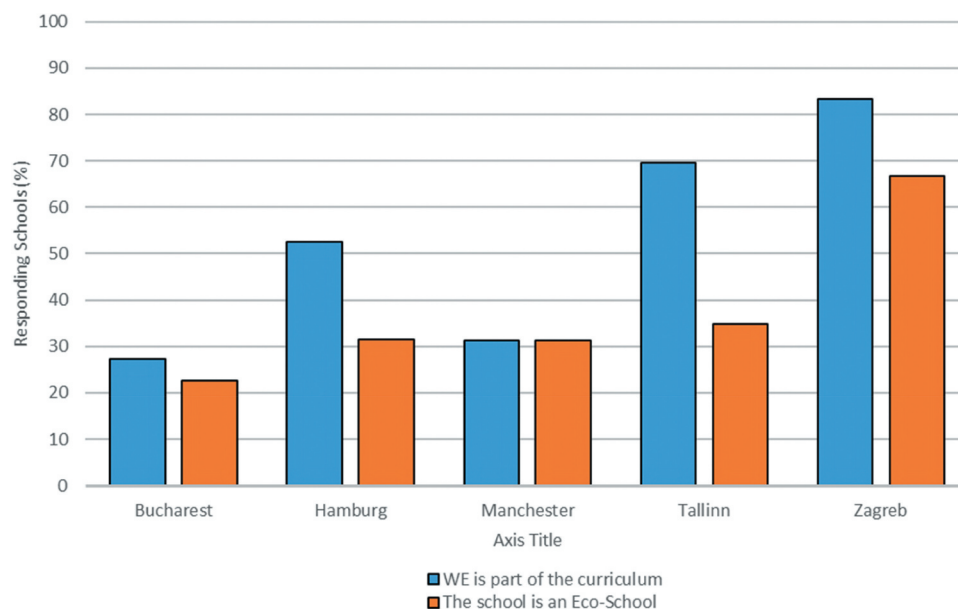


Figure 5. Percentage of respondents that have WE on the curriculum and or are an Eco-School.

than schools with WE on the Curriculum. Zagreb, as with the WE on the curriculum, outperforms the other cities by having the most number of Eco-Schools at 67%. This indicates that not only are teachers required to teach WE but they also incorporate WE as extra-curricular activities within the schools.

The Eco-School certification is not the only method of teaching WE as an extra-curricular activity, so to fully understand the frequency that WE is taught in schools teachers were asked how often they used WE materials in their classes. Frequency of WE in the classroom will have an impact on compounding knowledge (Starr and Nicolson 2015), so the more frequent materials are used the greater the long-term knowledge. Figure 6 shows

the frequency with which teachers said that they use educational materials based on waste management. Overall WE materials are rarely used by teachers across all cities daily. Although numbers start increasing, very few schools use WE materials once a week. Manchester and Hamburg are more likely to use materials from twice a year or less, noticeably over half of the teachers in Manchester and Hamburg said that they use WE materials less than once a year. More schools said they only use WE materials once a year in Tallinn than the other categories, however the numbers were more evenly proportioned with 26% saying they use the materials once a month and 21.7% saying that they use them once every 6 months. Bucharest and Zagreb

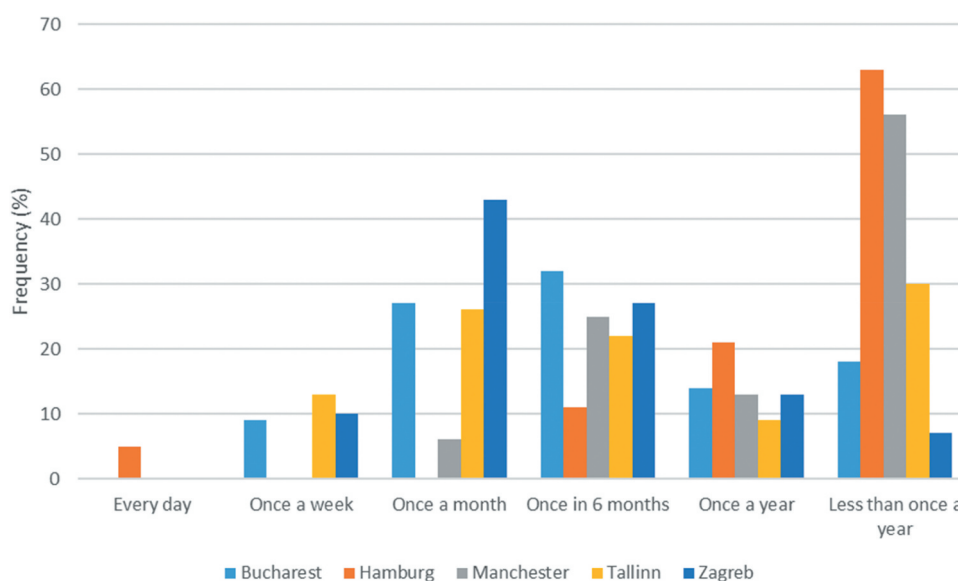


Figure 6. The frequency that waste management materials are used in schools (%).



Figure 7. Schools with local authority or waste contractor support.

mainly use materials between once a month and once every 6 months. Once again, these results indicate that the higher the recycling performance, the less WE are incorporated in the classroom.

The teachers were asked what prevents them from addressing the topic more often or with more detail; other requirements of the curriculum and time were the most popular category for all of the cities except Bucharest who highlighted insufficient suitable materials/not enough materials as being their main reason. It is worth noting that all teachers responded with both reasons. A small number of respondents in Bucharest and Tallinn also mentioned the interest of the children or their own interest prevented them from teaching WE more often. Finally, a small number of teachers in Zagreb responded that there were no reasons why they could not teach WE more often.

Overall, formal and informal WE is still not prevalent in most of the schools in Bucharest and Manchester; Hamburg has just over half of schools with a formal WE education; and the majority of schools in Tallinn and Zagreb have WE on the curriculum. Across all cities the lack of time due to other requirements of the curriculum and access to materials are the main reasons for teachers not addressing the topic of waste, recycling and the circular economy more frequently. It could therefore be concluded that if WE was on the curriculum in more schools, time and materials would be less of a reason not to include it in the classroom.

3.4. WE materials

To investigate the current teaching practices and the materials that the teachers use with respect to WE, the questionnaire initially asked if the school, education authority, non-governmental organisations or similar provided educational material. Only 13% of responses

said yes in Manchester, 42% said yes in Hamburg, 48% in Zagreb, 55% in Bucharest and 61% in Tallinn said that they did receive material provided by these institutions.

When asked who is responsible for providing the material/information on WE in their school, the teachers were able to provide multiple answers. Some mentioned that the school administration, local authorities and waste contractors were responsible; however all of the cities, including Manchester but less so, said that it is the responsibility of the individual teacher to provide the WE materials. Manchester's highest number of responses indicated that no one was responsible for providing the WE; many of the other schools also agreed that no one was responsible. It could be argued that if no one is responsible for supplying the teaching materials, then it would be up to the teachers to provide it should they wish to add the WE as a topic. With the lack of time to introduce non-curriculum topics and the unclear source of WE material supply, these present further barriers to covering WE as a topic in the classroom.

Teaching methods for WE used by the respondents include lecturing (or teaching), individual and/or group classroom-based work, homework and excursions to waste sites or educational centres. Nearly half of the schools in Hamburg and around a third of schools in Manchester and Bucharest had been on an excursion. Approximately 20% of schools in Tallinn had been to a waste site or educational centre and no schools had in Zagreb. When asked if there are improvements seen in the student's knowledge when going on excursions instead of conducting classroom-based work, between 59% and 75% of respondents said that there were no improvements seen in all regions except Zagreb, interestingly the body of evidence shows that cognitive learning increases with

personal experience (Stöckert and Bogner 2020). Approximately 77% of teachers did see improvements in students' knowledge after excursions in Zagreb; interestingly, the only city with no excursions to waste sites or educational centres, it should be noted that the respondents were probably basing their answers on experiences from other topics.

Despite not going on WE excursions, schools in Zagreb said that they receive the most amount of support from their local authority or waste contractor compared to the other regions with 67% of schools responding positively, see Figure 7. Tallinn respondents said that 35% did, and the remaining three cities had less than 25% of schools say they had support. Over half (57%) of the responding teachers in Tallinn said that they had received a visit from a waste expert, 43% in Zagreb had too. The remaining cities; Manchester, Hamburg and Bucharest saw around 31% to 32% of schools receive a visit from a waste expert. It is worth noting that it may not be a true representation of support provided by the local authorities or waste contractors, poor signposting to available resources could explain the results or the respondents are not teaching the relevant section of the curriculum and therefore have not been in receipt of the support or visit.

The two topics included most frequently in WE material are waste recycling and material separation. The idea that cognitive learning through the reflection of personal experience will influence long-term knowledge (Stöckert and Bogner 2020) is somewhat redundant with school children being taught material separation if there is no infrastructure, whether in the classroom or within the school. Other topics such as waste prevention are covered to some degree in all schools; however, this topic features heavily in Tallinn, as does waste treatment. Littering is also a significant topic for Manchester but topics such as the circular economy and the degradation of materials were not taught at all, an important factor in driving behaviour change through reduce, reuse and recycle of waste (Jørgensen et al. 2018). Principles such as the circular economy and the waste hierarchy were the least covered topics overall with landfill, waste treatment and material degradation also lacking in some regions. When asked if the material is adjusted for different age groups so that the material becomes meaningful to the students in each educational level (Pereira da Silva et al. 2020), the majority of respondents from Bucharest, Tallinn and Zagreb said that it was. Manchester and Hamburg were less likely to adjust the material for different ages at 25% and 32%, respectively, saying that they do.

The method and content of teaching WE varies greatly between the cities and between the schools themselves. Reasons for this inter-city variation might be explained by a lack of recycling infrastructure

making excursions difficult, lack of resources to transport children, no education centres or differences in the curriculum. Intra-city variation could be explained by poor signposting to resources, time restraints on teachers or lack of knowledge and/or interest in the subject. Despite this variation in teaching methods and materials, a clear gap in principles such as the circular economy and waste hierarchy was missing from WE across all cities.

4. Conclusions

The amount of waste education (WE), both formal and informal, within schools across the five cities varied. A general pattern emerged from the results showing that as the recycling rate increases the frequency with which WE is taught decreases. Teacher engagement and infrastructure within the schools repeat this pattern with the schools in areas with higher recycling rates less likely to engage in or have been involved in waste management projects. Across all regions, to increase the recycling performance of their school, teachers believed that more awareness of the topic was needed for both students and colleagues. The variation in the amount of WE on the curriculum was not consistent with the level of infrastructure in the city, although more students had been in receipt of excursions to waste/recycling sites in areas with higher recycling rates. Overall, the teachers from all five cities agreed that time pressures (other subjects on the curriculum) and lack of resources were the two main factors that impacted the amount of WE in their classroom.

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