The recognition of the educational needs in the field of detailed segregation and management of bakery waste

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Abstract. One of the fundamental problems of the present-day societies is over-excessive production of waste. In order to meet the growing recycling requirements, segregation should be done ‘at source’, i.e. directly by the consumers producing the waste. It is only possible with full acceptance and engagement of local societies. This, in turn, depends on the consumers’ access to information, their knowledge and ecological awareness of the benefits that at source segregation generates. Due to the varied factors determining whether citizen groups of different social status, age or access to education will take up environmental actions or not, it is very important to recognize the elements which foster such attitude. In this work, bakery products were selected as an exemplary waste stream, which can be isolated from mixed waste products through at source segregation. This work has diagnosed consumer attitudes which are attributable to various group ages. Six age groups were identified, including school-aged youth and adults. The results show the low effectiveness of school education programs in the field of waste segregation. On the other hand, research has shown a high social acceptance for the separation of bakery products as a separate category of organic waste. The action models for raising ecological awareness of particular consumer groups in the field of waste management also have been proposed.

1. Introduction
One of the fundamental problems of the present-day societies is over-excessive production of waste. Its quantity can be reduced by selective segregation and by directing towards proper waste management. According to the idea of sustainable development, it would be advisable to recover the maximum amount of raw materials from the mixed waste. Those materials can be a source of energy or valuable products. Meanwhile, in 2013, the number of selectively collected kitchen bio-waste in Poland amounted to only 10% [1,2]. Everything indicates that new solutions need to be explored to identify new waste streams, which are useful for the management to reduce waste disposal.

In order to meet the growing recycling requirements, segregation should be done directly by the consumers producing the waste, i.e. at the place of its origin. Such waste collection system is described as ‘at source’ segregation [3]. It is only possible with full acceptance and engagement of the local societies. This, in turn, depends on the consumers’ access to information, their knowledge and ecological awareness of the benefits that at source segregation generates. A properly functioning ecological education system is a key factor for proper management of raw materials. Effective segregation of waste requires environmentally conscious citizens. The level of this awareness can be shaped by undertaking various educational activities.
In most European Union countries are educational systems to promote pro-environmental attitudes, including selective waste management. The most common is the school education system. Formal education is taught at all levels and most often begins in kindergarten. Environmental education is designed to help students become convinced that all elements of the natural environment and human-made elements are dependent on each other and that everyone in their behavior is influenced by the environment and is responsible for it. The environmental content is provided to students on a variety of subjects. The purpose of schools is to prepare children and young people for conscious participation in waste management. The formal education in this area is also carried out by higher education institutions and research institutes [4-7].

The environmental education in Poland is conducted both in the form of formal school education and non-formal education. Includes all levels of education as well as adults. By 2008, ecological education in schools was implemented in the form of cross-curricular didactic methods. The environmental education was taught to students in different subjects (chemistry, physics, biology, geography), and the program was adapted to the specificity of the subject. In 2009, a new core curriculum was introduced in which no educational paths were introduced, while the content of environmental education was included in the core curricula of individual subjects. The presence of waste segregation issues on this basis is most prevalent in early school education and is decreasing in the subsequent education stages [8,9]. This was highlighted by waste management specialists, who requested the rebuilding of existing programs and reinforcing the issue of waste management in school education, particularly in the field of practice [10,11].

Environmental education in EU countries is supported by out-of-school education. It is carried out by state institutions, various organizations, education centers, scouts, churches. Most of them also deal with shaping adult awareness. In out-of-school education, a variety of methods are used to reach different age groups, social and professions. Programs are based on such forms of education as conferences, expert meetings, thematic courses, outdoor events, workshops, camps and educational trips. [9,12,13]. The main way of communication are the media, including the Internet that plays a huge role in the information society. The source of information on the environment, including waste management, are websites both responsible for the government institutions as well as non-governmental organizations. Platforms are being created to enable residents to contact relevant institutions as well as to obtain information on the results of scientific research, trainings, environmental actions [14]. Educational programs are also present in other media (television, the press, radio) and it is observed that local forms of communication are more effective. They reach a narrow audience, but they address issues closer to residents than broad-based media education program.

The environmental centres informing about properly managed waste management play a very important educational role, especially aimed at those not already covered by school education. An important factor is their presence in the local area. Employees have direct contact with citizens who can obtain information in an accessible manner. In case of local problems regarding waste and environmental protection, citizens have an agent who reports to the appropriate office. In special cases they may be assisted in the segregation of waste. Such solutions proved to be effective in some parts of the EU [9,15,16]. It is also encouraging that, by segregating waste, not only environmental care is shown but also tangible benefits for the local community are obtained. These could be resources that are saved by reducing transport and storage costs, or local biogas-driven transport [17].

The direct contact between waste management units and consumers makes the opinions which are taken into account in the decision-making and planning of waste segregation. The research conducted in Italy has shown that it is extremely important to organize their reception in the habits of residents in the area of segregation properly [3]. Therefore, the distribution and the quantity of containers should be preceded by an analysis of the behaviour and habits of the community. They also argued that direct household user surveys or the distribution of official questionnaires are not effective tools in this area as frequent claims of residents regarding waste categorization do not reflect subsequent actions [3,18].
A wide range of informal environmental education is available in Poland. Information about their existence is available on the Internet, but they are very scattered, lacking a platform to collect them. Non-governmental organizations working in the field of environmental education carry out a number of educational programs and projects for children, adolescents and adults, but most of them have a local character. There are festivals, happenings systematically emerging new projects, competitions. The offer in many regions is also addressed to teachers in order to improve their workshop. There are also authorial programs and interesting didactic aids, which allow to conduct practical activities in the field of segregation of waste. On the national level, the ‘Waste prevention and proper waste management’ campaign implemented by the Ministry of the Environment and directed mainly to the inhabitants of small towns appeared. This project included both a media campaign and propaganda through contests and happenings. There are also nationwide cyclical campaigns promoted by ecological foundations (e.g. ‘Clean up the World’, ‘Letters to Earth’)[9,19-22].

Despite the considerable number of educational activities, both publicly available (school, TV, Internet) as well as regional programs, the impression is that they lack some consistency. It can also be observed that the activity of environmental education is largely concentrated in the neighbourhood of academic units dealing with environmental protection or didactics. There are lack of nationwide programs and regional programmes are not widespread throughout the country. Regions use a very diverse collection system, but it is very difficult to get information on how to implement it. This results in a still very low level of public awareness of waste management and the unsatisfactory level of waste collection [2, 23,24].

According to European and Polish waste management rules, recycling is the most desirable method of using them. That is why we should strive to create a society that consciously promotes segregation of waste at source. It is necessary to educate children, young people and adults on selective waste collection and waste management. Countries experiencing a high level of waste segregation indicate that, with sufficiently developed sense of responsibility for the state of the environment, the public is prepared to face the nuisance of detailed segregation (e.g. large number of containers for segregation at home) and to bear its costs [9,18]. On the other hand, it is also important that knowledge about recycling and the further use of segregated waste is kept up, giving a sense of rational use. It is important because of the sense of purposefulness of the actions taken. The motivation for making a detailed segregation may also be the awareness of acquiring new sources of energy, which in consequence can reduce the cost of its consumption in households.

2. Conceptual framework

Due to the varied factors determining whether consumer groups of different social status, age or access to education will take up environmental actions or not, it is very important to recognize the elements which foster such attitude. Changes in legislation as well as progressive knowledge of the technological possibilities of waste treatment require a positive attitude of the society towards the emergence of new waste streams for recycling from mixed waste.

In this work, bakery products were selected as an exemplary waste stream, which can be isolated from mixed waste products through segregation at source. In the currently used waste segregation system in Poland, these products are passed mainly to organic mixed waste that is subject to thermal recycling and, in exceptional cases, composting [25]. Despite the dynamic development in this section of waste management, there are still few incineration plants in Poland. The utilization of mixed waste is associated with the necessity of transport, sometimes at very large distances, of hundreds of kilometres, which generates not only transport costs but also is a source of greenhouse gas emissions.

Previous studies have shown high social acceptance for isolation of bakery products as a separate category of organic waste [26]. In the household, depending on its structure, 0.7 to 3.7 kg per month of bakery waste is generated, which translates into a weight of 8.4 to 44.4 kg per year. In addition, from 5 to 10% of breads are already wasted at the stage of its production, followed by the next part at the sales stages: at points of sale and in catering establishments [27,28].
The second important factor determining the choice of this waste stream were numerous literature reports indicating various technological possibilities of its disposal. A number of efforts are being made to utilize bakery waste, rich in high energy organic compounds. One of the developing directions is alcoholic fermentation, leading to the obtaining of fuel- bioethanol from this waste [29]. Among the modern directions of development emphasize their usefulness to the production of biogas. From one tonne of dry bakery waste can be obtained 450 m³ of biogas, including 60 m³ of pure [30].

This work has diagnosed consumer attitudes attributable to various group ages. Three age groups were identified, including school-aged youth (11-13 y/o, 13-15 y/o, 15-19 y/o) and three groups of adults (up to 25, 25-40 y/o and over 40 y/o). Based on analysis of the acquired information, the educational needs characteristic for the surveyed age-groups were identified. In this work, action models for raising ecological awareness of particular consumer groups in the field of waste management also have been proposed.

3. Methodology

Surveys had been conducted in 2016 and 2017. The research tool was a questionnaire consisting of closed questions and specifications including socio-demographic data. Two study groups were identified: adults (323 persons) children and adolescents aged 11 to 19 with formal education (361 students). The group of educated respondents consisted of 11 - 13 y/o primary school children - 41.3%, 13-15 y/o junior high school students -24.9 %, and 15-19 y/o upper secondarieschool students - 15.5%, vocational school students with the profile of "nutrition and catering" - 18.3%

The pupils came from different backgrounds: 44.6% lived in rural areas, 17.5% in cities with the population of below 30 thousand, 14.5% were inhabitants of cities with the population of 30 to 100 thousand, and 23.5% of respondents were from cities with the population of over 100 thousand. People in the age group below 25 constituted 46.1% of the total adult respondents, aged 25 to 40 years - 20.5%, and over 40 years of age - 33.4%. Of the surveyed adults 24.8% were rural dwellers, 17.6% lived in cities fewer than 30 thousand inhabitants, 21.05% lived in cities 30-100 thousand inhabitants and 36.5% lived in the largest agglomerations.

The majority of adults aged 19-25 (71.1%) were in course of formal education. Because they were pursuing studies of very different profiles, and none of which was directly related to the environment, they were classified as not ecologically educated adults.

The first part of the study covered only children and adolescents and concerned the impact and effectiveness of education on waste management knowledge. In the second part of the study covering all respondents, their readiness to identify a stream of bake-waste ‘at source’ was assessed.

4. Results and discussion

4.1. Evaluation of the effectiveness of environmental education

The results show that, in the opinion of pupils, education has little impact on ecological awareness. It is alarming that as many as 33.6% of primary school children do not remember whether school ran waste segregation lessons. Among young people aged 15-19 there was a clear difference approaches to ecology in upper secondary schools and vocational schools, where a significant proportion of the curriculum is implemented through hands-on activities.
Figure 1. The answers to the question: Has school education contributed to shaping ecological attitude?

The majority of responses indicating positive impact of education on the attitude to waste segregation were presented by primary school pupils (54.6%) and vocational schools (44.9%) (see Figure 1). Approximately 30% of students at both junior high and upper secondary schools declared that school activities did not affect their waste segregation. This indicates a lack of effective education in this school group.

Responding to the question "What sources do you use to expand your knowledge of ecology", more than 60% of junior high and upper secondary schools youth gave the answer "I do not expand my ecological knowledge", which largely indicates their unwillingness to develop ecological attitude (see Table 1).

Table 1. Percent answers to the questions: What sources do you use to expand your knowledge of ecology?

|                      | TV / radio | Press | Internet | Other | I do not expand |
|----------------------|------------|-------|----------|-------|-----------------|
| Primary school       | 40.9       | 8.1   | 30.2     | 48.3  | 12.3            |
| Junior high school   | 26.7       | 4.4   | 22.2     | 0.0   | 64.4            |
| Secondary upper school| 17.9     | 3.6   | 28.6     | 0.0   | 60.7            |
| Vocational school    | 39.4       | 18.2  | 36.4     | 1.5   | 39.4            |
| Average              | 31.2       | 8.6   | 29.3     | 12.5  | 44.1            |

Among the media mentioned, press is the least effective (3.6% - 8.8%) in most groups. The information by press ceases to fulfil educational functions. Exceptions are vocational school students, of whom 18% point to this source, probably because they also use professional journals.

The Internet, the radio and television are more effective. In younger age groups, TV and radio play an increasingly important role in improving ecological knowledge, but this role decreases with age in favour of the Internet. The results are worrying because they prove that it is difficult to choose means of communication that would effectively increase environmental awareness of young people. This is because students are not interested in finding such information. Some young people reported that they did not expand their knowledge because they know how to sort waste. In their opinion the segregation system seems to be fixed and there is no need of education in this matter.
Despite the possibility to give an open response about other sources of out-of-school education that would extend ecological knowledge in any age group none of the following were listed: scouting, Earth Days, science festivals, green schools, etc. Surprisingly all respondents took part in this type of activities. This demonstrates that even the best-prepared ecological educational actions, if not continual, are marginalized by pupils.

The next questions checked the knowledge of modern waste processing technology. The question was directed exclusively at young people 15-19 y/o, who have these issues in the curriculum. Regardless of the education style, this age group most frequently pointed to the production of feed (56.1-62.2%) and composting (45.4-62.5%) as the possibilities of processing bakery waste (see Table 2).

Subsequently, production of automotive fuel and biogas were pointed out, while the most innovative biotechnological application, such as ethanol production, were the least known. The answer ‘feed production’ was the only incorrect response. Baking waste cannot be used for feed production. Due to microbiological pollution (especially contamination with mould). Contrary to this, up to 14.7% of respondents chose this answer as the only form of baking waste utilization.

The most knowledgeable in the field of waste processing were the pupils of upper secondary school, but the percentage of correct answers was still small. In the field most closely related to theoretical knowledge, there were a similar number of correct answers among vocational school students, and among much younger junior high school students. This may suggest that this area of knowledge is marginalized in a school that is geared towards a particular occupation.

| Table 2. The responses of young people aged 15-19 to the question: What method can be used to process bread waste? |
|--------------------------------------------------|
| Thermal recycling | Compost | Biogas | Ethanol | Automotive fuel | Feed |
|-------------------|---------|--------|---------|-----------------|------|
| Junior high school | 22.22   | 51.11  | 14.44   | 5.56            | 23.33| 62.22 |
| Secondary upper school | 10.71   | 62.50  | 33.93   | 21.43           | 33.93| 57.14 |
| Vocational school  | 24.24   | 45.45  | 19.70   | 7.58            | 19.70| 56.06 |
| Average            | 19.1    | 53.0   | 22.7    | 11.5            | 25.7 | 58.5  |

Unfamiliarity with the term "segregation at source" also means the low effectiveness of environmental education. Source segregation is the basis for a closed-loop economy. Only 16% of adolescents aged 12-15, 20% of adolescents aged 15 - 19 with general education and 39% of young people with a professional profile declare the knowledge of the concept. The introduction of such segregation, and thus the acquisition of new energy sources, is very difficult, because it is based on concepts incomprehensible to society. A number of educational programs assume that intense education for children and adolescents would positively affect other members of the household. Covered by formal environmental education, maturing part of the public should convey good practices and be a promoter of emerging trends in waste management. It is difficult, however, to assume that this would be possible since familiarity with the common concepts of recycling is so low among young people.

4.2. Bakery waste segregation

The second part of the survey included questions related to bakery waste. They concerned the attitudes of the respondents regarding various methods of their management and involvement of respondents in the selection of a new waste stream which may be bread. This study was conducted among both adolescents enrolled in formal school education and adults.

The survey posed the question “Do you want waste bread to be subjected to recycling?”. Respondents were asked to identify in the semantic scale 1-10 how important for them is the fact that
unused household bread is rationally used rather than thrown to mixed waste. This notes were presented in Figure 2.

**Figure 2.** Declared by the surveyed rank of the problem of dumping bakery products in the scale of 10 pts.

The vast majority of the respondents declared willingness to segregate bakery waste if there was created a possibility to do so. The desire to segregate ‘at source’ grows with age. The solution was opted for by: 62% of consumers aged between 19 -25, 77% aged 25-40 and 80.6% of consumers over 40 years of age. Among young people, the percentage of indications was lower. The adult respondents had also the opportunity to determine how to dispose of excess bread. The most popular form was feeding of birds (28.5%) or animals (25.1%). The least popular is giving away the excess bread to the needy 4.3 %.

Baked products are thrown into garbage containers 20.7%, but as many as 24.2% puts them next to the container, in a separate bag. The behavior of the latter group testifies to the fact that a large number of respondents themselves have decided to select bread as a separate waste stream. Thus, it naturally implements the idea of segregation at source, regardless of whether the term is understandable.

The prevalence of bird feeding is also confirmed by previous observations indicating low effectiveness of ecological education. Waste utilization was indicated by 26% of the children surveyed; 26% of the youth aged 15-19, 41% - the youth aged 12-15 years, and 28.4% of high school students. This solution is very inappropriate and this topic is widely publicized in the media. Topics related to the correct feeding of birds are included in the curriculum at the pre-school and early school levels. The popularity of bird feeding can also be linked to the belief of young people, discussed earlier, that animal feed can be produced from bakery waste. Such a high proportion of children and young people with formal education demonstrating such low ecological awareness in this area raise doubts as to the effectiveness of the educational forms used. The reasons for this should not be seen only on the education side. The answers obtained in the survey can led to the conclusion that the indifferent attitude of young people to the discussed subject and the lack of willingness to broaden knowledge in available out-of-school sources may also be the cause.

5. **Directions of change in ecological education**

Education, filled with textual content in a functional sense, does not meet expectations. Preparing effective out-of-school educational programs is difficult and requires the cooperation of professionals in the field of waste management, psychology, sociology, pedagogy. The need for environmental protection requires the cooperation of different disciplines of science to be considered whether the next reform of education will not return to cross-curricular paths.
In Poland, environmental protection, including recycling, is the focus of attention in the first and second stages of formal school education. However, this education should not be limited to the school area. Already at this stage children should be in contact with specialists (e.g. in thematic trips) who, in a completely different way than the accustomed by the teacher, will highlight the topic of waste management and answer their questions.

For education, practical classes are very important. The easiest way is to organize them in primary school, because children are very open to such a form of work. There is also a whole range of programs and educational support for this age group. Fun in the segregation, direct contact with their own daily generated waste remains longer in the memory than the system of segregation analysed in the school textbook. Since this is the age group most focused on the interest of parents, it is worthwhile to integrate into the cooperation of adults at this stage of education. The patterns, that are introduced in other countries where adults participate in homework and local community engagement, can be used [4,31]. These should not be sporadic, but as a series of joint activities covering the whole school year. It is important that the project ends with a summary of community-specific benefits (saved energy, money from waste collection etc.).

At the level of secondary schools there is a clear lack of issues related to the rational handling of waste. Research has shown that a very effective form in education is a practice oriented towards the chosen professional direction. It is also important to expand vocational schools in issues of municipal waste management and deviating from the nature of the industry profile of the school. Extending ecological awareness of new trends (e.g. biotechnology, nanotechnology, green energy etc.) could take place in the context of a joint student exploration of interdisciplinary fields linking the student's chosen profession to other areas of the economy. It is very important that a student assimilating such knowledge is aware of their relationship with the future profession, not a necessity to learn a textbook theory. The results obtained for pupils at general upper secondary schools indicate a very high dissatisfaction with the forms of ecological education and very little interest in extending this knowledge on their own. It should be noted, however, that the current form of education at this stage is highly profiled. Students already have developed interests and their cognitive interests are focused on selected subjects.

The pursuit of ecological education in the form of isolated divisions in the natural sciences is therefore quite irrelevant. This topic may be of interest only to enthusiasts or students preparing for environmental studies. Starting with the offer to general upper education schools, which graduates are most likely to undertake further studies, should be introduced to support this kind of education in cooperation with academic institutions and waste management units. The ability to undertake projects in collaboration with the academic community should provide young people with an attractive way of acquiring knowledge combined with awareness of the transfer to the next stage of education. Research projects are encouraged to keep up to date with current trends in science and the economy. The collaboration with the academic centre extends the possibilities of practical activities, gives the opportunity to realize one's own ideas and thereby develops the innovation. However, it is imperative that this is a long-term cooperation.

An indispensable element in the ecological education of the whole society, regardless of age groups, is constant contact with good patterns. Recycling should not be a part of the curriculum or educational campaign, but a part of everyday life. Colourful waste bins for segregated waste should be in every classroom, in the corridors of universities, offices, health centres, on the street etc. In schools, such baskets could be made or specially marked by students themselves at the beginning of school year. They should also be obliged to empty them into appropriate containers. Issues related to waste management should appear in other subjects, not just natural. The topic of waste segregation can be raised in an attractive manner both in the sciences and in the humanities [31,32]. If recycling becomes a school day-to-day issue, it will increase the chances that these patterns will be transposed to the households.
6. Conclusions

The conducted survey was a pilot. The problem of segregation of waste in differentiated environments and age groups has been diagnosed. The results obtained and the conclusions drawn from them interact with the professionally literature reports dealing with waste management.

The interview also shows that, regardless of age and ecological awareness, most respondents declared willingness to segregate bakery waste if the opportunity was created. This attitude is conducive to the initiative to select bread from mixed waste as a separate waste stream and to develop it in the context of existing technological solutions. In future research will be extended to a larger group of representatives from each age group and a more diverse industry group representing vocational education.

The current model for developing ecological awareness among youth has visible deficiencies. The decline of youth's interest in recycling is very worrying. This is accompanied by the lack of the necessary knowledge and understanding of the concepts that are dealt with in the field of waste management. It can be assumed that the growing public will be able to navigate the knowledge acquired in primary education, but it is difficult to assess whether they will be deliberately making decisions on, for example, segregation at source or new sources of energy. At all stages of education (including the process of teacher education), it seems necessary to include specialists in the teaching process as their knowledge goes far beyond the curriculum. The professional experience fosters the practical aspects of segregation and resolution of emerging problems. An educational and informational platform should be created by gathering sources available on the Internet (for example, by linking to specific thematic groups) to bring together waste management concepts, helping to find answers to the specific waste segregation issues and facilitate search partners for educational projects. It would also create a local facilities which would act as advisory and coordinate pro-recycling initiatives.

The unsatisfactory level of segregation of waste in Poland and especially the excessive content of organic materials in stored waste should induce appropriate government agencies to intensify environmental education at the national level. It is necessary to allocate more funds for the implementation of environmental education in schools and recycling promotion.

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