Digital Geomedia in Education for Sustainable Development

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Abstract
Successful Education for Sustainable Development (ESD) requires contemporary methods to achieve its goal, to motivate people to change their behavior necessary to shape a sustainable future and actively work for sustainable development. Such methods include the use of information and communication technologies and digital geomedia. Despite numerous possibilities, digital geomedia still seems to be used little or less in ESD. As a result, the associated advantages remain untapped. An important measure to deal with this situation is to provide suitable (i.e., user-centered) materials to guide the use of digital geomedia in ESD (teaching materials) and to prepare ESD-educators for this (training materials). But how can the need for materials that actually are in line with the requirements of ESD-educators be met? What should such materials look like? This is addressed by the ESDplus project. By considering design approaches, development models, and various methods such as literature review, analysis of similar systems, an online survey, and workshops with the target group, requirements and recommendations were identified. Both, requirements and recommendations, are central to providing materials that support the use of digital geomedia in ESD. Examples are the need to combine analog and digital methods, the consideration of usability, accessibility, and user onboarding criteria, and the taking into account of motivational factors and interests of ESD-educators.

Keywords: Digitalization, Geoinformatics, Non-formal Education, Innovative Learning, Sustainable Development

1. Introduction

Today, information and communication technologies (ICT) including digital geomedia can be and are used to support teaching and learning [1] and [2]. This refers, for example, to the use of interactive online maps, StoryMaps, interactive dashboards, geoportals, and Earth observation browsers [3]. By embedding digital geomedia in educational activities, an improvement in teaching effectiveness and a new dynamic of learning can be achieved [2]. This is due, among other things, to the fact that digital geomedia provides spatial context, and spatial representations create a special type of dual coding [2]. Further, location or space can serve as an interface to additional information [2].

Apart from the advantages, the use and handling of digital geomedia in education is associated with various challenges. This refers to the need for (specific) hardware and software devices, as well as Internet access [4], and the presence of specific knowledge and skills for using digital geomedia on the part of ESD-educators. Without such knowledge and skills, the use of digital geomedia is often associated with a certain burden for educators, including ESD-educators. This can lead to educators actually rejecting the use of digital geomedia [5] and [6]. Despite these points, digital geomedia is already being used to some extent in formal education, i.e., in schools [2]. The situation is different with Education for Sustainable Development (ESD) carried out as non-formal education by organizations such as protected areas, environmental stations, natural history museums, zoological gardens, environmental stations, NGOs and associations.

Although there are a significant and increasing number of open and free resources on geospatial data, as well as related methods, services and software, digital geomedia in ESD still appears to be underused, leaving the existing potential untapped [4]. ESD is a challenging topic in which ecological, economic, and socio-cultural aspects are discussed, negotiated, and implemented. ESD promotes the inclusion of sustainable development issues such as climate change, disaster risk reduction, biodiversity, and sustainable consumption. This also includes United Nations Sustainable Goals (SDG) such as no poverty (SDG 1), good health and well-being (SDG 3), and affordable and clean energy (SDG 7).

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The aim of ESD is to motivate and empower learners to change their behavior by acquiring new knowledge, skills, attitudes, competencies, and values that are necessary for shaping a sustainable future and actively work for sustainable development. To achieve this, ESD uses different teaching and learning methods and strives to develop and use innovative methodological approaches such as the use of digital geomedia [7][8] and [9]. This is underlined by the fact that several advantages are highlighted in the literature regarding the use of digital geomedia in ESD. Examples include the following [10][11] and [12] easy access, use and visualization of multi-dimensional data from different sources; facilitating the contextualization of observation and simulation data; enabling real-time feedback and increasing locational awareness; raising interest on environmental and ecological issues, sustainability practices and community; promoting critical thinking; enabling transformative action among participants; supporting research and educational projects related to ecology and sustainable development.

At this point it must be emphasized that, on the one hand, there is a lack of materials that support and guide ESD-educators in the use of digital geomedia in ESD (i.e., teaching materials). On the other hand, ESD-educators also miss materials that help them develop knowledge and skills necessary to successfully use digital geomedia in ESD (train the trainer materials, i.e., training materials). There are various open questions in this context: How can the need for teaching and training materials that actually are in line with the requirements of ESD-educators be met? What content do ESD-educators require in terms of appropriate teaching and training materials? How should such materials be realized in terms of structure, design and delivery characteristics?

These aspects are being investigated within the ESDplus project (https://ESDplus-zgis.hub.arcgis.com/). ESDplus (duration 4/2023 – 3/2025) is financed by the Earth System Sciences Funding Program of the Austrian Academy of Sciences. In close cooperation with the partners Lungau Biosphere Park (Austria) and Berchtesgadener Land Biosphere Region (Germany), ESDplus strives to promote the use of digital geomedia in ESD and pursues three goals: (i) proving a concept for teaching materials to guide ESD-educators using digital geomedia independently and flexibly, (ii) proving a concept for training materials to prepare ESD-educators to become familiar with digital geomedia and to use digital geomedia in ESD, and (iii) designing and implementing ESDplus material as online resources based on the developed concepts. This leads to the realization of three modules: two modules as teaching materials, i.e., one focusing on the use of crowd mapping and one on the use of Earth observation data, and one module as training materials. In this context, ESDplus addresses the following three key objectives: (i) providing a practical basis for the use of digital geomedia in ESD, (ii) providing a theoretical basis for the use of digital geomedia in ESD, and (iii) building a community of ESD-educators using or being interested in using digital geomedia.

2. Workflow and Methods

In order to deliver the ESDplus materials in a particularly user-centered manner, a project-specific workflow was created and used. In addition to taking into account the main tasks related to application development (i.e., requirements specification, design, implementation and testing with optimization; [13]), the consideration and combination of different design approaches and process models are of central importance. Together with the selection of appropriate methods, this enables comprehensive participation of representatives of the target group (i.e., ESD-educators) in the development process of the teaching and training materials (Figure 1). The workflow, as well as design approaches, process models and methods used are described in more detail below.

2.1 Design Approaches

Design approaches put future users at the center of a development process and allow their involvement to different extents and at different levels. Examples of such approaches that are related to the field of human-computer interaction are participatory design, user-centered design, and design thinking [14][15] and [16]. These approaches are briefly presented in Table 1. As shown in Figure 1, the ESDplus development process is generally driven by selected aspects of participatory design (i.e., direct and active user involvement) and user-centered design (i.e., user feedback).

2.2 Process Models

As mentioned above, application development includes requirements specification, application design and implementation, and testing with optimization. The focus and order of the related tasks can vary depending on the development process model used. Thus, according to the process model, the activities regarding requirements specification, design, implementation, and testing are organized into different stages.

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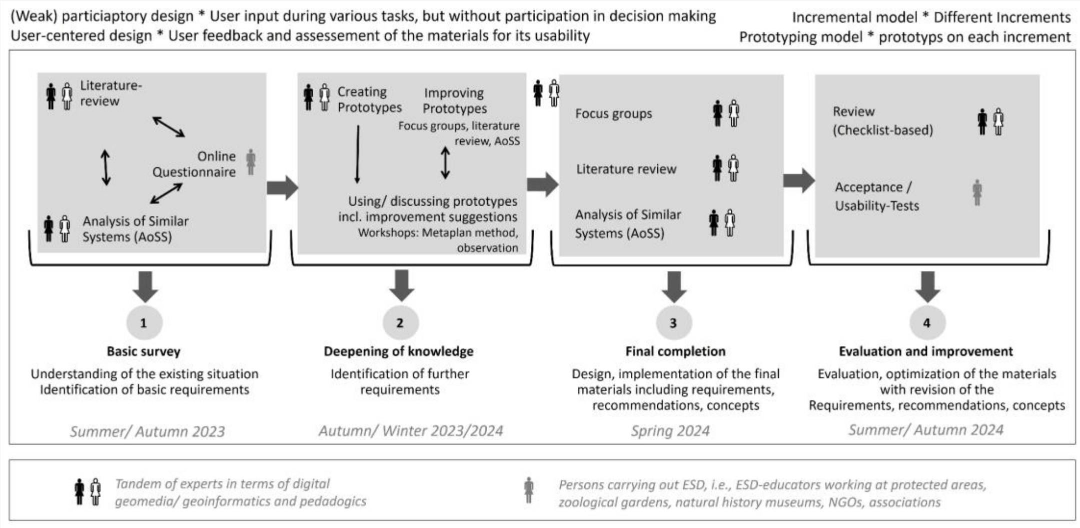

Figure 1: Schematic and simplified ESDplus development process including methods and tools used

Table 1: Examples of design approaches

Design approach	Description
Participatory design [14][15] and [17]	• Designing-with rather than designing-for users, i.e., the target group • Future users actively and directly take part in all activities of an according development process • Distinction between strong and weak participatory design: in strong participatory design, representatives of the target group are involved throughout the entire development process including decision-making; in weak participatory design, input is obtained from the future users, but decisions are made exclusively by the experts and/or developers
User-centered design [18] and [19]	• Focus on early and repeated user feedback during application design and implementation • Enables iterative refinement of the requirements specification, design and implementation • Makes use of several methods that allow users to assess a product for its usability
Design thinking [20][21] and [22]	• Process for solving problems by prioritizing the users' needs above all else • Brings together what is desirable from a human perspective with what is feasible from a technological and economical point of view • Relies on observing with empathy, how the target group interacts with their environments • Uses an iterative, hands-on approach to generate particularly innovative solutions • Takes into account evidence of how users actually engage with a product, rather than how others, i.e., an organization thinks that users will engage with a product • Evolves the thinking and responds to user needs; the overall goal is to identify alternative strategies and solutions that are not immediately apparent upon an initial level of understanding

These stages can be sequenced differently, and different relevance can be assigned to them [13] and [23]. Examples of process models are the waterfall model, the prototyping model, and the incremental model [24][25] and [26]. These models are briefly explained in Table 2. The ESDplus development process is framed by the prototyping and the incremental model (Table 2): On the one hand, requirements were collected and refined by creating and discussing various prototypes. They ultimately served as the basis for the design and implementation of the final ESDplus materials. On the other hand, the ESDplus teaching and training materials were divided into increments (with respect to the incremental model; Figure 2). For these increments prototypes were realized, used, discussed and optimized.

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2.3 Methods

Within the ESDplus workflow, different methods were used in the various development steps and activities (Table 3). The basis for their selection and combination was their ability to allow appropriate involvement of target group representatives, i.e., ESD-educators, in the development process. In order to clarify the actual situation of the use of digital geomedia in ESD and to learn about the basic needs (i.e., initial requirements) of ESD-educators, a literature review and an analysis of similar systems (AoSS) were carried out (step 1). An online survey was then conducted among ESD-educators to close the identified knowledge gaps. This resulted in user requirements that enabled the development of prototypes of the defined increments in connection with the ESDplus teaching and training materials. The prototypes were used and discussed in six workshops with representatives of the target group. This also included the elaboration of suggestions for improvement of the prototypes. The discussions of the prototypes were supported by the Metaplan method. In addition, workshop participants were observed using the prototypes. This allowed the requirements to be refined and additional requirements to be raised. The activities in step 2 thus lead to the definition of the final requirements of ESD-educators for materials that support them in the use of digital geomedia in ESD. Based on this, design and implementation of the final ESDplus materials, i.e., the different increments, took place (step 3). In step 4, the ESDplus materials were tested and evaluated (review, acceptance/ usability tests) and optimized based on received feedback. The ESDplus teaching and training materials were implemented using various tools, among other things, from the ESRI ecosystem: ArcGIS Hub, StoryMap Collection and ArcGIS StoryMaps.

Table 2: Examples of process models

Process model	Description
Waterfall model [24] and [25]	• First, process model to be introduced • Classic description of an application development process • Easy-to-understand • Linear-sequential process model in which each phase, i.e., requirements specification, design, implementation and testing, is completed before the next phase can begin; this means the phases do not overlap
Prototyping model [27] and [28]	• Characterized by its iterative nature: starting from an initial specification, the requirements directed towards an application are continuously and further identified and improved until the stakeholders including the users are satisfied • Based on several loops in which specially developed prototypes are discussed and optimized according to the feedback received • Leads to comprehensive requirements learning and final user requirements specification, which form the basis for the design, implementation and testing of the ultimate final product
Incremental model [25] and [29]	• Based on the initial and known requirements different subsets are identified so that standalone increments are developed considering the respective requirements • Development of each increment encompasses the specification of additional requirements, design, implementation, and testing

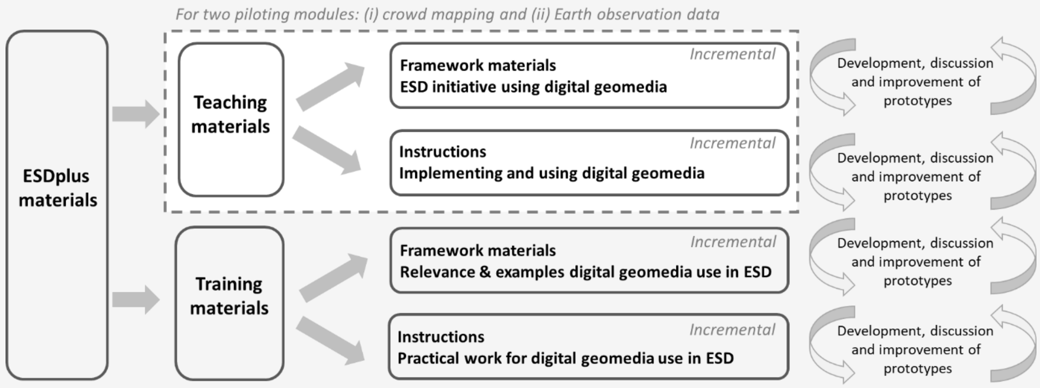

Figure 2: Increments of the ESDplus materials for which prototypes have been realized

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Table 3: Selected methods used throughout the ESDplus development process and its work steps focusing on target group requirements and understanding and suitability of addressing these

Work step	Method	Description and selected details
1	Literature review	• Literature on the use of digital geomedia in education (e.g., spatial citizenship, spatially enabled learning, learning with geoinformation and ESD
	Online Questionnaire	• 14 open and closed questions • Open autumn and winter 2023/2024 • 83 valid responses • Directed towards ESD organizations such as protected areas, natural history museums, zoological gardens, environmental stations NGOs, associations
	Analysis of similar systems (AoSS)	• Analysis of 139 websites of organizations performing ESD (focusing on information regarding ESD events using digital geomedia) • Analysis of websites presenting/describing ESD events using digital geomedia (e.g., Sustainicum,[1] BNEBOX,[2] PlayGreen,[3] PublicClimateSchool,[4] ESRI resources[5])

[1]http://www.sustainicum.at/
[2]https://www.bne-box.lehrerbildung-at-lmu.mzl.lmu.de/
[3]https://www.play-green.net/
[4]https://publicclimateschool.de/
[5]https://www.esri.com/en-us/arcgis/products/arcgis-online/resources

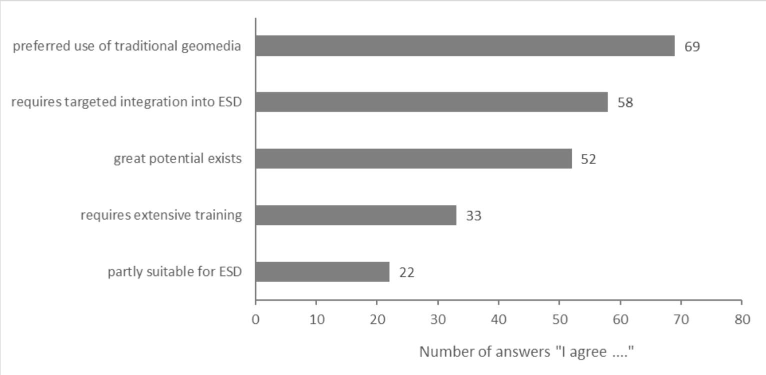
3. Results on Requirements and Recommendations Regarding the ESDplus Materials

The methods used in the created workflow, defined by the selected participatory approaches and development models (Figure 1) provide requirements and recommendations for the content, structure, design and delivery characteristics of the ESDplus materials. They form the basis for the design, implementation, as well as testing, and optimization of the final materials available at https://ESDplus-zgis.hub.arcgis.com/pages/ESDplus-materialien.

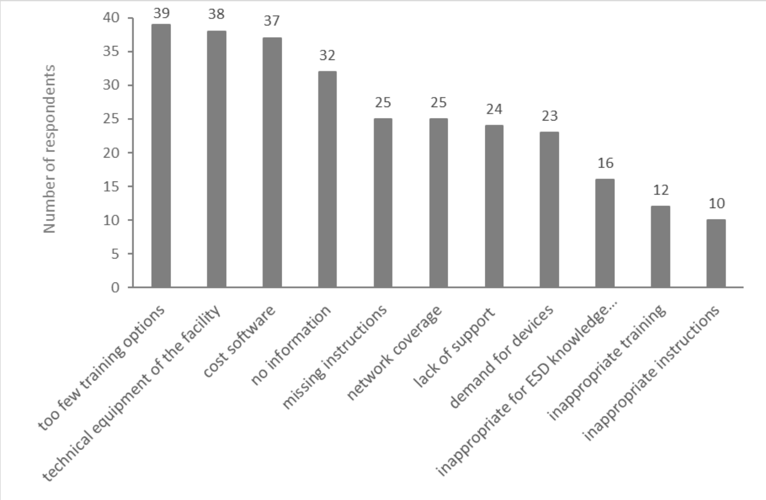
Figure 3 contains selected results of the questionnaire outlining general requirements from ESD-educators. The answers to the questions about agreement with certain statements (Figure 3(a)), barriers to use digital geomedia in ESD (Figure 3(b)) and supporting measures for the use of digital geomedia in ESD (Figure 3(c)) underline the following: (i) the need for a targeted integration of digital geomedia in ESD, (ii) more and suitable instructions for the use of digital geomedia in ESD, (iii) extensive training opportunities, and (iv) the demand for information and an overview of possible uses of digital geomedia in ESD.

3.1 Content

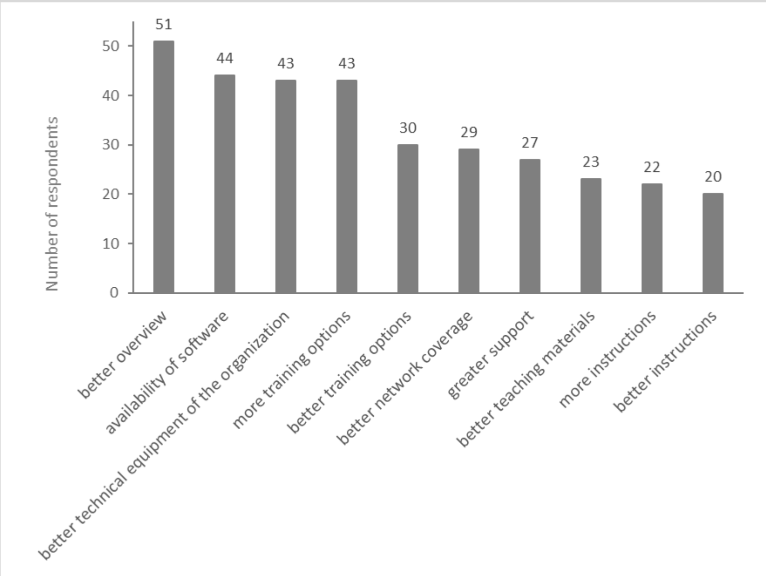
The results of the questionnaire are substantiated by findings from the workshops with representatives of the target group. This highlights that ESD-educators need different types of information, which can be divided into five categories (Table 4): (i) background information, (ii) framework information, (iii) instructions, (iv) working materials, and (v) supportive information. With regard to the content, the workshop participants underlined several special features: The motivation and interests of ESD-educators is a key issue to be taken into account. Particular attention has to be paid to the use of interesting examples, ideally related to existing ESD applications. Especially when on-boarding the materials, ESD-educators need to come across information that interests and motivates them. Further, it is also important to maintain ESD-educators' motivation and interest throughout the entire process of using the materials. Within the framework of the materials, it should be emphasized again and again that digital geomedia is just another tool for implementing ESD and that the combination of analog and digital methods is relevant. The information provided is also intended to enable ESD-educators to create their own individual ESD event, different from the one described per se. Moreover, it is pivotal to not overwhelm the users. For this, the focus on the important aspects and/or providing an overview plays an essential role, as does the opportunity to access further information if necessary. In addition, content should be based on and build on existing knowledge on part of ESD-educators. As for the training materials, it is helpful to use methods and tools that are already familiar to the target group, such as Google Maps and Google Earth. Finally, the focus has to be on practical work and not on theory.



(a)



(b)



(c)

Figure 3: Selected questionnaire results (n=83)
(a) agreement with selected aspects on the use of digital geomedia in ESD (single choice question)
(b) obstacles in using digital geomedia in ESD (multiple choice question),
(c) supporting aspects on using digital geomedia in ESD (multiple choice question)

Table 4: Types of information required by ESD-educators with respect to the ESDplus materials

Content	Description
Background information (1), (2)	• Introduction information on the materials including the philosophy behind
Framework information (1), (2)	• Information on how to design and implement a respective ESD initiative/ activity using digital geomedia (teaching materials) • Information on the relevance of different training units (training materials)
Instructions (1)	• Step-by-step guidelines on how to implement digital geomedia tools to be used in the respective ESD initiative, i.e., activity; showing possibilities for individualization and adaption; being particularly suitable for lay people in using geomedia
Working documents (1)	• Exemplary materials to support the work with digital geomedia, i.e., to guide the analysis of data and images etc. By certain key questions
Supportive information (1), (2)	• Additional information which might be interesting in terms of the other information types

****Remark:* (1) is ESDplus teaching materials and (2) is ESDplus training materials

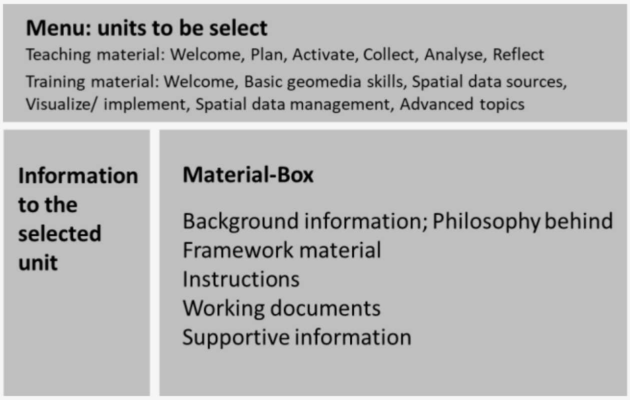


Figure 4: Schematic structure of the ESDplus materials

3.2 Structure

ESD events consist of different activities rather or units such as activation, exploration, reflection, and facilitation [30]. The same applies to educational initiatives that use geomedia. They are divided into activities centered, for instance, on spatial data provision/collection, visualization and analysis, interpretation and discussion [31] and [32]. In addition to the need to describe the various activities that make up ESD events, the AoSS results show that materials supporting the use of digital geomedia in ESD must provide framework information (i.e., to address the target group, topic, needs for hardware, software, Internet etc.), in which instructions for the implementation and use of geomedia are embedded. Taking this into account and the requirements for different types of information (Table 4), a structure consisting of three areas is recommended (Figure 4): (i) menu to select a material unit, (ii) area with a short explanation of the respective selected unit, and (iii) a collection of materials (i.e., material-box) providing information related to the particular unit. However, the teaching materials require information to get an overview of all content, plan the event, and perform the respective activity, i.e., activate, collect, analyze, reflect (https://wiesenpflanze-zgis.hub.arcgis.com/; https://eo-landnutzung-zgis.hub.arcgis.com/). The training materials require an overview of the materials themselves including background and philosophy behind as well as the different training units that focus on basic geomedia skills, spatial data sources, visualization and implementation, spatial data management, and advanced topics (https://trainthetrainer-geomedien-zgis.hub.arcgis.com/).

3.3 Design and Delivery Characteristics

The findings from the workshops reveal a variety of aspects on the design and delivery characteristics of the ESDplus materials (Table 5). These can be divided into several categories. Aside from an appropriate user onboarding process, aspects that support joy of use must be considered in all materials, including usability and accessibility criteria (also compare [33]).

Table 5: Selected recommendations for the design of the ESDplus materials (based on [33])

Criteria	Recommendations
User-Onboarding	• No registration/ login, open access (i.e., open educational resources - OER). • Short personal welcome, direct approach to users. • Presentation of the project/product, among other things, through multimedia (short video/audio files) if at all only short text to read. • Highlighting the context and relevance for ESD, e.g., benefits of using digital geomedia in ESD
Joy of Use	• Using a mascot to lead through the material. • Clear and easily understandable structure. • Simple, compact and short and concise instructions. • Variation and combination of different multimedia, e.g., images, video, and audio files. • Ability to access further information (if required and interested). • Context-related instructions that are optional and available with varying scope and depth (short content with links to further information). • Attractive corporate design (i.e., appropriate for the target group): suitable, consistent and stringent use of colours and symbols etc.
Usability, Accessibility	• Conscious and well considered use of language (no technical terms from the IT/ GI domain, use of national language etc.). • Conscious, well considered use of colours, symbols, font type and size (title, subtitle, text etc.). • Reduced amount of text to read (> 120 words at a glance), well-structured (e.g., bullet points). • Use of multimedia (audio, video, images etc.). • Intuitive, simple and appropriately structured graphical user interface (GUI). • Avoidance of unnecessary details, elements, interactions. • Consideration of F/Z design. • Using the same structure and design in all elements that make up the materials. • Alternative access to materials with online and offline use (possibility for download).

Table 6: Levels of user involvement (based on [37] and [38])

Levels	Description
Informative	Users involved provide and/ or receive information, e.g., regarding requirements specification
Consultative	Users involved comment on predefined services or facilities, e.g., regarding requirement specification and/ or testing
Participatory	Users influence decisions relating to the whole system, e.g., regarding requirement specification, design including implementation, and testing

4. Discussion

4.1 Specially Designed Development Workflow

The ESDplus workflow is based on the selection and combination of design approaches, process models, and methods. This enables and supports different types and levels of user participation (Figure 1), which brings various benefits. Hence, not only can user needs be identified and understood, but they can also be adequately implemented in such a way that the product actually meets user needs [34]. While design approaches are a suitable means of involving future users in development activities and comprehensively considering their needs, the use of process models is helpful to support appropriate forms of user participation [35] and [36]. This was leveraged through the ESDplus development process by incorporating aspects of user-centered design and participatory design. On the one hand, this refers to involving representatives of the target group in testing activities for the product including user feedback (i.e., user-centered design approach).

On the other hand, it relates to the participation of ESD-educators in evaluating and discussing the prototypes of the different increments and, based on this, giving concrete recommendations and suggestions for their improvement (i.e., participatory design). This is in line with different authors, such as [37] and [38], who distinguish different levels of user involvement ranging from informative and consultative to participatory involvement (Table 6). Each type and level of user participation brings different information and results and thus benefits for the product to be developed. However, this requires a corresponding structure or framework - as can be provided by process models (i.e., incremental model, prototyping model). The use of the incremental model proved to be advantageous for the development of the ESDplus materials.

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The reasons for this are that the incremental model is useful when the focus is on user feedback on individual key components of a product, when the developers have little experience with a topic or user group, or a quick release of the product, i.e., of its key components, is required [13] and [25]. The prototyping model made it possible to involve representatives of future users actively and directly in the creation of the ESDplus materials. This is based on the use of different prototypes which are then discussed, i.e., here together by future users as well as experts and developers. In addition, the prototype model is useful for the development of ESDplus materials since it provides a framework for involving representatives of the target group in the process. Other relevant benefits are that the prototyping model is suitable when the needs of the future users of a product are relatively unknown at the beginning of the development process, or when developers are dealing with a new and/ or unknown topic [27] and [28]. This also applies to the ESDplus materials, where problems of ESD-educators and their use of digital geomedia were less known.

Despite these advantages, it must be noted that the involvement of laymen - such as ESD-educators - in the use of geomedia and geoinformation is difficult and cumbersome. Successful participation requires commitment, time and resources in terms of money, energy and appropriate personnel [39] and [40]. As demonstrated in ESDplus, this also relates to the following issues also identified in other initiatives (see, e.g., [41]): (re)motivate participants, face and handle discussions on unexpected problems, expect and deal with different knowledge and backgrounds. Moreover, user integration must be designed in such a way that it fits the product being developed, the topic and the future users. This asks for specifically designed workflows based on the consideration of diverse design approaches, process models and methods - as discussed here.

4.2 Target Group Centered Requirements and Recommendations and their Implementation

The requirements and recommendations regarding the ESDplus materials refer to content, structure, design and delivery characteristics. They are consistent with findings and experiences from fields such as user experience (UX) including usability and accessibility, user onboarding, participation, adult teaching, and eLearning (Table 4 and Table 5). Examples are the consideration of colours, symbols, language (usability, accessibility: [19] and [41]), an attractive and gentle first contact with the materials (user onboarding: [42] and [43]), addressing people's motivation (participation: [39] and [44]), taking existing knowledge into account and focusing on practical work (adult teaching: [45] and [46]), re-use of existing materials, relevance of layout and design, use of multimedia (eLearning: [47] and [48]; guidelines on ESD materials: [49]).

Apart from this, there are also aspects that are of particular relevance for ESD. Examples of this include the use and combination of analogue methods and digital geomedia, the need to focus all information and instructions related to the use of digital geomedia on ESD and its respective objectives, provide all information in a way that it is possible to adapt methods and materials to one's own needs, as ESD initiatives depend heavily on the respective topic, location, target group and responsible ESD-educators. Further information on advantages and background information (including a general overview on tools, data, applications) with regard to the use of digital geomedia must be at hand. This is crucial to address ESD-educators' doubts on the use of digital geomedia, and to raise their awareness and motivation. The implementation of the recommendations and the consideration of the identified requirements must be specifically tailored to ESD-educators. For example, ESD-educators highlighted the use of a mascot that guides through the ESDplus materials as a motivational and exciting factor. This demand is met by implementing the honeybee "Polli". The mascot "Polli" not only gives an introduction to the ESD materials, but also provides explanations in selected situations.

Further, it became clear that the focus must be on practical work and not theoretical aspects behind geomedia. Theory must be reduced to what is absolutely necessary. It is more relevant to arouse interest and awareness so that ESD-educators are motivated to take a deeper look into the use of digital geomedia on their own initiative. It is key that the examples used, including applications, data and methods, are related to ESD, its topics and goals. This can show and prove to ESD-educators how important and useful the use of digital geomedia in ESD is.

5. Conclusion

Digital geomedia is currently underused in ESD, although its use has several advantages. To support ESD-educators in the use of digital geomedia in ESD, teaching and training materials tailored to their needs play a key role. But how can such materials be created? What should such materials look like? The ESDplus project is investigating this question.

By using different methods such as literature review, analysis of similar systems (AoSS), an online questionnaire, and workshops, various recommendations were identified and elaborated regarding the design and implementation of training and teaching materials to support the use of digital geomedia in ESD. They outline how important it is to consider existing knowledge and experience. Furthermore, it is crucial that the focus is always on practical work and taking the interests and motivations of the target group, i.e., ESD-educators into account. It must be made clear to ESD-educators that digital geomedia are used to achieve ESD goals and that they are not the focus per se. This requires a targeted integration of digital geomedia into ESD. It is pivotal that all explanations etc. are realized in such a way that the educators who practice ESD recognize the inherent potential of digital geomedia for ESD. This includes emphasizing how valuable the combination of analogue and digital methods is and how both complement and enrich each other and thus provide added value for ESD. For both training and educational materials, consideration of guidelines and quality criteria for the creation of ESD materials, including paying attention to usability, accessibility, and user onboarding concepts, is central. It has also been shown that the use of digital geomedia in ESD requires much more awareness-raising. Here, a central point is the establishment and maintenance of a community of ESD educators who are interested in the use of digital geomedia, and the use of various communication channels to promote the topic.

Further, the findings from ESDplus - regarding the development process as well as the materials - are valid beyond ESD. The same principles apply fully in other contexts of non-formal education, where the use of digital geomedia can play an important role and still has room for expansion. For instance, there is a need to implement materials in an understandable and appealing way, not to overwhelm the user and to arouse their interest in the topic. Therefore, it is key to learn in detail about the intended target group to know their needs and skills and take them into account comprehensively when designing and implementing materials. This closes a gap, as teaching and training materials are already available for the formal education sector, but not specifically for non-formal education and in particular for ESD.

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