

# Information Systems, Embedded Systems and Intelligent Applications

International Conference ISESIA'2023

Sofia, Bulgaria, May 26 – 27, 2023

Book of Abstracts



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# Information Systems, Embedded Systems and Intelligent Applications

International Conference ISESIA '2023

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## **Preface**

This conference was being held for the sixteen time on 26–27 May 2022. It is supported by the Science Fund of the University of Sofia “St. Kliment Ohridski” and by the Bulgarian Chapter of the Association for Information Systems (BulAIS).

This year conference name is changed from “Information Systems and Grid Technologies” to “Information Systems, Embedded Systems and Intelligent Applications”. One reason for this change is that there is a conference with the same abbreviation ISGT.

Total number of papers submitted for participation in ISGT’2023 was 37. They undergo the due selection and revision by at least two members of the Program Committee.

This Proceeding comprises 21 papers of 14 Bulgarian authors and 7 with foreign coauthors.

The conference papers are available on the CEUR Workshop Proceedings (<http://ceur-ws.org>) and on the ISESIA web page <http://isesia.fmi.uni-sofia.bg> (under “Previous conferences” tab).

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*The editors*

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# Information Technology Adoption in Promoting Digital Mental Health Literacy – Data Usage and Specifics

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## **Abstract**

The present study indicates the applicable rules by which legality is ensured when processing special categories of personal data for the needs of a scientific project. The study was conducted as part of the me\_HeLi-D: Mental Health Literacy and Diversity project, which collects online data on mental health literacy among ages 11–15. Alternatives and approaches are indicated, including through adequate technological measures to protect personal data during the implementation of a scientific project at a multinational level. The specific requirements of the law for the protection of persons who cannot express their consent are considered.

## **Keywords**

Personal data protection, consent, health status

## **1. Introduction**

In the framework of a scientific project, it is often necessary to process personal data. In order to ensure legality when processing personal data, should be taken into account the specifics related to the characteristics of the category of data that are collected, as well as the category of persons from whom the data is collected.

The research was conducted as part of the project me\_HeLi-D: “Mental Health Literacy and Diversity. Enhancing Mental Health and Resilience through Digital Resources for Youth.” The me\_HeLi-D project is co-funded by the European Union (Erasmus+) and involves four European countries, namely Bulgaria, Poland, Slovenia, and Austria, and eight partner institutions. The goal of the me\_HeLi-D project is to develop a digital tool to promote mental health among youth ages 11-15. The tool should be diversity-sensitive, adaptive and target group specific. Therefore, both the target group and other stakeholders (e.g., teachers) are

involved in all stages of the tool's development. During the course of the project, visual and audio recordings will be made to create a project video for the presentation, promotion, and dissemination of the project. In addition, written and oral feedback, as well as creative creations (drawings, pictures) will be collected to inform the development of the tool. Thus, the data will be used for the design and content, as well as for the promotion of the digital mental health tool. Data collected from students, teachers and school principals include visual and sound recordings, school type and grade level, written (feedback forms) and oral (group discussions) feedback, drawings/sketches and images. When the project is implemented in the territories of different countries, there is complexity due to the application of different national legislations regarding aspects of the regulation outside the application of generally applicable regulations within the EU.

The research focuses on and analyzes special category of collected data and the special category of persons with regard to whom the data is processed within the implementation of the scientific project on the territory of several different EU member states. The current research is in line with the fact that the project aims to obtain answers and measure data related to (mental) health status, literacy, and behavior, such as mental health literacy, help-seeking behavior, resilience, cognitive and affective mindfulness, depression, anxiety, stress, and mental well-being. An additional complication in the context of data processing is the fact that the data refer to children aged 11 to 15 years.

Within the framework of the specific project, the Moodle platform is used. The standard GDPR functionality has been added to it, without initially taking into account all the specific requirements resulting from the features described above, summarized as follows: the scientific project, the data of persons under 18 years of age, the sensitive information and the data collection in cross-border research. The value of the present study is in the description and systematization of the main aspects that must be taken into account when implementing the project in the context of GDPR and compliance with ethical norms.

Under these previously known conditions, a platform is developed in the context of project implementation, which saves data on students' level of mental health literacy aiming at applying this for personalized learning experiences. This data is stored and made available to researchers. General privacy rules apply here, as for any other data collected, meaning compliance with General Data Protection Regulation (GDPR) and other national legislation for EU countries is required.

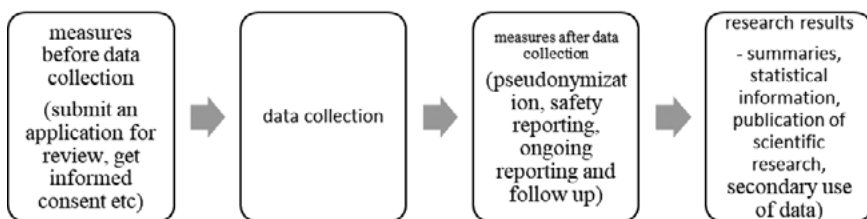
Moodle has developed a specific API for helping institutions become compliant with GDPR. The added functionality in Moodle includes a number of components, amongst others these include a user's right to [1] request information on the types of personal data held, the instances of that data, and the deletion policy for each, to access all of their data, and to be forgotten. The compliance requirements



also extend to installed plugins (including third party plugins). These need to also be able to report what information they store or process regarding users, and have the ability to provide and delete data for at user request. Students – participants should know what they would be asked to provide the system with, before engaging with the platform. Finally, since every browser asks at least once for permission to access a webcam, the consent request cannot be disabled. This is important, in view of the conclusion that is made in the present study about the need to provide consent in a certain sense and scope, as well as the fact that such consent must be obtained before a user’s data is being logged. Potentially, any data can be mistreated. In our platform, someone with access to the data could understand the mental health literacy level of a student – participant significantly breaching privacy. Evaluating someone’s literacy level is a normal procedure in the everyday practice of a teacher, and it is conducted during the face-to-face teaching – learning process. There are two differentiation components. The larger scale of automated processing of data, and second the ability to save this information. By saving the information one can build someone’s mental health literacy profile with features above the ones developed normally during the teaching – learning process. This is why the student – participant is allowed to have the above-mentioned rights on deletion policy, access to their data, and to be forgotten. During the development of the platform, it is taken into account that the platform deals with a potentially vulnerable group, potentially facing depression or other mental health issues. Monitoring a student’s – participant’s emotional or mood state, while interacting with the platform, may cause discomfort, as these are data related to his/her wellbeing.

To answer the specifics concrete requirements were defined, so the student – participant should be allowed to stop the participation at any time, and erase any data in an anonymous way. The entire participation session should be anonymous, allowing a student – participant to withdraw without any backtracking information.

In the development of the present study, we first took into consideration the project phases [2] for the respective data collected and the data processing steps are described in Figure 1 respectively.



**Figure 1:** Data processing process in the project me\_HeLi-D

This is the phases that will be followed in the processing of the data within the framework of the specific project. Within each of the described phases, the specified circumstances should be taken into account as the due considerations are described below as technical and organizational measures.

Keeping this project specificity in mind, an attempt is made to analyze the order in which the lawful processing of personal data related to the health and behavior of persons under the age of 18 should be ensured. This is done in the context of scientific research for the needs of a scientific project implemented on the territory of various member states of The European Union. The fact that the project is based and implemented on the territory of several member states of the European Union facilitates the research from the point of view of the implementation of the GDPR, because each of the member states is obliged to implement the regulation. The cross-border implementation of the project creates a complication from the point of view of complying with the specific requirements in each of the national legislations on the rights of the patient and on the rights of children, which are not uniformly regulated at the Community level. These considerations are important considering that the right to protection of personal data is not an absolute right and must be considered in relation to other fundamental rights according to the principle of proportionality.

In view of the above, when carrying out the study, we first took into account the need to establish the applicable legal framework and its general content and principles. On the next place, we consider the applicability of specific regulations within the specific data that will be processed within the project. As a result, we make proposals for the implementation of specific procedures to ensure the legal application of the regulation in the administration of the project.

Consideration of human rights is due when processing the sensitive data, as well as the rights of the child in the context of online tests and the information provided by the child for the needs of scientific research. The superimposition of such different specificities and their generalization and real application within one project is the subject of the present study.

### **1.1. Compliance with Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC /GDPR/**

Research into the legal regulation regarding the lawful processing of data, including medical information and biometric data /if there are any/, is undoubtedly due.

It should be indicated that the fact that the data are processed for scientific research purposes and that the data are anonymized are not enough to guarantee legality.

Therefore, additional understanding is needed, as well as the provision of additional procedures.

Within the framework of the project, the stakeholders are identified as follows:

- the child, adolescent – persons, from whom the data is collected, the parent/legal guardian – persons, who exercises rights regarding the declaration of will of the children in accordance with the legislation of the country of origin;
- the teacher, school director – persons who provide data related to the educational system;
- the researcher, (mental) health sciences professional – the persons who carry out the scientific research, adolescent – IS developer – the person who should comply with and apply recommended technical measures.

## **1.2. General applicability**

Data processing within the project falls within the legal regime of GDPR.

The purpose of the regulation is to ensure a consistent level of protection of natural persons throughout the Union and to prevent differences from hindering the free movement of personal data within the internal market in order to ensure legal certainty and transparency for economic operators.

For a clear understanding, we need knowledge of the specific concepts/definitions used in the context of Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC /GDPR/[3] and Regulation (EU) 2018/1725 of the European Parliament and of the Council of 23 October 2018 [4] that defines the rules regarding the protection of physical persons in relation to the processing of personal data by the institutions and bodies of the Union, as well as the rules regarding the free movement of personal data between them or to other recipients established in the Union.

The meaning of the used concepts is unified by introducing definitions. Here we present some of the definitions, provided by the GDPR [3] that are central to understanding the subsequent interpretations:

- ‘Personal data’ means “any information relating to an identified or identifiable natural person (‘data subject’); an identifiable natural person is one who can be identified, directly or indirectly, in particular by reference to an identifier such as a name, an identification number, location data, an online

identifier or to one or more factors specific to the physical, physiological, genetic, mental, economic, cultural or social identity of that natural person”.

- ‘Data concerning health’ means, “personal data related to the physical or mental health of a natural person, including the provision of healthcare services, which reveal information about his or her health status”;
- ‘Biometric data’ means “personal data resulting from specific technical processing relating to the physical, physiological or behavioral characteristics of a natural person, which allow or confirm the unique identification of that natural person, such as facial images or dactyloscopy data” The concept should be known considering the measurement of certain behavioral specifics carried out through the data in the project;
- ‘Processing of personal data’ means “any operation or set of operations which is performed on personal data or on sets of personal data, whether or not by automated means, such as collection, recording, organization, structuring, storage, adaptation or alteration, retrieval, consultation, use, disclosure by transmission, dissemination or otherwise making available, alignment or combination, restriction, erasure or destruction”;
- ‘Processing for research purposes’ [5] should be interpreted in a broader sense and include basic scientific research, applied scientific research and privately funded research. Research purposes should also include studies conducted in the public interest in the field of public health. The former Article 29 Working Group has already indicated that the term cannot be extended beyond its ordinary meaning. It must be understood that in this context “research” means “a research project established according to the relevant methodological and ethical norms of the sector, in accordance with good practices”.
- ‘Personal data register’ means any structured set of personal data accessed according to certain criteria, whether centralized, decentralized or distributed according to a functional or geographical principle;
- Bearing in mind these basic definitions provided by the GDPR, it be established that at every stage of the conducted research within the framework of the scientific project, student data is processed, and this data is related to their health and is processed for scientific purposes.

### **1.3. General principles in the processing of personal data**

Because the GDPR applies, it is necessary to ensure compliance with the principles derived from the regulation, which are presented here briefly. Each of the measures described below that are considered and used in the project *me\_HeLi-D: Mental Health Literacy and Diversity. Enhancing Mental Health and Resilience through Digital Resources for Youth* are in accordance with and ensure compliance with the principles stated here. In the specific case, it is also taken

into account that the administrator of the data, respectively the joint administrators, is responsible for compliance with the principles and must be able to prove the accountability.

The general principles in the processing of personal data are:

- Principle of legality, good faith and transparency
- Purpose limitation principle, which means that the data are collected for explicitly specified and legal purposes
- Principle of data minimization, which means that only the data necessary for the purposes are processed
- Principle of accuracy, which means that the data should be true and up-to-date
- Principle of limitation of data storage, which means that data is stored in a form that allows the identification of the data subjects for a period no longer than necessary for the purposes for which the data are processed
- Principle of integrity and confidentiality which means that the data should be processed in a way that ensures an appropriate level of personal data security

These principles apply in accord with and as a guarantee of the rights of the subject whose personal data are processed. These rights include right to transparent information, communication and conditions for the exercise of the rights of the data subject – including purposes of processing, data categories, data recipients, the storage period. In addition, the right to request from the administrator access to, correction or deletion of personal data or to limit the processing of personal data related to the data subject, respectively the right to withdraw consent at any time. The right to erasure is known as the “right to be forgotten”. The right to submit a complaint to the European Data Protection Supervisory Authority is also recognized as the right to be informed of the existence of automated decision-making, including profiling.

The recognition of these rights and the compliance with these principles is mandatory in any process in which personal data is processed; including the specific scientific project within the research is carried out. The overall regulation should always be interpreted in its specific application. The measures and procedures described below are meant to ensure compliance with the stated principles.

#### **1.4. Special rules for special categories of personal data**

There is legal prohibition to process genetic data, biometric data for the purpose of unique identification of the natural person, data related to the health or sexual life and sexual orientation of the person.

Exceptions are applied as a rule:

- when the data subject has given his express consent to the processing of the data for one or more specific purposes;

- or without the explicit consent of the data subject when the processing of data is necessary for scientific;
- or historical research or for statistical purposes on the basis of Union law, which is proportionate to the intended purpose, respects the essence of the right to data protection and provides for appropriate and specific measures to protect the fundamental rights and interests of the subject of the data.

It is important to point out that the processing of data for a scientific purpose is a reason to overcome the ban and to process the data accordingly, in compliance with all regulations. Specifically, where personal data is processed for the purposes of scientific or historical research or for statistical purposes, there may be derogations in national law regarding the subject's right to request restriction of processing. However, this must be followed at the level of national law of each of the countries where the relevant institutions involved in the project are based.

As a result, it is of particular importance to specify the legal grounds for processing personal data within the project. In the particular hypothesis, we understand that the data could be processed because of scientific/statistical purposes, as well as based on data subject consent. In the context, the conclusion is that the regulation cannot be interpreted, that only explicit consent of data subjects can be used to legitimize the processing of health data for scientific research purposes.

In addition, as stated in the EDPB Document on response to the request from the European Commission for clarifications on the consistent application of the GDPR, focusing on health research, adopted on 2 February 2021 by the European Data Protection Board [7], ethics standards cannot be interpreted in such a way that only explicit consent of data subjects can be used to legitimize the processing of health data for scientific research purposes. Article 6 and Article 9 GDPR contain other options for a legal basis and an exemption that can be relied on for processing health data for scientific research purposes. Separately, regarding the regulation of multinational projects within the EU as for relevant Union law, until now, only the Clinical Trial Regulation (CTR) can be identified as Union law in which a uniform legal basis for controllers can be found in the stipulated legal obligation for controllers (Articles 41–43 CTR) to process personal data in clinical trials for reliability and safety related purposes. However, this legal obligation for controllers does not cover all (other) purposes for which personal data are processed in a clinical trial. Therefore, the controller will have to rely on another legal basis in Article 6 GDPR for processing personal data for such other research purposes.

However, in the specific hypothesis, our proposal is to receive the consent of the data subjects, in view of the fact of special legal protection of children and the sensitive data that are collected. This will provide an additional legal ground for the specific data processing in accordance with the special child protection and health research regulations described below and applicable by analogy here.

## **1.5. The different type of data usage**

We understand that in the case of “processing of health data for scientific research purposes”, there are two different types of data usage.

First, there is the data usage for scientific research based on personal (health) data, which consists in the use of data directly collected for research purposes (“primary use”);

And second scientific research based on personal (health) data, which consists in the further processing of data originally collected for another purpose (“secondary use”).

Both of the described ways of using and processing data, which exist as a potential possibility in every scientific project, are considered in the systematization of the applicable measures. In the specific project – object of research, it is intended not to provide the use of personal data at a secondary level to third parties, as they will summarize and systematize as a statistical result and this is described in the sections about technical and organizational measures below.

### **Compliance with the ethical norms**

For additional clarity, it should be stated that it is necessary to comply with another relevant regulation because we process data concerning health and this is the closest analogy. This is a Convention for the protection of human rights and human dignity in relation to the application of the achievements of biology and medicine: Convention on Human Rights and Biomedicine [5]

This convention introduces the principle that everyone has the right to inviolability of his personal life with regard to information related to his health.

Also, the general rule when conduct the scientific research in the field of biology and medicine shall be carried out freely relative to the participants, if the provisions of this Convention and other legal provisions for the protection of person are observed

The Convention explicitly states that, in addition to all other conditions related to scientific research, the person who undergoes scientific research should be informed about the rights and guarantees that the law provides for his protection and the person should give his consent explicitly, specifically and in writing; and it can accordingly be withdrawn freely and at any time.

## **3. Consent of the data subject**

### **3.1. According GDPR**

For the needs of compliance with the ethical norms related to the processing of data for scientific research purposes in this particular case it would be advisable to receive the consent of the data subject for the processing of personal data, regardless of the fact that the processing of the data is for scientific purposes.

The proposal is also argued by the fact that there are similar precedents in which it is expressly stated that the data subject's consent obtained pursuant to Article 6(1) (a) and Article 9(2) (a) of the GDPR may constitute a legal basis for the processing of health data. The precedent is in Guidelines 03/2020 on the processing of health data for research purposes in relation to the COVID-19 pandemic Adopted on 21 April 2020 by the European Data Protection Board [6]. Pursuant to Article 70 (1) (e) of Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of individuals with regard to the processing of personal data and on the free movement of such data and repealing Directive 95/46/EC (hereinafter referred to as "GDPR"). To avoid misunderstanding, data can be collected for scientific projects even without the consent of the persons whose data is being processed. However, in the case where personal data of persons under 18 years of age is processed, this is not recommended, because a strict standard of ethical requirements is met and in this sense, it is necessary to obtain the consent of a person exercising the parental responsibility.

"Consent of the data subject" [3] means "any freely expressed, specific, informed and unequivocal indication of the will of the data subject, by means of a statement or a clear affirmative action, which expresses his consent to the processing of his personal data ". There are additional regulations related to the protection of children and related to the category of data being processed /mental health, behavioral characteristics /

Article 8 of Regulation related to the conditions applicable to the consent of a child in connection with the services of the information society, is applicable within our project by analogy in view of the digital environment in which the research is carried out. The norm prescribes that the child must be at least 13 years old to be able to give his consent. In case the child is under 13 years of age, this processing is lawful only if and to the extent that such consent is given or confirmed by the person bearing parental responsibility for the child. In such cases, the controller shall make reasonable efforts to verify that consent has been given or confirmed by the holder of parental responsibility for the child, taking into account available technology. At the same time, it must be said that this is a norm related to activities of a commercial nature in the online environment / services of the information society/. Therefore, when it comes to any project, data of a child under 13 years of age could be managed if it can be justified that the data makes have scientific sense and it is justified from the point of view of the research objectives.

We consider also that it is necessary to comply with additional conditions, arising from the national legislation. For example, Bulgarian legislation requires parental consent for children up to 18 years and it is more restrictive.

In addition, if consent is used as a lawful basis for processing, under Article 7(3) GDPR, individuals must have the possibility to withdraw this consent at



any time. If consent is withdrawn, all data processing operations that are based on consent continue to be lawful in accordance with the GDPR, but the controller shall cease the relevant processing activities and, if there is no other lawful grounds that justify their retention for further processing, the data should be deleted by the administrator.

### **3.2. According Convention on Human Rights and Biomedicine**

Convention for the protection of human rights and human dignity in relation to the application of the achievements of biology and medicine [5] explicitly states that, in addition to all other conditions related to scientific research, the person who undergoes scientific research should be informed about the rights and guarantees that the law provides for his protection. The person should give his consent explicitly, specifically and in writing. It can accordingly be withdrawn freely and at any time. In this regard, the person whose data will be processed should provide his consent to participate in the research, which means that he will provide his consent and his data to be processed, in view of the specificity of the research and the environment in which it is carried out, such as the legal basis for this.

Separately, the Convention protects persons incapable of giving their consent for scientific research, requiring that the permission of their representative, authority, person, or instance specified by law be requested for minors.

In conclusion, for the needs of compliance with the ethical norms related to the processing of data for scientific research purposes in this particular case it is necessary to receive the consent of the data subject for the processing of personal data, regardless of the fact that the processing of the data is for scientific purposes. The requirement of informed consent for participation in a scientific research project can and must be distinguished from explicit consent as a possibility to legitimize the processing of personal data for scientific research purposes. In all cases /regardless of age of the person /written consent must be requested from the relevant person to participate in the project /research. The person whose data will be processed should provide his consent to participate in the research. In this sense, it is identified that two types of consent are necessary for the legality of the study – informed consent to participate in the project and explicit consent to processing personal data.

## **4. Specific applicability of regulation within the project me\_HeLi-D implementation**

During the processing of the data within the project, it was found that the members of the consortium are joint data controllers, which means that they bear joint responsibility. The practical meaning is that common/identical pro-

cedures and rules should apply. They should have general processing rules to apply. Accordingly, identical procedures described below were identified and implemented.

One of them is the application of the data protection approach at the preliminary/design stage. The controller introduces, at the time of the determination of the means of processing and at the time of the processing itself, appropriate technical and organizational measures. For example pseudonymization, which has been developed with a view to the effective applying the principles of data protection, for example data minimization and integrating the necessary safeguards into the process to comply with the GDPR requirements and to ensure the protection of the rights of data subjects [3].

The other is related in creation of guarantees for the purposes of archiving and complying with the principle of data minimization. The measures include pseudonymization. In addition, it is possible to refer to Article 12 of the Regulation. It states that if the purposes, for which a controller processes personal data do not or do no longer require the identification of a data subject by the controller and the controller shall not be obliged to maintain, acquire or process additional information in order to identify the data subject for the sole purpose of complying with this Regulation. The controller must be able to demonstrate that it does not identify the data subject at any stage. The application of Article 12 of the regulation, does not exempt from the application of the regulation, only from application of the provisions of Art. 17-22, which relate to certain rules in relation to consent of data subject

It is good to provide a guarantee that profiling is not carried out. 'Profiling'[3] means “any form of automated processing of personal data consisting of the use of personal data to evaluate certain personal aspects relating to a natural person, in particular to analyze or predict aspects concerning that natural person’s performance at work, economic situation, health, personal preferences, interests, reliability, behavior, location or movements”

Within the project is provided compliance with requirements for traceability through dynamic registers of data on the way they are stored, processed, and archived.

## **5. Technical measures**

The GDPR recognizes the degree of development of technology and therefore foresees that technical measures should be taken when processing data. It is also considered that these measures can work in favor of protecting the rights of subjects. In addition to the legal basis and purpose for data processing and the presence of consent, guarantees of legality the availability of appropriate technical measures in data processing are also recognized by the law.

The GDPR explicitly provides pseudonymization and encryption of personal data as applicable technical measures.

Pseudonymization by [3] means processing of personal data in such a way that the personal data can no longer be associated with a specific data subject without the use of additional information. It provides that it is stored separately and is subject to technical and organizational measures in order to ensure that the personal data is not linked to an identified natural person or to an identifiable natural person. Pseudonymization is the ability to ensure ongoing confidentiality, integrity, availability, and resilience of processing systems and services and the ability promptly to restore availability and access to personal data in the event of physical or technical incidents. Pseudonymization includes the process of regular testing, assessment and evaluation of the effectiveness of technical and organizational measures in order to guarantee the security of the processing.

A distinction should be made between pseudonymization and anonymization of data. These concepts are often confused, but the GDPR does not talk about data anonymization. When techniques for pseudonymization of data have been applied, these data are still considered personal data under the GDPR (see Article 4(5) GDPR [3]). In Article 89(1) GDPR [3] pseudonymization is considered to be an additional safeguard which should be employed in the context of scientific research to ensure respect for the principle of data minimization.

Anonymized data are considered not to be in/under the scope of the GDPR (see Recital 26[3]). Therefore, the concepts of anonymization and pseudonymization of data should be clearly distinguished. EDPB Document states in response to the request from the European Commission for clarifications on the consistent application of the GDPR, focusing on health research [7] what should be taken into account that anonymization of personal data can be difficult to achieve (and upheld) due to ongoing advancements in available technological means, and progress made in the field of re-identification. For this reason, the anonymization of personal data should be approached with caution in the context of scientific research. Those parties, which consider that they are using anonymous information in research, should be in a position to satisfy themselves – and when questioned also the competent Supervisory Authority, according GDPR – on an ongoing basis that this continues to be the case, and that they have not inadvertently become data controllers of personal data for the purposes of the Regulation. Therefore, we gradually arrived at the next type of GDPR requirements related to the provision of technical measures.

## **6. Organizational measures**

The data controller is obliged to create procedures to organize and manage the process of personal data processing. In the researched context, specifics are

revealed in view of different national legislations that are applied in the countries in which the project is implemented. Within the meaning of the Regulation when the data is processed jointly, the persons who process the data are joint administrators/ controllers. The administrator of the data, respectively the joint administrators, is responsible for compliance with the principles and must be able to prove it. This determines the need to follow common procedures, respectively to apply uniform organizational measures.

In this connection, general regulations for the processing of personal data and for the provision of encrypted individual data for scientific and research purposes have been developed, including dynamic data register and appointment of a data protection officer.

The data minimization is achieved by requiring specification of research questions and an assessment of the type and amount of data needed to answer adequately those research questions. Which data is needed depends on the purpose of the scientific research, even when it is exploratory in nature, and should always comply with the principle of purpose limitation under Article 5(1) (b) of the GDPR

It was foreseen regulation of the period of use by determining them proportionally. In order to determine the storage periods (terms), criteria such as the duration and purpose of scientific research must be taken into account. It should be noted that national regulations might also set rules for the storage period.

It will be created regulation of the method of publicizing the results. Regulation of the possibility to provide the data to third parties requires data to be pseudonymized. There is a requirement to sign affidavits from the persons who use the information at the secondary level. Also requires each member of the team to sign a declaration that he will protect the confidentiality of the data provided to him and will use the provided data only for the purposes of scientific work and will not provide the obtained data to third parties, and in the process of work. Bans have been introduced about identification of individual data, copying the data or parts thereof, export of data from the premises of the applicant and inaccurate interpretation of the provided information, in accordance with the applied definitions, methodologies and metadata. Within the meaning of the Regulation when the data is processed jointly, the persons who process the data are joint administrators/ controllers. The administrator of the data, respectively the joint administrators, is responsible for compliance with the principles and must be able to prove it.

## **7. Conclusions**

The described considerations are relevant to the realization of the project me\_HeLi-D. In view of the analysis carried out in the project, procedures and technological security measures were established and undertaken in order for legality to be ensured. The following conclusions have been drawn:

GDPR regulations should be applied, regardless of the fact that measures have been taken to pseudonymize the data subject at an initial stage /at the stage before conducting the tests. Data collection is part of processing of data and therefore falls within the scope of the regulation.

When conducting a (mental) health research project in multiple Member States, it is recommended to use, whenever possible, the same legal basis in the project.

The legal grounds for processing personal data within the project could be for scientific/statistical purposes, as well as – based on data subject consent. Within the project me\_HeLi-D we implement as a legal ground for processing of data the explicit consent, provided by the data subject.

The administrator should provide information on data subjects and their rights in transparent way. The persons' subject to research should provide two types of consent – informed consent to participate in the project and explicit consent to processing personal data.

In case the person subject to research has not reached the age of 13, all applicable norms should be applied with particular care, ensuring compliance with ethical norms as well.

Processing of data of a child under 13 years of age could be managed but it should be justified that it makes scientific sense. It is justified from the point of view of the research objectives.

For legal security within the project, consent given by students –participants that are children under age of 16 years, should be authorized by the holder of parental responsibility over the child, taking into consideration available technology.

It was considered, that when we are talking about two types of consent and there is no obstacle to give them in one written document /declaration, statement/, as long as they are clearly separated as two types of consent.

Compliance with the obligations under the Organizational Measures Regulation when processing data by joint administrators should be provided. General rules and procedures should apply from all project members, including rules of processing, data register, as well as appointment of a data protection officer, etc.

Each member of the team has to declare that he/she will protect the confidentiality of the data provided to him/her and will use the provided data only for the purposes of scientific work and will not provide the obtained data to third parties. and that it will comply with existing prohibitions in the context of processing personal data.

Regulation of the period of use of data is applied. In order to determine the storage periods (terms), criteria such as the duration and purpose of scientific research must be taken into account. When possible, the administrator should determinate the deadlines for erasure of the different categories of data.

The administrator regulates the method of publicizing the results in the context of personal data protection and the possibility to provide the data to third parties. The requirement is to sign declarations from the persons who use the information at the secondary level.

The application of the technical measures for pseudonymization and encryption of personal data are undertaken and maintained at each stage of data processing.

Protection against profiling is necessary and is administered with the creation of special rules.

The value and the meaning of the present study is in reconciling the requirements from the point of view of the application of the ethical norms in scientific research and the GDPR regulations in the context of processing sensitive data of minors for scientific research conducting a transnational scientific study in a way, guaranteeing legality. The considerations, regulations, and real applications described here can be of help in the implementation of any scientific project with some of the specifics of me\_HeLi-D.

## 8. Acknowledgements

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# The Adoption of Information Technologies in Health Promotion

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## **Abstract**

The adoption of information systems (IS) and information technologies (IT) in health promotion has been proved to involve great benefit, as the COVID-19 pandemic showed us. Health sciences professionals need to play an active role in such adoptions. The aim of this paper is to explore health sciences students' attitude towards the adoption of information technologies related to physical activity (PA). Special focus is given to the students' opinion on PA and noncommunicable diseases (NCDs), and the necessity of related IS adoption. To achieve the purpose of this cross-sectional survey a questionnaire was distributed among first academic year health sciences students. Properly analyzing the received answers will help in the development of common understandings between IT specialists and health sciences professionals necessary for the development and the deployment of effective IS. At the same time health sciences professionals will be more prepared to participate, contribute, and promote health using IT.

## **Keywords**

Information systems (IS), information technologies (IT), health promotion, digital health, physical activity (PA), noncommunicable diseases (NCDs)

## **1. Introduction**

The development of specialized IS for the promotion of health, and their adoption have beneficially affected public health [1]. The wide distribution of digital information can potentially contribute to enhancing health and digital health literacy [2]. Patients and health professionals can reduce distances and together can share experiences and find solutions.

Both patients and the public can share their data, helping thus professionals to improve the diseases understanding, in terms of etiology, diagnosis, prognosis, and possible treatment. Health monitoring data can be used to provide early warning of disease and by being linked to other data, can even improve the used models, and provide disease's prognosis. Mobile medical applications and wearable devices are often used for disease prevention [3].



The use of Internet searches provides people in real time with health information, something of crucial importance as we all realized during the COVID-19 pandemic [4]. Still the various uses of Internet search data cannot be limited, and can support people in wide geographic locations and with differentiated combinations of interests.

Wide range of tools is also available for providing monitoring of social media and sentiment analysis. Natural language processing and machine learning techniques can be used to help specialists understand how people undertake key concepts, and support the development of health promotion material [5].

Once again, during the pandemic we used at a more practical level many advanced digital technologies. We got familiar with a range of new ways of interaction, and even more, we used those ways in the provision of health services. For instance, remote consultations or providing real-time advices using many different platforms, and packages were everyday practices.

All the above tools, applications, platforms, packages etc. have similar prerequisites. Digital transformation of health offers diverse opportunities for delivering health care. They proved their potential in positively affecting and transforming healthcare services provision. However, the results can differ substantially, and vary from case to case. They depend on well-educated or not in the use of digital technologies, and with a strong or weak health literacy background end users. During the pandemic, we have tested the tools to facilitate communication with, but also within the healthcare setting, with, but also between the health sciences professionals. We need to make sure that those tools can keep supporting the provision of health services, by enhancing medical education.

The development of IS in the health sector typically aims to achieve high quality, efficiency, equity, affordability and accessibility of health care [6]. However, the final achievement is a result of permanent efforts to balance and optimize between those parameters. Such balance and optimization are related to trade-offs between those sometimes-conflicting parameters.

Health sciences professionals face persistent challenges, including understaffing, underfunding, and underappreciation that affect many roles in both public health and healthcare delivery [7]. We all witnessed those challenges during the pandemic. Public health systems succeeded to be aligned to, and responded rapidly. Guidelines were issued clearly and timely, with detailed descriptions and explanations on the testing procedures, treatment, and vaccination, while at the same time the baseline services were kept ongoing. It was definitely a major disruption nearly everywhere around the globe [8]. In this context, we saw how technology played a very successful role on many dimensions. Health systems everywhere planned, prepared, and took action. Information technologies were adopted the response to the challenges and develop new working environment. This new environment used collaborative communication with patients and health profes-

sionals. This proved to be a very convenient and elastic environment, which will continue to contribute in the future.

Under the pressure of the pandemic, there was not given the luxury of waiting and long testing information technologies, but a quick hand on approach was imposed. The provision of health services cannot stop, and all measures helping in this direction were applied. The success of those measures strongly depended on the stakeholders' common ground and understandings [9, 10].

In conclusion, as the results and outcomes of digital transformation of health services strongly depend on the involved developers, IT and health sciences professionals, and the end-users, there should be given special attention. The success requires the development of common grounds and common understandings in a variety of subjects. The purpose of our study is to evaluate the health sciences students' understandings, as future health sciences professionals.

## 1. Methodology

The deployment of any innovative solution in the field of digital health services provision can improve the health outcomes, if it is designed and developed in a way to answer the health system's needs. Procedures should be in place to make sure the implemented digital health services work in this direction. The scope of the procedures needs to respect the predefined balances. The development of IS in the health sector, like other technologies affects certain parameters positively, and some others not. In this paper, we analyze health sciences students' opinion on the role of information technologies adoption in health promotion. We try to include parameters that will help developers, and IT professionals in improving the results of their work.

Our cross-sectional survey employed a questionnaire distributed among first academic year health sciences students. The cross-sectional approach was applied in our study, in order to describe what is happening now. Data was collected during January 2023. All respondents participated anonymously and voluntarily. Completed questionnaires were received from 210 students. The participants were medical students from the Faculty of Medicine in Medical University – Sofia in Bulgaria, and students from various specialties in the Medical College “Yordanka Filaretova” – Sofia – Bulgaria.

The questionnaire consisted of 14 questions. The majority of the questions were developed as closed and if only they answered “yes” or “other” in a question, students had to designate their answer. Statements related to closed questions were given a range for the answer like:

- Yes / No
- Yes, No, “I cannot evaluate”
- Very important, important, neutral, not important, not at all important

In order to achieve the best participation rates from participants, the questionnaire was developed by flowing the questions from the more general to the more specific, from the least sensitive to the most sensitive ones. A descriptive statistical method was used to analyze the data collected.

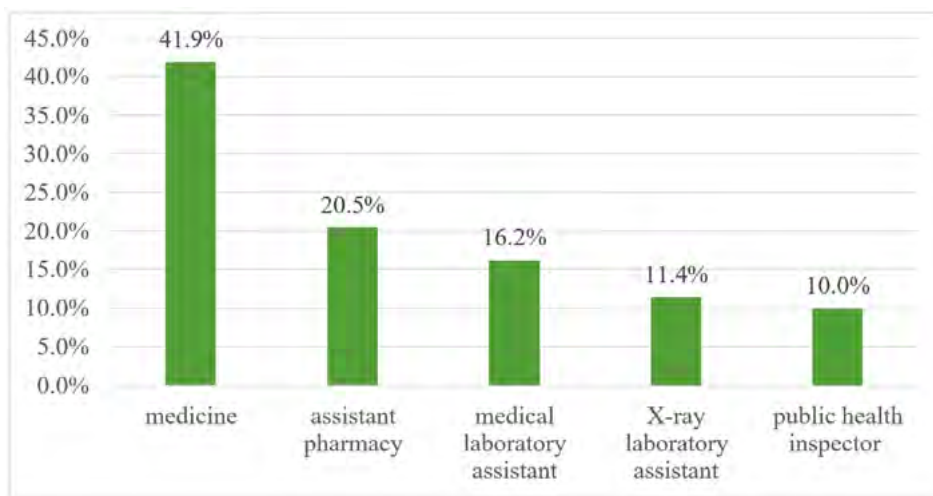
### 3. Results

In many cases, there are variations at the level of understanding, implementing and using IT in the health sector. Those variations depend on the existing infrastructure, platforms, and application. This is the reason we need common standards for the development and the adoption of the IT in health promotion.

Data collected from 210 students provided demographics characteristics, and insights regarding our students' understandings for the adoption of IT in health promotion.

#### 3.1. Demographics related results

To the question related to their study field, "Please indicate the specialty of your study" the results are presented in the following figure (Figure 1).

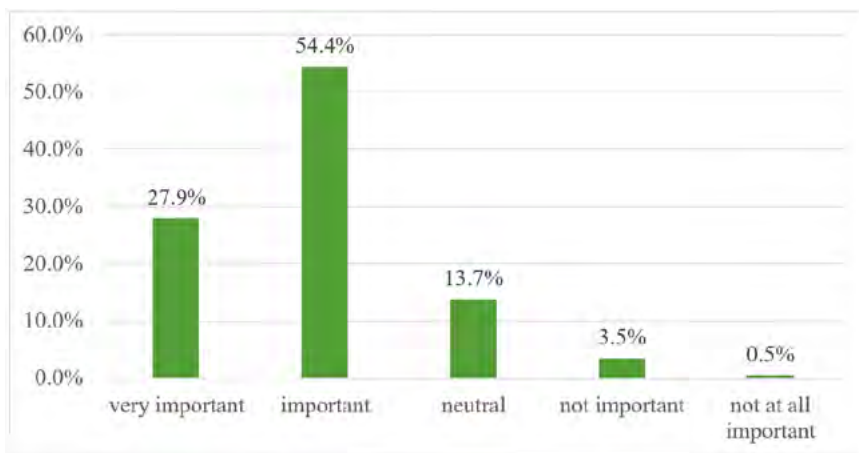


**Figure 1:** Please indicate the specialty of your study.

The majority of the respondents were medical students (41,9%), followed by assistant pharmacist students (20,5%), medical laboratory assistant students (16,2%), X-Ray laboratory assistant students (11,4%) and 10% were students from public health inspector specialty.

### 3.2. Students' understandings for the adoption of IT in health promotion

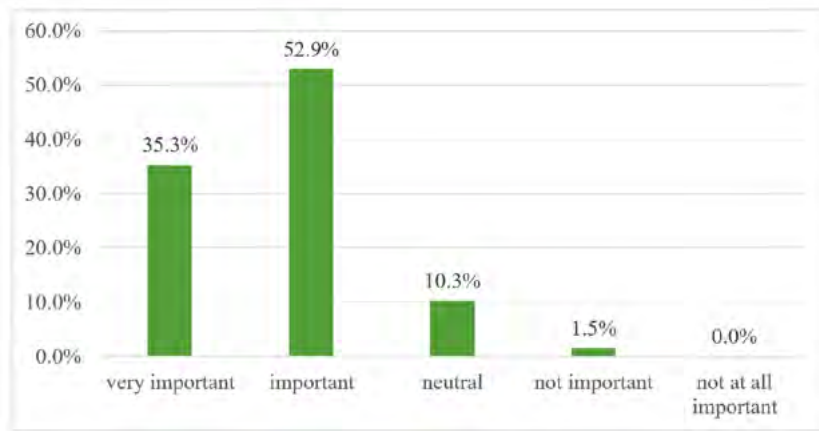
The students were asked to provide their opinion on the role of digital technologies, on noncommunicable diseases (NCDs) prevention. To the question “In your opinion what is the role of digital technologies (m-health apps, AI, big data, etc.) on NCDs prevention?” the results follow in the next figure (Figure 2).



**Figure 2:** In your opinion what is the role of digital technologies (m-health apps, AI, big data, etc.) on NCDs prevention?

More than half of the respondents (54.4%) consider the role of digital technologies important, 27.9% very important, only 13.7% are neutral, 3.5% consider as not important, and just 0.5% not at all important.

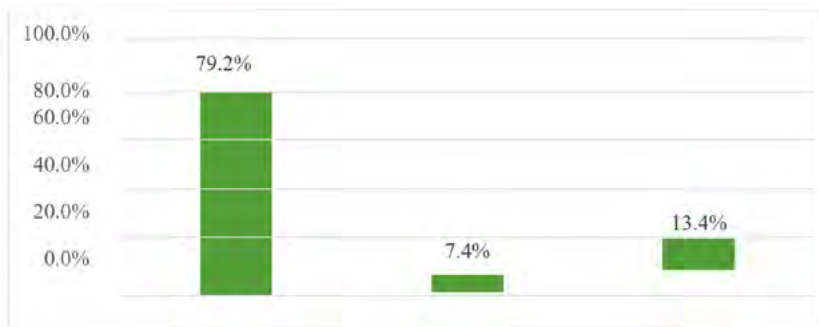
As discussed above it is important the various stakeholders participating in the digital transformation to have clear responsibilities. Those responsibilities aim to clarify the next question, “In your opinion, what is the role of digital health literacy among medical and non-medical professionals for NCDs prevention?”. The results are given in the following figure (Figure 3).



**Figure 3:** In your opinion, what is the role of digital health literacy among medical and non-medical professionals for NCDs prevention?

Of the students, 88.2% consider very important or important the role of digital health literacy among medical and non-medical professionals for NCDs prevention. Neutral are 10.3%, not important consider only 1.5%, and none declared not at all important.

We asked our students to evaluate whether the advance in digital technologies (m-health apps, AI, big data, etc.) could contribute for monitoring and promoting physical activity (PA). The results are provided in the following figure (Figure 4).



**Figure 4:** Do you believe that the advance in digital technologies (m-health apps, AI, big data, etc.) could contribute for monitoring and promoting PA?

More than three fourth (79.2%) of the students believe that the advance in digital technologies (mhealth apps, AI, big data, etc.) could contribute for monitoring and promoting PA, only 7.4% are negative, and 13.4% cannot evaluate.

Trying to identify the ethical aspects of the usage of digital technologies in promoting health, the students were provided the options:

- data protection
- discrimination
- right to freedom of choice and autonomy
- equity (such as by widening social gaps)
- stigmatization
- others

The students were allowed to point more than one options. Students' answers are provided in the following figure (Figure 5).



**Figure 5:** Identification of the affected ethical aspects of the usage of digital technologies in promoting health.

First choice for our students for the affected ethical aspects of the usage of digital technologies in promoting health was “data protection” with 84.5% of the respondents pointing. The right to freedom of choice and autonomy followed with 53.6%, and the equity (such as by widening social gaps) was close with 49.1%. More than one-third (36.4%) pointed discrimination, 21.8% stigmatization, and only 8.2% indicated others.

#### 4. Conclusions

This cross-sectional survey employed a questionnaire distributed among first academic year health sciences students. The results underline students' opinion on the role of digital technologies (m-health apps, AI, big data, etc.) on NCDs prevention. They highly evaluate the role of digital health literacy among medical and non-medical professionals for NCDs prevention. Students strongly support the idea that that the advance in digital technologies (m-health apps, AI, big data,

etc.) could contribute for monitoring and promoting PA. The respondents recognize many fields as affected ethical aspects of the usage of digital technologies in promoting health. Well-educated stakeholders can contribute for the promotion of health enhancing PA.

As the results and outcomes of digital transformation of health services strongly depend on all the involved stakeholders, namely the involved developers, IT and health sciences professionals, and the end-users, there should be given special attention on the development of common understandings among them in a variety of subjects.

## 5. Acknowledgements

This work was supported by the National scientific program: “Young Researchers and Postdoctorates-2” (MES – Bulgaria).

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# Information Technology Specifics of Digital Mental Health Literacy Promotion

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## Abstract

Young people face many changes and challenges during adolescence, and increasing mental health issues in youth and adolescents have become a major concern for mental health professionals. Interventions supported by digital technologies can promote adolescent mental health and are one way to counteract the rise in mental health problems. Those interventions include activities asking participants to identify mental health issues or distinguish between disorders (e.g. depression) and temporary emotional states (e.g. sadness). All these aspects are integrated into the concept of mental health literacy as an important underlying concept, amplifying possibilities for prevention and represents a necessary prerequisite for preventive measures. Basic concepts of mental health literacy are important for maintaining and/or promoting mental health and are needed to raise awareness and understanding of mental health, mental disorders and their symptoms, as well as to promote insight into helpful strategies and awareness for when it is necessary to seek (professional) help and where and how to find it. Many mental health interventions are being delivered in a school-based setting through digital means, using contemporary digital tools, thus taking advantage of technological advances and the educational environment. The aim of this paper is to provide the main information technology (IT) specifics, by providing the main structures and the approach used to deal with them in the development of the me\_HeLi-D (mental health literacy and diversity) program, a digital mental health, and mental health literacy promotion tool for youth aged 12–15 years. Three concrete structures are proposed to cover the needs of such interventions, as applied for the needs of the me\_HeLi-D tool.

## Keywords

Health literacy (HL), mental health literacy (MHL), digital mental health literacy (DMHL), information technology (IT)

## 1. Introduction

An alarming number of young people around the world are facing mental health challenges. A recent report of the United Nations Children’s Fund (UNICEF) estimated that in 2019, 13.5 % of boys and 11.2 % of girls aged 10 to 14 and 14.1% of boys and 13.9% of girls aged 15 to 19 worldwide – i.e. a total of approximately 166 million adolescents (10 to 19 years) – had a mental disorder [1]. Almost half of this group (42.9% of adolescents with a mental disorder) experienced symptoms of anxiety and depression. Other highly prevalent mental health disorders among this group were conduct disorders (20.1% of the group with mental disorder), attention-deficit/hyperactivity disorder (19.5%) and idiopathic developmental intellectual disabilities (14.9%; [1]). Mental health issues cause significant suffering and add additional strain during the already sensitive time of adolescence, characterized by critical changes on a social, cognitive and emotional level, and have the potential of negatively affecting outcomes in adulthood [2]. However, often adolescents are not well informed when it comes to mental health [3], and studies with young people reported deficiencies in areas such as accurate recognition of mental disorders or the knowledge of how and where to seek professional help [4]. Therefore, promoting mental health and MHL among young people is critical and of utmost importance on a global scale [1,5].

Mental health “is a right to be nurtured” and a goal to be achieved for all, but especially for children and adolescents [1]. One common definition of mental health as proposed by the WHO is “a state of well-being in which the individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community”<sup>5</sup>. A newer definition, that better distinguishes conceptually between a state of well-being and mental health, recognizes mental health as an internal and dynamic experience of balance or stability, where harmony within, as well as with the external world is possible [6]. It validates the mind-body interconnection, an individual’s resilience, emotional self-awareness and regulation, as well as one’s ability to be in positive relation with others. Thus, it is intended to be aligned with an inclusive, less culture-bound approach that recognizes the diversity of human experience [6].

Health literacy (HL) and mental health literacy (MHL) are important influencing factors when it comes to sustaining and promoting mental health [7]. MHL includes knowledge of available services and their offerings, knowledge of disorders and their symptoms and knowledge about when it is indeed necessary to seek help [2]. In order to seek help, one must be able to identify the need for it, decide to seek help and carry out the decision in doing so. Major barriers to mental health help seeking are the stigma around it, the ability to discern that outside

help is necessary and subsequently know where to find it and have the motivation to do so [2]. As adolescents show deficiencies in those skills, MHL promotion for this population is crucial [4].

One way in which MHL can be promoted is through psychoeducation. This is why psychoeducation demonstrates an integral part of many digital mental health interventions for youth [8]. For instance, effective digital interventions included activities, where participants were asked to identify mental health issues or distinguish between disorders (e.g. depression), and temporary emotional states (e.g. sadness) [9]. The latter seems to be very important as an alarming phenomenon can be observed in social media, especially on the video-streaming platform TikTok. A growing trend is users posting videos of their self-described mental health symptomatology [10]. Although this may be beneficial for increasing general mental health awareness, many of these videos convey misinformation and have been uploaded by self-diagnosed users, who often romanticize, glamourize or sexualize the disorder [10]. Accordingly, increasing numbers of young people, who engaged extensively with this content, reported having similar, and often rare, mental health conditions, such as dissociative identity disorder or Tourette's syndrome, with symptoms that differed from clinical classification [10,11].

MHL interventions for youth, such as the planned me\_HeLi-D (mental health literacy and diversity) program, aim to provide young people with appropriate mental health information. As such, they are a crucial component of maintaining and/or promoting mental health and are needed to increase awareness and understanding of mental health, mental disorders and their symptoms, as well as to promote insight into when it is necessary to seek (professional) help and where and how to find it. Me\_HeLi-D is a project co-founded by the Erasmus+ Programme, including seven partner institutions from four European countries. This paper aims to provide the main information technology (IT) specifics and the approach used to deal with them in the development of the me\_HeLi-D program, a digital mental health and MHL promotion tool for youth aged 12-15 years.

## **2. Mental health literacy in the digital era**

### **2.1. Health literacy**

MHL can only be understood in relation to HL. It represents an important construct to consider for the me\_HeLi-D tool. HL represents a well-researched concept and is considered a stronger predictor of health than other variables such as education, income or ethnicity [12]. The first clear definition for HL was provided in 1995 in a report on national health standards by the US Joint Committee on National Health Education Standards [13]. Since then, many other definitions were put forward, with a recent review finding up to 250 different definitions in 774 scientific articles [14]. Among the most commonly used definitions, a sur-

prising common denominator was found, i.e., each definition placed the individual's ability/skill at the center of the concept. Variability was found in the characteristics that constitute a health literate individual, such as the number and types of abilities/skills, or the environment and time in which those abilities were considered important [14]. In 2012, the European Health Literacy Consortium proposed a now popular and widely used definition, which was the result of an extensive systematic review with a sample of 19 studies and aimed to summarize the most thorough evidence-based HL components, and defines HL as follows:

“Health literacy is linked to literacy and entails people’s knowledge, motivation and competences to access, understand, appraise, and apply health information in order to make judgments and take decisions in everyday life concerning healthcare, disease prevention, and health promotion to maintain or improve quality of life during the life course.” [13]

With regard to the me\_HeLi-D tool, it is of importance to consider how HL is defined for the younger population. In their systematic review, Bröder and colleagues analyzed 30 publications including 12 definitions and 21 models of HL developed specifically for children and adolescents of 18 years and younger [15]. Surprisingly, the dimensions found did not differ significantly from those proposed for adults, which the authors attribute to a lack of youth involvement in the conceptual development process. HL in young people is commonly described as a multidimensional, complex construct with a strong focus on action and performance as well as on individual characteristics, context variables play a minor role. Young people are seen as active participants in seeking, understanding and evaluating health information, generally aimed at promoting their personal health and health outcomes. Individual characteristics that were commonly associated with HL involved cognitive (e.g. knowledge, critical thinking), behavioral or operational (e.g. seeking and accessing information) and affective or conative (e.g. self-regulation, interest) characteristics. Bröder and colleagues argue that future development of HL definitions and models should include participatory approaches and appeal to the use of youth-specific definitions in the development of HL interventions [15].

## **2.2. Mental health literacy**

The concept of MHL emerged from the domain and research of HL [16] and is described as an element or component of it [17,18], that should not stand apart, but always be considered together with HL [16]. MHL was first introduced by Jorm and colleagues because they found that HL was insufficient to describe the skills and knowledge needed to achieve, maintain or promote mental health. They defined MHL as the “knowledge and beliefs about mental disorders which aid their recognition, management or prevention.” [3]. Its definition, understand-

ing and key components have, similar to HL, constantly evolved since then [16]. The initial components introduced [19], have been expanded [16] and build the underlying foundation used in the current MHL promotion instrument.

There is an in-depth and multifaceted debate about the definition, conceptualization, and reliable measurement of MHL [20,21]. Some researchers question the meaningfulness of MHL as a stand-alone concept, claiming that it is too vague and lacks consensus in definition. Furthermore, the continuous expansion of the concept may violate the principles of a sound construct definition and may have led to confusion and inconsistency in attempts to measure it [20]. Jorm and colleagues argue for the validity and necessity of a domain-specific concept of MHL, rather than a broad and general construct, because (a) mental disorders were ignored in the field of HL, and (b) HL was ignored in the mental health field before the concept was introduced. Recognition of MHL as a distinct construct has reportedly had a positive impact on MHL-related policy making, development of specific MHL interventions, and precision in evaluation and assessment [21]. The debate is ongoing and there is recognition that a common approach is needed. This study, as well as the me\_HeLi-D project, recognizes the value of considering MHL as an important theoretical concept, while acknowledging that consensus has not been reached in defining and conceptualizing MHL.

As proposed by Kutcher and colleagues, MHL entails “understanding how to obtain and maintain positive mental health; understanding mental disorders and their treatments; decreasing stigma related to mental disorders; and, enhancing help-seeking efficacy” [16], and ideally MHL promotion interventions should address all components to maximize the likelihood of efficacy. Similar to the dimensions of HL, the multicomponent construct of MHL highly encompasses individual attributes such as cognitive (e.g. knowledge on MH disorders), behavioral (e.g. help- or information-seeking), and affective (e.g. motivation to adhere to treatment) characteristics.

Especially when it comes to seeking information on mental health and mental disorders, the knowledge about valid health information resources is crucial. In our increasingly digital world, the internet has become an important source for seeking and retrieving information about one’s (mental) health [22]. Within the context of the digital and/or online world, two sub-concepts of HL are important to discuss, the concept of DHL – digital health literacy and eHL – eHealth literacy [23,24]. Media literacy and eHealth literacy have been described as separate concepts [22], and media literacy has also been defined as a sub, or overlapping concept of a broader eHealth literacy model [24]. The concept of eHL was introduced by Norman and Skinner (2006) as “the ability to seek, find, understand, and appraise health information from electronic sources and apply the knowledge gained to addressing or solving a health problem” [24]. It should be seen as a dynamic and process-oriented literacy, rather than a static construct, which

is influenced by personal, environmental, and other factors [24]. Similar to eHL, DHL encompasses the abilities or skills to search for health information, to add self-generated content, to evaluate the reliability of health information, to determine its relevance for one's one life experience, and to protect one's privacy – all within the digital realm [23].

### **2.3. The promotion of mental health literacy in a digital setting**

The importance of MHL in the context of health is widely recognized and has led to extensive efforts to develop MHL interventions. Several important aspects should be considered in the design and creation of these interventions to ensure relevance and effectiveness, and they receive considerable attention in the present project. First, developments in the field of HL must be taken into account. Second, the context and setting in which they are implemented must be considered. Third, they must be designed to be developmentally appropriate. Fourth, valid and reliable measures must be applied that are adequate for the setting and age of the participants [16]. A recent scoping review found indicators for effective school-based MHL interventions some of which overlap with those identified in previous research [25]. Five recommendations were summarized, namely (1) use of valid and standardized measures, (2) training of facilitators and clear description of implementation modalities, (3) use of a control group design, (4) provision of a detailed intervention description, (5) follow-up measures of at least 6 months [25].

Like the me\_HeLi-D, more and more of these preventive interventions for children and adolescents are being delivered digitally [26]. And indeed, it has been argued that MHL interventions for youth can best be delivered using contemporary digital tools in a school-based setting [16], taking advantage of technological advances and educational environments. These interventions may be introduced on a class- or curriculum-level [27]. In addition, MHL programs in the school setting provide low-threshold interventions which help to reduce treatment gaps [28].

In their review of 11 intervention studies, Ma et al. (2022) conclude that school-based MHL interventions should address stigma on the personal as well as the societal level. In addition, a mere provision of knowledge is not enough for the transfer of skills. Thus, practical elements for enhancing help-seeking behavior should be incorporated [28]. This has already been effectively done in prior digital interventions targeting help-seeking behavior, such as the serious game *Singularities* [29] or the mobile app *WeClick* [30], where the user is actively encouraged to use help-seeking strategies for self and/or others. As has already been argued by Kutcher et al. (2016), a MHL intervention should also address all components of the construct [16]. This means to equally address knowledge in how to obtain and maintain mental health, knowledge of mental disorders and

their treatments, stigma related to mental disorders and help-seeking behavior. To date, few interventions have addressed all four components, with knowledge and stigma being the most implemented [31]. Finally, choosing reliable and valid instruments to measure the construct of MHL is particularly important to find evidence-based efficacy of MHL interventions [28]. Therefore, the me\_HeLi-D project paid special attention to the process of selecting accurate screening instruments for MHL. The next section deals with the rigorous, multi-stage selection process carried out by the dedicated working group with members of all partner countries.

### 3. Mental health literacy measures

There are already quite a few instruments for measuring MHL that use different approaches. One measure that has been used quite extensively is the measure by Jorm and colleagues, which makes use of brief disorder/case vignettes [32]. Albeit frequently used, concerns have been raised that it does not cover certain aspects of the construct, such as the ability to distinguish between a mental disorder and a mental health problem [16]. Other measures have been proposed that encompass further aspects [16], depending on the target group and the context of their use. As mentioned above, the use of valid, reliable and standardized measures is important for assessing the effectiveness of interventions. However, MHL intervention studies have often used non-validated or self-developed questionnaires, or measures that do not have sufficient psychometric properties [33,25].

A measure that has gained global recognition in measuring the digital component of HL is the *eHEALS* developed by Norman and Skinner [34]. Even though its validity has been challenged in the past [22], it has been successfully used with the younger population [35]. Building on careful considerations, two distinct MHL instruments will be used in the pre- and post-test of the me\_HeLi-D intervention, the *eHEALS – eHealth Literacy Scale* [34,36,37], and the *MHLS – Mental Health Literacy Scale* [38,39]. In addition, a self-created knowledge test aiming to gauge the gain in knowledge will be implemented before and after the intervention.

Screening tools were selected through an extensive 11-week process (01/12/2022 to 16/02/2023) and followed a multi-step approach: (1) collection of validated measures; (2) initial review of collected measures, (3) voting and selection; (4) adaptation, (5) translation, (6) back-translation, (6) finalization. As a first step, a large pool of possible instruments (previously validated) was generated, drawing on the findings of a previously conducted systematic review [8]. In a second step, a general discussion on all collected measures in the pool was initiated in the working group, where topics such as concerns, favorites/preferences, or missing instruments were discussed. The most appropriate scales remained in the

pool, others were excluded. In a third step, the relevance of the instrument was rated, whereas higher numbers indicated a better fit in relevance and appropriateness: (1) low, (2) medium, (3) high. The scores of the voting were summed up and evaluated. For final in- or exclusion of the respective measures, a second voting was initiated. Adaptations and translations were then made wherever necessary. Adaptations included tailoring the instruction or item to the school context or target population. To test these adaptations, a pilot test was conducted with approximately 20 adolescents using the think-aloud method, and all items were checked for clarity and comprehensibility in two of the national languages (SLO, GER).

For all measures that were not available in national languages, back-translation was done: (1) translation into the national language, (2) back-translation into English by a translator outside the project team, (3) comparison of translations and back-translations by the lead of the working group, and (4) further adaptations if needed. In a final step, the screening tools/questionnaire battery was subjected to the last necessary adjustments and finalized.

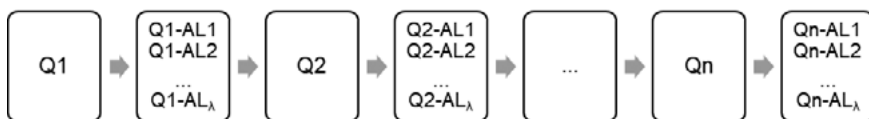
#### 4. Structure specifics of digital mental health literacy questionnaire

How can these instruments be implemented in a digital tool? The central aim to be considered is that the intervention should be aligned with the specific individual needs of each student. Some students might be very competent, while others might be distressed or anxious. These needs are reflected in the answers to the screening questions and can be transposed in an adaptive structure of the program. The adaptive structure allows for tailored and individualized assignment of tasks and exercises. These requirements need to be fulfilled by and implemented in the tool architecture.

This section takes a close look at the structure and sequence of the questionnaires. The aim is to provide a high-level description of the questionnaire structures and their integration.

##### 4.1. Sequence of questions structure

Questions are provided to the participant in predefined or random sequence (Figure 1). The participant is evaluated as the sum of the results per question (Equation 1)



**Figure 1:** Sequence of questions structure.



$$\text{Total Grade (sequential)} = \sum_{k=1}^m Q_k AL \lambda$$

**Equation 1:** Total grade in sequence of questions structure

Such structure is appropriate when the aim of the interventions is to evaluate the level of skill, understanding and knowledge on specific subjects of the participants. For instance, this would be the screening and the knowledge test in the beginning of the intervention.

## 4.2. Structure of adaptive questionnaire

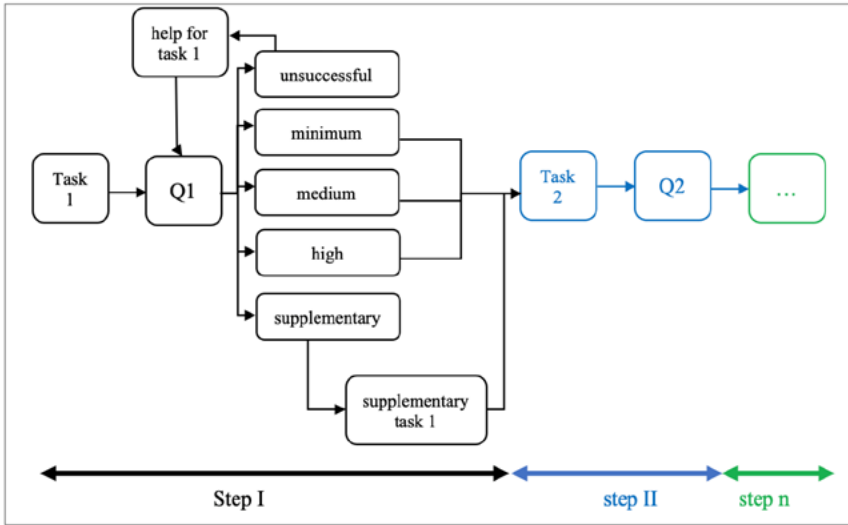
For matching the psychological difficulties of the students with provided information and exercises, an adaptive system is implemented (Figure 2). In the adaptive questionnaires each participant – student has the possibility to proceed according to his/her achievement related to the corresponding Task X question, and the provided answer levels (AL):

1. (AL: fail) use help and re-try and accomplish the current task or
2. (ALs: minimum, medium, high) proceed with the next task or
3. (AL: advanced) be instructed in advanced activities related to the current task that correspond his/her needs.

The levels “minimum”, “medium”, “high”, can refer to different emotional or mood states. Each emotional dimension can be rated in these three levels, for example for stress, anxiety and depression it could be for example:

- “minimum = relaxed”, “medium = comfortable”, “high = stressed”
- “minimum = confident”, “medium = neutral/unconcerned”, “high = anxious”
- “minimum = cheerful/happy”, “medium = balanced/content”, “high = depressed”

Depending on the response to Q1 they are assigned different exercises, e.g., if they are stressed, they are given a relaxation exercise; if they feel anxious, they are offered a short story in which a peer explains how they overcame their worries or fears. At the same time the levels “minimum”, “medium”, “high”, can refer to levels of understanding of specific concepts. In this second case, depending on the response to Q1, they will receive additional learning materials to delve deeper into the topic.



**Figure 2:** Adaptive questionnaire structure.

$$Total\ Grade\ (adaptive) = \sum_{k=1}^m Q_k AL\lambda + (-unsuccessful) + (supplementary\ tasks)$$

**Equation 2:** Total grade in adaptive questionnaires structure

The adaptive questionnaire’s structure allows participants to make more than one attempt before moving on to the next task. That is if a participant is not sure about the answer, it’s possible to review it and repeat their answer. However, for each subsequent unsuccessful attempt, a supporting help task will be proposed, and the attempt will be recorded/tracked, resulting in a total number of unsuccessful attempts/trials, which will be calculated.

The same way the adaptivity of assessment works using similar modes for additional incentives in giving participants choice whether they want to put more efforts on some additional, optional, and more elaborate tasks “supplementary tasks” and gain additional points. If one already has completed all the quizzes or questions, the person gets additional material at an advanced level.

### 4.3. Quiz with additional gamification components

In order to include gamification components a serious game should be developed based on the quest or mission game by following the steps (Figure 3):

1. initialize the quest game project, by defining a game board,
2. each step (I, II, ...) in the “virtual world” is related to a concrete achievement,



**Figure 3:** Quest game virtual world example layout.

3. the total achievements are reported in a health bar, that shows the state of a participant,
4. by using interactive elements, one increases the number of badges and/or other intensives,
5. the target object may define a path from the beginning to the end in the “virtual world”.

$$\text{Total Grade}(\text{quest}) = \text{health bar} + \text{badges}, \text{ where} \\ \text{health bar} = \text{Total Grade}(\text{adaptive})$$

**Equation 3:** Total grade in Quiz with additional gamification components.

The total grade consists of the health bar plus the collected badges. Again, the health bar is the sum of the intermediate accomplished tasks.

## 5. Conclusions

For the requirements of the me\_HeLi-D tool, numerous HL and MHL instruments, as well as digital tools for mental health promotion were reviewed and evaluated against various criteria. The process involved the creation and review of a large pool of possible instruments, a thorough discussion of all collected measures, two separate voting loops, and adaption and (back-)translation procedures. The instruments, as well as the knowledge test, represent the raw materials to be implemented in a digital environment with an attractive design for the participating youth. The related IT specifics are discussed in the paper, with the provision of three different structures. The proposed approaches can be used to

deal with the sensitive nature of the topic in the development of a motivating digital tool to promote mental health and MHL for youth aged 12–15 years.

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# Tools and Digital Technologies Used for the Promotion of Mental Health Literacy in *me\_HeLi-D*

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## Abstract

Participatory research approaches (PRA) such as co-design and co-creation, involve users directly in the design process of digital mental health interventions. They not only enable participation, but also empower users to become part of the solution. Furthermore, co-designed interventions show promise to increase user engagement with the interventions. This paper presents the PRA and their digital implementation in the *me\_HeLi-D* (mental health literacy and diversity) tool. The tool applies PRA and digital technologies to better address the needs of its target population (children and adolescents aged 12–15 years) and make it engaging and relevant to them. Aligned with this goal, we present firstly different methodologies, secondly the iterative participatory design approach detailing the participatory workshops used to design the tool, and thirdly the implementation of the corresponding components in Moodle. Mainly, we describe the architecture, the components to be implemented, and some gamification components, which would be applicable.

## Keywords

Health Literacy (HL), Mental Health Literacy (MHL), Digital Mental Health Literacy (DMHL), Information Technology (IT), Participatory Design Research (PDR), Moodle

## 1. Introduction

The aim of this paper is to provide a high-level description of the digital technologies used for the development of the *me\_HeLi-D* (mental health literacy



and diversity) program, a digital and inclusive tool aiming to promote mental health and mental health literacy (MHL) among youth. A special focus lies on the applied participatory research methods during the different stages of tool development and its related benefits and challenges.

Participatory research as described by Hella von Unger (2014) [1] is an umbrella term for research approaches that involve social stakeholders as co-researchers in the research process in order to explore and influence social realities together. In this, they differ from the traditional research approach, in which the target population – in this case, children and adolescents – often remain passive recipients, and therefore require a change of perspective in the perception of their role [2,3]. Co-design and co-creation are among these participatory research approaches (PRA) and refer to collaborative design processes of collective creativity, such as the co-developing a digital intervention directly with the target population [4]. In these processes, the partnership between researcher and stakeholders should be a democratic one [2], in which the stakeholders involved are seen as the experts of their experience, and take an active role in exploring potential solutions [4]. Furthermore, participation is one of the guiding principles of inclusion and means the equal involvement of non-scientific stakeholders in the research process [1]. This directly reflects the key components of PRA, namely participation, empowerment, and the dual goal of exploring and changing social realities.

The level of participation can vary depending on the design and goal of the research project and in many cases is described as a continuum. Chung and Lounsbury (2006) propose four levels in their participation continuum, (1) compliant participation, (2) directed consultation, (3) mutual consultation, and (4) empowering co-investigation. The extent of participant responsibility increases with each level, from passive participation at level 1 to sharing equal responsibility and decision-making power at level 4 [5]. Similarly, Wright (2021) also proposes four levels, but takes on a different perspective and proposes a multi-stage model of participation in which each level (1 – non-participation, 2 – preliminary participation, 3 – participation, 4 – exceeding participation) includes one to three steps. Level 3 comprises of three steps, from co-determination, to partial decision-making authority to decision-making power [6]. Thus, consistent with Chung and Lounsbury's continuum, participant responsibility and authority increase with each step of the model.

Empowerment represents another key component of PRA [1] and another guiding principle of inclusion. It refers to enabling and supporting people, so that they become aware of their own strengths and resources and are able to arrive at their own solutions to problems. Participatory approaches can promote youth empowerment [3], by actively encouraging them to share their ideas, voice, and preferences and thus become part of a solution tailored to their needs.

Finally, PRA are characterized by a dual objective, as they are not only about exploring and understanding the social realities at hand, but also about initiating change within them. This entails generating knowledge on the one hand, and reflecting and taking action on the other [1]. Since extensive actions of PRA have been incorporated into the development of the me\_HeLi-D tool, its central components are considered in the tool's development process.

As the aim of the me\_HeLi-D tool is to be inclusive and diversity-sensitive, the PRA must also be designed and used accordingly. Implementing the requirements of inclusion in heterogeneous classes means to deal with students with very different abilities, as well as their different emotional and social needs [7]. Above all, it is about ensuring that every student finds a learning environment that enhances his learning process in the best possible way. For the teachers this means keeping each student in mind, implementing high expectations and aspirations for each individual child, and involving each student in quality teaching. For successful inclusive teaching, it is important to constantly question one's own teaching strategies and improve them with the help of colleagues and students. To initiate and support such way of teaching the "Inclusive inquiry" method provides important ideas [7]. Messiou and Ainscow (2021) propose an exploratory view of teaching, which is constantly evolving due to the implementation of action research strategies. Action research belongs to the family of participatory research methods [1] and draws impetus from student and teacher peer feedback.

In order to include the voices of students, Messiou and Ainscow [8, 9] have developed different inspiring methods. It is not enough to ask the students for their opinion, but the students have to be involved in the process as co-researchers. When students are involved in this role, a joint preparation, and introduction to the research process is necessary. A common purpose and understanding of the task to be undertaken has to be established, e.g. designing a lesson in a way that includes all students, assuring that all can learn in a good way or that a digital program is designed to best meet the needs of all students [9].

In preparing this process, it is first necessary to define the aim and the research question together with the students, and then to initiate the action research process together. This includes elaborating the research method, sharpening the students' observation skills, giving them time to find answers and introducing different methods to make students' voices visible (e.g. photovoice). Methodologically, the students are trained as co-researchers and as such, they are included in the process. The overall aim is that teaching and learning should motivate and involve all students in their class. When this aim is clear, students identify obstacles and challenges, but they also find solutions and develop a framework that works for all. For teaching, this may signify that some time learning will be individually differentiated and some time it will take place in

a setting where all students are included. Both higher and lower performing students can be involved in this process of research. Their opinion is just as relevant as that of the other students, they are given time and space to clarify their own opinion just like other researchers. This leads to a new view of teaching, to question own strategies, to an ongoing development based on the inclusion of students' perspectives [7, 9].

However, PRA also brings challenges that need to be carefully considered. One challenge relates to privacy, confidentiality, processing, and dissemination of the data collected [4, 10]. This challenge can be addressed through compliance with data protection regulations, such as the European Union's General Data Protection Regulation [11], and the use of usernames and passwords and secure servers [10]. Another challenge is low engagement and active participation in participatory activities. This challenge can be mitigated by a carefully considered didactic approach that includes short activities with clear objectives and uses scenarios with clear examples that participants can relate to [4]. In addition, an open, and safe atmosphere characterized by patience and flexibility can foster engagement and creativity [10]. One challenge that requires special attention is the potential power imbalance between researchers and participants, especially when children and adolescents are involved [2]. Again, creating a safe and trusting environment with transparent communication and offering choices can help even out inequities [10]. The responsibility for creating such an environment lies with the adults (researchers/workshop leaders). Finally, a major challenge is that diverse users may express different needs and preferences. Strategies to address this challenge include asking participants to evaluate relevance, making the tool adaptable, and informing participants that their ideas and feedback needs to be balanced with other considerations, such as evidence-based literature [10]. This means that students need to be made aware that not all of their ideas and opinions can be implemented in the final tool, as they need to be balanced with evidence-based solutions, the capabilities of the digital platform (i.e. Moodle), and other considerations of researchers.

Although there are challenges that need to be considered, the benefits of applying PRA are manifold, such as enriching projects with new ideas and making the tools/programs more responsive to user needs [4]. In addition, collaboration and democratic partnerships between researchers and social actors are fostered, and the rights and voice of the community are guiding elements of research [1]. For these, and the above reasons, the development of the me\_HeLi-D tool includes several opportunities for student and teacher participation.

## **2. Participatory research methods in me\_HeLi-D**

We have established that participatory research is a key component of developing a digital tool/program for youth, such as the me\_HeLi-D, with the aim

of exploring and then directly targeting the needs and interests of this specific population [4]. A program for students needs to address their specific interests to overcome challenges such as low engagement and inconsistent adherence to the mental health tool [12]. Implementing PRA has the potential to increase engagement [13], and make the tool more appealing to youth. It needs to be intuitive, motivating, and stimulating. This is only possible if the students themselves are directly involved in all steps of the design and implementation of the program. Especially when it comes to the look and design of the program, feedback, and collaboration with the students is essential.

The importance of co-design is not only necessary to guide the development process of the tool, but co-design and co-creation, if implemented thoroughly, show promise to increase the impact of the intervention for children and adolescents [3]. With this in mind, the me\_HeLi-D tool takes a multilevel approach in which PRA play an important role.

The me\_HeLi-D tool aims to directly enhance mental health and mental health literacy, and more indirectly, to promote diversity-awareness among students. More specifically, the tool aims to strengthen the students' resilience, mindfulness, and help-seeking behavior and to equip them with knowledge and skills about anxiety and depression so that they can respond appropriately if or when they encounter such conditions (either in themselves or others). To this end, a multinational team from four European countries (Austria, Bulgaria, Poland, Slovenia), aims to develop and evaluate an evidence-based, inclusive and adaptive digital tool/program that promotes the mental health and mental health literacy among students aged 12–15 years. Program development is based on two pillars, (1) a systematic review process of the available literature and in-depth analysis of existing effective digital mental health interventions; and (2) a participatory research approach. The content and design of the tool are developed in an iterative, participatory process. This means that content and design are developed, discussed, and revised to varying degrees with the target group (students) in several stages of program development.

## **2.1. Objectives**

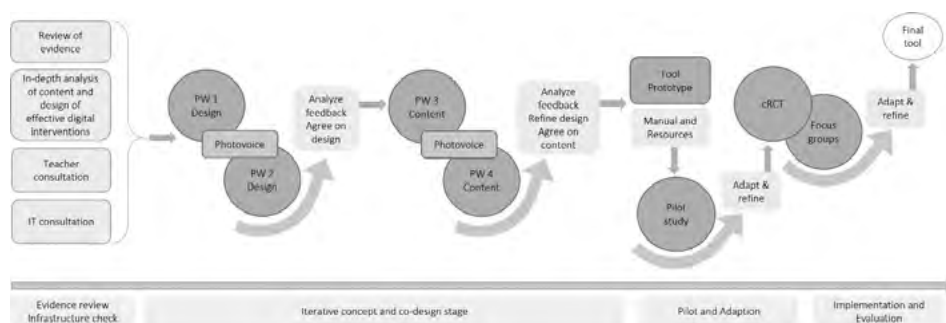
In line with the key components of PRA, the overarching objectives of following a participatory approach are participation, empowerment, understanding, and changing the social reality of youth [1]. Following the guiding principle of *Nothing About Us, Without Us*, the me\_HeLi-D project provides opportunities for youth participation at several stages of the research cycle, namely through participatory workshops, a pilot study and interviews or focus groups. Students are empowered to express their needs, ideas, and preferences regarding content and design. Specific goals include, but are not limited to, gathering feedback on rel-

evance, usefulness, ease of use, appropriateness of language, color scheme, preference in terms of media (video, audio, text), possible features (avatar/persona) and level of interactivity (forum, social cooperation, co-creation, collaborative activities). Since the me\_HeLi-D tool is to be implemented in a school setting, teacher’s feedback represents another crucial element.

## 2.2. Iterative design activities and involved parties

The main target group is students of ISCED (International Standard Classification of Education) level 2, between the ages of 12 and 15. In order to gain adequate access to the target group and to minimize challenges such as sample recruitment and student drop out, three schools from Austria, Poland and Slovenia, respectively, are involved in the project as full partners. Teachers play an important role, as they not only act as a direct link between the researchers and the students, but also provide insight and knowledge as experts throughout the project in meetings and in all related participatory activities.

Figure 1 shows an overview of all iterative design activities in the different stages of the project cycle. All participatory activities, with the exception of the interviews/focus groups, are conducted with students and teachers from the partner schools. Approximately 40 students and 2 teachers from 2 classes per country will participate in the participatory workshops (PW) and pilot study, for a total of 120 students and 6 teachers. After adapting and refining the tool according to feedback from the pilot study, the tool will be evaluated in a cluster randomized controlled trial (cRCT). Qualitative interviews (N= 5) or focus groups (N= 10) with students and teachers are planned to accompany the cRCT for a final gathering of feedback from the parties involved. Final adjustments will be made before the tool is released open access.



**Figure 1:** Overview of participatory research methods used in the various stages of development of the me\_HeLi-D tool

### 3. Participatory design workshops in me\_HeLi-D

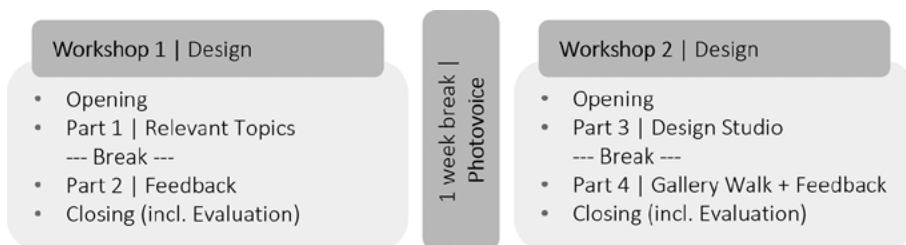
As part of the design workshops in me\_HeLi-D, the focus is on student ideas and voice of regarding the design of the tool. Teachers take on a dual role, both co-leading the workshops and providing feedback on feasibility strategies for implementation. Both design workshops (1 and 2) take place at school, rather than at a university, as it is advantageous to choose an age-appropriate setting [4]. It was found that co-design workshops for mental health tools with young people ideally last between 30 minutes and two hours [4]. With this in mind, two school hours (90 minutes) are allocated for both Workshop 1 and 2.

#### 3.1. Preparation

In accordance with the General Data Protection Regulation [11], informed consent is obtained from students and their parents/guardians for their participation and for the recording/collection, processing, and storage of data. To ensure maximum accessibility to the workshops, so that every student is able to participate within their means, support needs are clarified with teachers in advance. Another important element of the preparation work is to inquire about the infrastructure, facilities and materials available at the schools, such as computers, projectors, Wi-Fi access, and flipcharts. To enable an effective start/opening, teachers are asked to introduce the project, its topics, and its goals to the students in advance.

#### 3.2. Concept

To ensure that the design is relevant, attractive and engaging for the students, two participatory workshops are conducted with students from the partner schools in Austria, Poland, and Slovenia. Both workshops, as well as the intervening photo voice activity, aim to obtain feedback on the design of the tool. The time interval between PW 1 and PW 2 should be about one week. The concept of the workshops was developed by a designated working group and discussed in detail with all partner countries. Their general structure is shown in Figure 2.



**Figure 2:** Framework of the concept of participatory workshops 1 and 2 on the tool's design

### 3.3. Activities and Methods

In their review on co-designed mental health technologies, Bevan Jones et al. (2020) provide a checklist of elements to consider in co-design activities, such as target group, aspects of involvement, methods and techniques, general approach to activities and facilitation, influence of user input, recording of user input, possible challenges, and evaluation of activities [10]. This checklist of questions was closely considered when planning the activities in the participatory design workshops for me\_HeLi-D. In addition, activities and instructions are designed with reference to the Universal Design for Learning Guidelines [14]. Care is taken to provide multiple means of engagement (e.g., fostering collaboration), multiple means of representation (e.g., offering visual and auditory information), as well as multiple means of action and expression (e.g., varying the methods for response) wherever possible. An overview of the activities, objectives, and methods can be found in Table 1.

**Table 1**

Detailed description of activities, aims, and methods used within PW1 and PW2

Activity	Objective(s)	Method(s)
<b>Relevant topics</b>	Inquire about topics relevant to this age group	<p>1. <b>Topic collection</b>   Individual activity Each student gets sticky notes or colored cards and a pen and is asked to write responses (anonymously) to concrete questions, e.g. <i>What do you think are relevant stressors for your peers?</i></p> <p>2. <b>Clustering &amp; Rating</b>   Group activity The collected topics are clustered and the students get the chance to rate the topics with stickers/points.</p>
<b>Feedback PW1</b>	Receive precise feedback (incl. quantitative data) from students and teachers	<b>Feedback form – DESIGN</b>   Small group activity Students fill out a form consisting of 5–10 multiple choice (MC) questions and 1–3 open questions, e.g., <i>Think about a game or an app you like. What elements/features do you enjoy most about it?</i>
<b>Transition time between PW1 and PW2</b>	Inquire about helpful resources when critical stressors are present; Inquire about what prevention should look like	<b>Photo voice</b>   Individual activity Visual research methodology; Students are asked to take pictures that are related to 1–3 guiding questions, e.g. <i>What helps you in critical situations?</i>

<b>Design Studio</b> [15]	Initiate a creative process; collect design ideas from students; visionary and creative approach	<b>Drawing</b>   Small group activity In teams or small groups, students are encouraged to ideate/generate ideas based on guiding questions, such as <i>What should the welcome screen and its icons look like? What color scheme would you use? How should the level of progress be presented? Design an avatar for the tool – what would they look like?</i>
Feedback PW2	Receive precise feedback (incl. quantitative data)  Gather feedback on most popular /preferred designs	<ol style="list-style-type: none"> <li data-bbox="617 396 1120 617"><b>1. Feedback form – DESIGN</b>   Small group activity Students fill out a form consisting of 5–10 MC questions and 1–3 open questions; at least one open question refers to photo voice activity, e.g., <i>Briefly share what you photographed and why.</i></li> <li data-bbox="617 617 1120 800"><b>2. Gallery Walk</b>   Small group activity An anonymous rating activity, where the students are given the opportunity to view and rate each other’s designs/creations of the Design Studio activity</li> </ol>

### 3.4. Measures

A mixed-methods approach to data collection is used, employing qualitative and quantitative measures. Three feedback forms are developed, two for students and one for teachers. The forms for students target their preferences and opinions on design of the tool and consist of 5–10 multiple choice (MC) and 1–3 open-ended questions each. The form for teachers consists of 10–15 MC and 2–5 open-ended questions related to feasibility and implementation strategies. All group discussions are audio recorded. In addition, other materials, such as flipcharts, designs, and creations of students are collected. Finally, an evaluation sheet with 5 MC questions is given to the students to obtain feedback on the workshops themselves.

### 3.5. Analysis

Quantitative outcome data from the questionnaires will be statistically analyzed. Audio recordings will be transcribed. A thorough content analysis (e.g. thematic analysis) will be performed, including all other materials.

## 4. DMHL on Moodle platform

In this paragraph a description of the related components’ implementation in Moodle are discussed. Moodle as a Course Management System (CMS), also



known as Learning Management System (LMS) or Virtual Learning Environment (VLE) provides various tools and plugins to cover the above-identified needs. The major components described for this purpose are Quiz activity, Adaptive Quiz activity, and Gamification.

Moodle [16], stands for Modular Object-Oriented Dynamic Learning Environment. It is an open-source software, and as such can be used free, which increases the number of Moodle users. It is provided under the GNU General Public License, which means as GNU's Not Unix.

The word “free” in “free software” refers to the freedom to use it, and does not describe the price. In general, there is a price or no price for using GNU software. The purpose is to clarify the four specific freedoms granted when using it. The freedom to:

- run the program as you wish;
  - copy the program and give it away to your friends and co-workers;
  - change the program as you wish, by having full access to source code;
- and
- distribute an improved version and thus help build the community.

The current version is 4.1, and was officially released on November 2022, together with the full list of fixed issues, and upgrading instructions from a previous version [17]. Additional functionality is provided using plugins. Plugins can include new activities, quiz question types, reports, or can provide integrations with other systems or platforms.

In Moodle, the basic understanding for evaluation refers to the course content assimilation verification process. It is used to confirm the results achieved, which are nothing more than learning. Unlike the traditional educational understanding of evaluation, where it takes place in a synchronous approach, in e-learning platforms it takes place online. In Moodle, various plugins are available for this purpose. Both trainers, and trainees can participate both online, and offline.

A comparison between the traditional and the e-learning approach can help us to understand better how to use the two approaches (Table 2).

**Table 2**

Comparison between traditional and e-learning approach

	<b>Traditional classroom</b>	<b>E-learning</b>
<b>Classroom</b>	Physical with limited: • size & • time	Virtual with unlimited: • participants • time & • location
<b>Content</b>	PowerPoint /transparency / etc. Library & textbooks Video Interactivity / communication / col- laboration	Multimedia / simulation Digital library Video on demand Syn & asynchronous com- munication
<b>Personalization – adaptability</b>	Usually provided by one single learning path	Adaptable learning path and pace determined by learner

#### 4.1. Quiz activity

The most standardized Moodle activity is the Quiz activity. A widely used activity usually satisfies the needs of teachers. It provides evaluation tests with multiple-choices. However, it can also be used for extended self-assessment tasks. The use of Question banks, where Questions are created and stored provides the opportunity to reuse questions in different tests. When creating a Quiz, questions are added using a sequential approach, but during the evaluation, the questions are provided in either a standardized or a random order [18].

Adaptive learning is a method of computers-based education. Using advanced algorithms, the teaching materials change according to the particular results, needs, and achievements of each trainee. This provides the trainee with a unique, customized learning experience.

#### 4.2. Adaptive Quiz activity

The Moodle Adaptive Quiz activity [19] is an example of such a CAT (Computer-Adaptive Testing). It enables a trainer to create tests that efficiently measure the trainees' results. The Question banks used in adaptive tests are structured corresponding to various difficulty levels. Each next question is then chosen reflecting the trainee's current level of results, needs, and achievements. In this way, the trainee has a unique experience when they have successfully solved a question; a more challenging question is presented next. The experience then deviates from the sequential one previously described, as it depends on the trainee's achievements level. The evaluation continues until the platform determines the trainee's achievements level to an acceptable accuracy.

### 4.3. Gamification

Gamification in education refers to the introduction of game design elements and game-like experiences in the design of learning processes. It has been adopted to support learning in a variety of contexts and subject areas and to address related attitudes, activities, and behaviors, such as participatory approaches, collaboration, self-guided study, completion of assignments, making assessments easier and more effective, integration of exploratory approaches to learning, and strengthening student creativity and retention [20], this is the oxymoron develop serious games.

Examples of gamification plugins [21] available for Moodle include:

1. **PLUGINS FOR ADDING BADGES:** enables you to add badges in Moodle. Badges are a good way of celebrating smaller achievements and for showing eventual progress.
2. **ADDING BADGES:** you get a library of gamification badges that can be used in Moodle or for any learning management software.
3. **TRACKING LEARNING PROCESS:** automatically captures and attributes experience points to students' actions.
4. **GAMIFICATION IN MOODLE:** contains gamification style plugins that works on experience points that is given to the students.
5. **ADDING POINTS FOR GAMIFIED LEARNING:** improves gamification particularity in the Moodle platform.
6. **ADDING GAMES TO E-LEARNING:** helps your learners solve quizzes, provides glossary, questions and allow them to play some games.
7. **FOR GAMIFYING E-LEARNING:** quiz questions from the course can be added and the possible answers will come down as space ships, and the learners have to shoot the correct one.

## 5. Conclusions

In this paper, the description of the PRA architecture applied in the digital implementation for the me\_HeLi-D (mental health literacy and diversity) tool was provided. The whole cycle of the different methods, the applicable iterative participatory design approach detailing the participatory workshops, and the implementation of the corresponding components in Moodle were presented. A solid approach for the feedback to be reflected in the program development, and ensure that voice of youth is heard/reflected was provided.

PRA have the potential not only to allow users to participate in the development of digital mental health tools, but also to empower them to express their needs and take an active role in designing an intervention that is tailored to their preferences. In developing the me\_HeLi-D tool, the application of PRA guarantees youth involvement throughout the different research cycles. Incorporating various

feedback measures and thorough analysis and synthesis of the data ensures that the voice of youth is reflected in the final tool to the greatest extent possible.

## 6. Acknowledgements

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# An Ontology-based Verification Model for Intelligent Systems

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## **Abstract**

Autonomous and intelligent systems (AI/S) functionality confirmation, and verification of performance are time-consuming and expensive to conduct. The control of limits, threshold values, and respective annotations additionally require time-consuming procedures based on standardized reporting models. For the purpose are necessary methods and tools that can control and verify the functional consistency and predict deviations. Such methods and tools can improve the testing environment and exploitation setup. The aim of the paper is to propose an ontology-based approach to validate the consistency of AI/S functions control and performance verification. A high-level description of the approach is provided. The ontology development is described with the definition of the limits, threshold values for every component and function provided. In conclusion by applying the model on a concrete domain, it could help to identify several instances of faults detection, and improve the overall quality of the provided verification tests. The approach will be further tested, and used as an intelligent maintenance prediction system.

## **Keywords**

service robots, autonomous intelligent systems, automation, verification

## **1. Introduction**

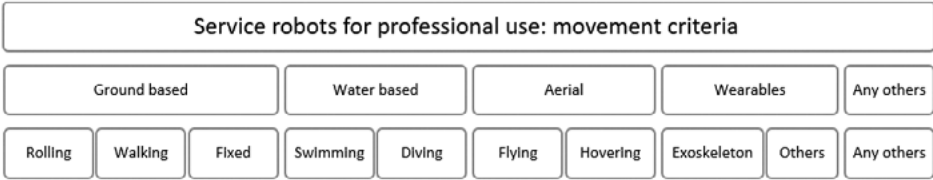
Information systems, automation, and management systems and their integration with technologies are all areas that need standardization. Technical Committee (TC) ISO/TC 184 was established by the International Organization for Standardization (ISO) to handle standards in the area of automation systems and their integration, including those related to design, manufacture, and maintenance, as well as the supply of products and associated services.

A service robot is a robot that conducts autonomous useful tasks, with the exception of industrial automation applications, according to the description given in ISO 8373:2021 [7] [8]. When performing repetitive tasks, previously performed by humans, service robots become more accurate and productive. Ex-

amples of these activities include handling and transporting objects, conducting ongoing, repetitive tasks, etc. The evolution of service robots over the past years has shown that they are constantly improving their abilities to process and deliver more service-oriented tasks and results in broader areas like human health care, navigation, and medicine [3].

Service robots, also called have a certain level of autonomy, which depends on their capacity to carry out one or more predefined tasks, based on the input data from sensors. The robots could be categorized based on their movement, and application [2] as:

- movement-related categories



**Figure 1:** Service robots for professional use: movement criteria

- application-related categories



**Figure 2:** Service robots for user and non-professional use: application criteria

The use of artificial intelligence (AI) and robotics technology to automate or replace manual operations is known as automation in robotics. Robotics automation can take many different shapes, ranging from straightforward software-driven systems for controlling a single robot arm to extremely complex systems for controlling hundreds of robots, and perform complex operations. It’s critical to comprehend both the potential and long-term consequences of robotic automation as it develops. Autonomous systems are additionally useful in enhancing security and lowering potential risks.

A key design step that significantly affects the efficiency of service robot functionality is the relationship of functionality to the used components or how such structures, and algorithms are organized.

Components representing standard robot functionality need to be adjustable to various automation control techniques and use cases, and they shouldn’t be re-

stricted to a particular robotic platform, a software development methodology, or a control model. An emphasis of component-based architecture is dividing every aspect of the design into discrete functional or logical parts that operate as clearly specified communication interfaces with techniques, occurrences, and attributes. It gives the matter a higher level of concept and decomposes a problem into smaller issues that are each related to component segments. Here a component is a collection of well-defined, reusable, replaceable, and portable functions that export its implementation as an advanced structure. Such components can have three different views – object-oriented view, conventional view, and process-related view.

By describing the level of quality of a robotic application component, processing speed, productivity, and trustworthiness are all commonly utilized. If sufficient criteria and references can be retrieved, quality can be examined with appropriate verification. Verification focuses on creating the model appropriately. The process of assessing if the model has been properly executed and if it complies with its requirements is the manner in which verification tends to be defined. The precision of converting the model's specifications into an abstract model and the abstract model into a functioning model is the focus of verification. In a particular scenario, a conceptual model is a generic description of an actual system that has been documented according to predetermined criteria and modeling objectives. Afterward, this is improved upon and turned into a more functional paradigm. According to these definitions, conceptual modeling is a type of modeling process that involves transferring from a scenario to a description of what will be detached from its execution specifics, which are subsequently treated as part of a functional model.

This paper presents an ontology-based approach to verify the consistency of AI/S functions control, and performance verification. In the second chapter a high-level description of the approach is provided, along with the proposed ontology. The development of ontology is described with the respective definition of the limits, threshold values for every component and function provided. In the third chapter, a generalized use case is used to show how the approach testing can be conducted.

## **2. Ontology-based control and verification overview**

The rapid development of emerging information and communication technologies (ICT), experimental technologies and methods, cloud computing, the Internet of Things (IoT) and social networks provide us with the amounts of generated data that grow massively for example in medicine and healthcare as well as in other domains [4]. Control and verification are important activities during the system development process, focused on checking the system requirements



conformance. Control aims at system precise implementation and verification at its end-user requirements satisfaction. The system is controlled to cover the requirements that have been specified and then is verified whether it satisfies the end users' needs.

This section describes the preliminary elements of an ontology-based control and verification approach. It describes the knowledge-based domain definition and provides a formal representation model of the key data regarding the specific domain. The model contains a knowledge base defined by using a classification and the respective classes of the ontology with the necessary information and appropriately defined for the purpose limits, and threshold values. The classification and the initial examples used in the ontology are based on one generalized use case.

The purpose of the design is to develop and implement an AI/S prototype setup. The proposed approach is built on a generalized model of service robot that has sensors, alarms, and data processing capabilities. By utilizing current developments in the field of robotic navigation, the model is able to prevent collisions and lead people in challenging settings to their intended destinations. The model is intended to make all navigational decisions as the user is not involved in this process. Devices with a moderate degree of autonomy suggest a path to avoid close impediments, but they do not lead the user over great distances to the intended destination. In this model, a system of sensors is identifying barriers that are close to the user.

In the case of more specialized quality management systems (QMS), for quality management in medical devices and medicine processes controls, improved with the development of IT technologies the provided processes standardization clarifies the difference between processes from quality assurance lifecycle [1]:

- Monitoring – in this specific use case is considered ontology-based control and verification service queries with prototype input data and predefined constraints;
- measurement – of quality and quantity, in the proposed generalized case, for instance a distance;
- analysis – of the outcomes and results trends and tendencies;
- evaluation – against criteria, able to confirm the performance or conformity of the process and the output;
- improving – based on the verification method used, and its analysis and evaluation outcomes and results.

The functionality confirmation of AI/S and the performance verification provide valuable feedback in cases of testing environment, but also in real exploitation setup [5]. They can be used to identify functional deviations, improve faults detection, and help in system maintenance. Identifying functions, as well as their control and verification require experiments, which are time-consuming

and expensive to conduct. Developing the required limits, threshold values, and respective annotations additionally require time-consuming procedures based on standardized reporting models. Methods and tools that can support the control and verification of the functional consistency of AI/S, and robotic systems as well as to predict deviations, would greatly improve the testing environment and exploitation setup.

Ontology-based approach development is chosen to validate the consistency of AI/S functions and performance verification. The proposed approach can also be applied to concrete use cases, and instances of fault detection can be identified. This helps to improve the overall quality of the provided verification tests. Further work will expand approach's application, and it can also be used as an intelligent maintenance prediction system.

## **2.1. Control and verification service**

The proposed ontology-based approach is implemented in Protégé ver. 5.5.0 as a standardized bank of control and verification queries defined using DL Query. The queries test the Ontology by comparing it with the predefined constraints (limits & threshold values). For each statement validated, the Protégé reasoner returns a Query result representing a control and verification report. The results are additionally interpreted based on individual statements corresponding to the Query results, aiming to provide additional results explainability. In other words, the result of the control and verification process is further interpreted as errors and deviations summarizing the conformance report.

The main steps of the approach for the ontology-based approach are:

1. DL Query: used as a powerful feature for searching a classified ontology,
2. Ontology: defines a common vocabulary, reflecting the specifics of the concrete use case, domain etc.,
3. Limits and threshold values: representing normal situation articulated on user demands, or other concrete requirements of the use case, domain etc.,
4. Protégé reasoner: used to perform specific reasoning tasks based on the configured to be displayed inferences,
5. Query results: results from the search conducted on an in advance classified ontology, and
6. Results interpretation: provision of domain specific comments, that can help the user understand the issue.

The ontology specifies concepts, relations, and constraints in machine-readable formats [6]. The implementation of domain ontology in this research is based on a standardized Resource Description Framework (RDF) [9] and Ontology Web Language (OWL) [10], an extension of RDF expressiveness. The axioms validate

the conceptualized part of the domain and infer the non-implicitly defined facts. Thus, it can realize business logic and implement monitoring and controlling the necessary consequent actions. The proposed domain ontology differentiates the different robot types and specifies and manages the application with specific rules over various parameters. The domain model primarily aims to categorize the AI/S and monitor the operations following specific predefined values. The ontology classifies the type of AI/S based on various characteristics, including the implemented capabilities, the domain is designed for, movement, and their components.

Further, the control model will ensure system monitoring, suggesting the following activities according to the parameter’s value using rule-based decisions to determine the failures or levels that need additional action. The pre-defined rules may define the next step according to the components and classified type. The rules required to control the system based on a combination of OWL and Rule ML. We use a reasoner, which supports Ontology Web Language Description Logic (OWL DL) profile [11] and Semantic Web Rule Language (SWRL) rule.

The conceptual model in Fig. 3 presents ontology concepts, relations, and constraints.

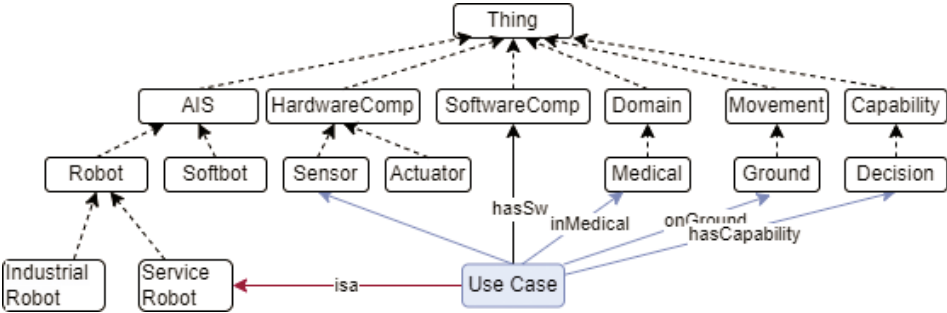


Figure 3: Conceptual diagram

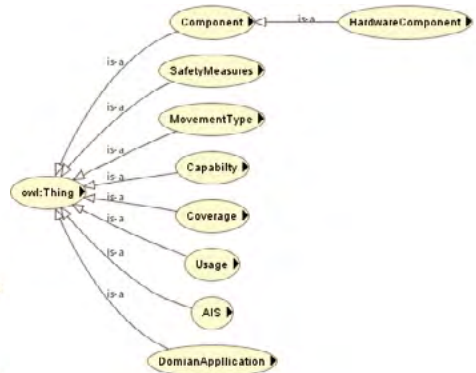
### 2.2. Specification

The domain ontology classifies AI/S. In Fig 4, Fig. 5, Fig. 6. Fig. 7. the excerpt from classes taxonomy is shown. Some of the main categories are AI/S, and its specification subclass *robot*, the subclass *named robot* relates to the specific robot. The sibling classes present the related categorization according to the domains of operation, the components, implemented functionalities, the type of sensors, and movements. The robot can be considered as a composite agent with different parts; the subclasses are platform-specific subclass for instance ARDUINO platform, various software components, and hardware components. In the presented case *hardware components* are described with the subclassing

device and the respective *actuating* and *sensing* device types; the *sensing device* is sensor organized according to different types of sensors.



**Figure 4:** High level categorization



**Figure 5:** Categorization using is-a relations



**Figure 6:** Domain application categorization



**Figure 7:** Categorization by movement type, capacity, and domain

In the following sections the specification of the ontology is provided by using the ontology web language OWL format.

## 2.3. Domain module of the Ontology

### 2.3.1. Classes

Table 1 represents the ontology classes, that are provided in OWL format.

**Table 1**

Classes of the Ontology

**OWL Class** ars:Device

**sub-class-of:** ars:HardwareComponent

**OWL Class** ars:SensingDevice

**sub-class-of:** ars:Device

**OWL Class:** ars:IntelligentRoboticSystem

**sub-class-of:** owl:Thing

**OWL Class:** ars:Platfom

**sub-class-of:** ars:Thing

**restriction:** domain of object property hasComponents

**OWL Class:** ars:SensingDevice

**sub-class-of:** owl:Thing

**OWL Class:** ars:Robot

**OWL Class:** ars:Service Robot

**sub-class-of:** owl:Thing

**restriction:** owl:EquivalentClass (hasFunctionality some DecisionMaking)  
and (hasFunctionality some Recognition)  
and (hasHardwareComponent some Device)

### 2.3.2. Object Property

Table 2 represents the ontology object property is provided in OWL format.

**Table 2**

Object properties of the Ontology

**OWL Class** ars:Device

**sub-class-of:** ars:HardwareComponent

**OWL Class** ars:SensingDevice

**sub-class-of:** ars:HardwareComponent

**OWL Class:** ars:AutomatedIntelligentSystem

**sub-class-of:** owl:Thing

**OWL Class:** ars:Device

**sub-class-of:** ars:HardwareComponent

**OWL ObjectProperty:** ars:hasHardwareComponent

**sub-class-of:** owl:ObjectProperty

**rdfs:domain** ars:AutomatedIntelligentSystem

**rdfs:range** ars:HardwareComonent

**OWL ObjectProperty:** ars: hasDomainApplication

**sub-class-of:** owl:ObjectProperty

**rdfs:domain** ars: AIS

**rdfs:range** ars: DomainApplication

**OWL Class:** ars:DomainRobot

**sub-class-of:** owl:Thing

## 3. Conclusion and further work

The problems related to autonomous and intelligent systems (AI/S) functionality confirmation, and performance verification, are related to time-concussion and required cost to conduct. Additionally time-consuming procedures based on standardized reporting models are required for the respective limits, threshold values, and annotations to be identified and applied. Methods and

tools that can control and verify the functional consistency, and predict deviations are necessary to improve the testing environment and exploitation setup. The paper proposed an ontology-based approach applicable to validate the consistency of AI/S functions and conduct performance verification. It was provided a high-level description of the approach. In conclusion, the approach application on a concrete domain could help to identify several instances of faults detection, and improve the overall quality of the provided verification tests. The approach will be further tested, and used as an intelligent maintenance prediction system.

#### 4. Acknowledgments

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# Machine Learning for Biomedical Applications – Focus on Brain Signals

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## **Abstract:**

There is a growing interest in machine learning (ML) in this decade. This growing interest is accelerated by cheaper computing power and low-cost memory. Thus, large amount of data can be stored, processed, and analyzed efficiently. Machine learning has used in brain machine systems (BMS) system that converts brain impulses into messages or commands. In this paper, we propose an EEG-based BMS with the focus on evoked potential. An average classification accuracy of 95% was attained among nine participants. With a rate of four flashes per second implemented, selecting one of four possibilities takes 5 seconds, resulting in an information transfer rate of 24 bits/min. In addition, brain computer interfacing using oscillatory activity was measured. The results show that after around 5 hours of co-adaptive training over many days, the average 3-class accuracy of the Linear Discriminant Analysis committee classifier reached about 80%, with a false positive rate for motor imagery recognition of around 17%.

## **Keywords:**

Brain-machine system, EEG, machine learning, classification, accuracy, false alarm rate

# Preprocessing Techniques for Brain MRI Scans: A Comparative Analysis for Radiogenomics Applications

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## **Abstract**

In this study, we aim to investigate the use of preprocessing techniques on brain magnetic resonance imaging (MRI) scans for the prediction of Methylguanine-DNA methyltransferase methylation (MGMT) status in glioma patients. MGMT methylation is a biomarker that has been linked to treatment response and prognosis in glioma. We review several studies that have applied preprocessing techniques to brain MRI scans, along with molecular genetic information, for this purpose. The preprocessing techniques include but are not limited to image registration, normalization, brain extraction, and tumor segmentation. We compare the effectiveness of the techniques used in these studies and evaluate the performance of each technique in terms of accuracy, computational efficiency and other parameters. Our goal is to identify the most effective preprocessing techniques for radiogenomics applications and to determine the potential of these techniques for improving the accuracy of predictions in brain MRI scans by combining different types of data. The results of this study have the potential to serve as a basis for the development of more accurate and efficient imaging-based diagnostic tools for glioma patients, and to improve the understanding of the relationship between imaging and genomics in glioma.

## **Keywords**

Radiogenomics, glioblastoma, MGMT promoter, MRI scans, medical imaging, machine learning, deep learning

# Adapting Data Models in Health Data Secondary Use for Treatment Evaluation

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## **Abstract**

With a wide range of medical data contained in various systems and documents, there is a huge potential for both effective treatment and better distribution of healthcare resources. Although many groups are working in this area, the available information is still not actively used for the assessment of the effectiveness of new treatments. This research focuses on developing a methodology, appropriate data models, and relevant software decisions that support reuse and explorations based on data routinely collected from clinical systems. The first results are presented and discussed.

## **Keywords**

Data model, data quality, secondary use of data, medical data, treatment evaluation

# Real-Time Data Integration in Information Systems Using Stream Processing for Medical Data

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## **Abstract**

Real-time data processing in medical information systems is becoming harder with the increase in data volume. Stream processing is a popular approach for real-time data processing, which can process large volumes of data including medical in a scalable manner. In some cases, medical data may not be available in real time because of privacy and security concerns. In this paper, we explore the use of stream processing with static medical data using streaming platforms Kafka and Apache Spark. We demonstrate how these platforms can be used to work with static data in streams and discuss the benefits and limitations of this approach. We also present a case study to illustrate the effectiveness and performance.

## **Keywords**

Stream processing, performance comparison, Apache Kafka, Apache Spark, data analysis, medical data

# Increase Digital Health Literacy with the Practical Implementation of an e-learning System According to WCAG Compliance Standards

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<sup>2</sup> University “Ss. Cyril and Methodius”, Skopje, 1000, RN Macedonia

## **Abstract**

Individuals with cognitive difficulties (CD) have very limited access to appropriate learning resources. Their unique individual needs and requirements prevent them from accessing traditional online formal and informal learning methods, and resources are usually inadequate. We develop an e-learning platform with health content as an opportunity for all to increase digital health literacy, including people with cognitive disabilities. The paper aims to present some feature's settings important for people with a wide range of cognitive disabilities.

## **Keywords**

Cognitive disability, accessibility, Learning Management System (LMS), ATutor, usability

# Exchange of Occupational Health Assessment Summaries Based on the EN 13606 Standard

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## Abstract

The globalization of world economy stimulates large number of people to search abroad for better employment opportunities. This is the reason to consider the exchange of occupational health assessment summary (OHAS) content from cross-border view point. It is a problem of larger social-significance than the cross-border exchange for International Patient Summary (IPS). While the IPS dataset is well studied in the framework of an international standard, the OHAS remains rather insufficiently explored in the existing literature. This paper proposes a novelty systematic approach to provide a practicable solution to this problem by ensuring semantic interoperability in the exchange of OHAS. It starts by presenting a description of the use case for cross-border exchange. Next, the OHAS dataset is defined on the basis of exploring common data requirements the national legislation of EU countries. The final step of this approach is the design of an EN 13606 archetype of OHAS satisfying all the requirements for semantic interoperability in the exchange of clinical data. Further on, the static, non-volatile and reusable information model of OHAS is used to create EN 13606 instances that are valid with respect to the Reference model and the datatypes of this standard. Finally, this paper demonstrates the software implementation of basic activities in the OHAS use case in a fully functional web application, where the EN 13606 instances are managed by means of a native XML database.

## Keywords

eHealth, occupational medicine, occupational health summary, use cases, semantic interoperability, EN 13606, workplace hazards, occupational disease, proactive prevention

# Modeling and Clinical Data Exchange in Registration of Infectious Disease Cases

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## Abstract

The registration of communicable disease cases aims to limit their prevalence. The Ordinance on the Procedure for Registration, Notification and Reporting on Communicable Diseases, issued by the Ministry of Health, determines the rules for the implementation of the registration procedure in Bulgaria. Currently, this information is communicated by phone, email or on paper, and then the data is manually re-entered. This significantly complicates the exchange of information between health care participants. In addition, valuable information to produce reports noting disease prevalence levels is lost or fragmented. This paper aims to resolve these problems by the means of information technologies and ensure efficient storage, processing and management of data registration for patients with communicable diseases. The business process for the implementation has been studied in detail. The main roles, resources and sequence of activities at each stage of the application of the regulation have been determined. A relational database model is created for centralized storage, processing and management of data for registered patients and their contacts. An algorithm is developed and implemented for the automated determination of cases based on the symptoms of each disease specified in the regulation. ICD-10 is used, thus, creating the possibility of exchanging the collected data with international centers for tracking the spread of the disease. A three-tier application is created where web services perform the activities of registration, communication and reporting of communicable cases. The obtained results were tested with real data, consulted with experts from the health inspections and demonstrate the advantages of the developed software for fulfilling the requirements of the provisions in national legislation.

## Keywords

eHealth, interoperability, clinical data exchange, clinical information models, communicable diseases, disease prevention

# An Approach for Ecological Water Bodies' Environment Modeling Using GIS and 3D Systems

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## **Abstract**

The study presents an approach for modeling ecological water bodies' protection in order to support the transformation of agricultural land surrounding water springs into woodlands. The approach involves the use of Google Earth Pro and SketchUp as software tools. Google Earth Pro was selected for its advanced Geographic Information System (GIS) data import feature. It allows the measurement of ground area, radius, and circumference as well as creation of high-resolution screenshots and offline movies for sharing. SketchUp, a 3D modeling tool, offers various drawing applications and features an extensive online library of free model assemblies. The combined use of these tools allows the creation of file formats that can be accessed in Google Earth Pro for virtual presentations. The efficacy of the proposed approach was illustrated using data from two springs located in the region of North Macedonia, which are utilized for bottling drinking water.

## **Keywords**

Google Earth Pro, SketchUp, EU Water Framework Directive (WFD)



# Frequency Modulated Signal Standing Out by Stochastic Resonance Effect

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## Abstract

In this paper, the phenomenon, which is known as stochastic resonance, is considered to the signal processing application. Signal standing out with the presence of noise is considered one of the basic problems of telecommunication and radio engineering. The stochastic resonance effect is shown to provide significant improvement of some characteristics of the information signal, such as power gain, and noise dispersion at the system output at a certain optimal noise level. In the present article, Minimum Shift Keying signal mixed with Gaussian white noise has been studied using stochastic resonance effect. Noise coefficient, which is one of the quantitative characteristics of noise immunity is calculated and investigated.

## Keywords

Stochastic resonance, minimum shift keying, signal standing out, noise coefficient, noise dispersion, data engineering

# Scattered Data Interpolation with Quartic Triangular Bézier Patches: An Optimized Implementation

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## **Abstract**

We present a new program package for interactive modeling and visualization of smooth scattered data interpolation using quartic triangular Bézier patches (TBP). We implemented an optimized algorithm (Vlachkova, 2021) based on quartic smooth interpolation curve networks and splitting. The algorithm allows to reduce the complexity of the resulting surface and to improve its smoothness. We have chosen the open-source data visualization library Plotly.js as our main implementation and visualization tool. This choice ensures the platform independency of our package and its direct use without restrictions. The package can be used for experiments with user’s data sets since it works with the host file system. The latter allows wide testing, modeling, and editing of the resulting interpolation surfaces. We performed a large number of experiments using data of increasing complexity. Here we present and comment the results of our work.

## **Keywords**

Scattered data interpolation, curve network, optimized algorithm, Bézier patch, Plotly.js

# Game Theme Based Instructional Module to Teach Loops and Choice Statements in Computer Science Courses

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## **Abstract**

With the fast development of computer science and technology, computer games have become one of the integral parts of modern way of living. Research studies have conveyed that educational games are motivating, engaging and provide a reliable learning context. Due to the expansion of the educational transform, game theme-based learning methodology has become one of the current research focuses. There is a need to change the traditional passive method of teaching to an active method of teaching such as game and simulation-based learning. So, we need to provide a better learning environment by increasing the student's motivation towards learning. The game theme-based instructional (GTI) modules prepare the learners to think critically, and the students can adopt new challenges of the relevant knowledge. This paper presents a novel and exciting methodology of teaching algorithms by motivating the students towards learning. We designed and developed The Ball Targeting Game consisting of two GTI modules to teach loops and choice statements. The gaming modules demonstrated in this paper were developed using Vizard, which is a virtual reality toolkit used for developing virtual worlds and immersive applications for visualization and simulation using Python as its scripting language.

## **Keywords**

Game Theme Based Instructional Module, computer science, algorithms

# Security Improvement Text Encryption Algorithm Based on Two-Dimensional Two Clifford Attractors

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## **Abstract**

In this paper, we present a text encryption algorithm based on the Clifford chaotic functions in order to improve security of data transfer. The algorithm is subjected to security tests. The experimental outputs shows that the text encryption algorithm proposes more efficient performance against other similar text encryption algorithms.

## **Keywords**

Clifford attractor, text encryption, NIST statistical tests, DieHarder, ENT statistical tests

# Next Generation Service Models of Mobile Autonomous Assistants

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## **Abstract**

In this paper, we present an evolution overview of the autonomous streaming-based services for mobile autonomous assistants in the human environment. In Section 1. we present the hypothesis that the technologies are in transition from fixed or portable and wearable devices to those in which the main function is based on independent and possibly self-initiated and remote-controlled movement of the devices. This transition is outlined and categorized in Section 2. Retrospectively, with the progress of the penetration and technologies of the fixed devices, they have evolved from those that function separately and in isolation to those that offer group services in networks of multiple devices known today as Internet of Things (IoT). Another point of our considerations is that consequently and analogously, mobile autonomous devices are also subject of evolution towards service models of multiple cooperating mobile devices. We propose a multidimensional and layered taxonomy for the basic case of isolated mobile autonomous systems for 1d-, 2d-, and 3d-movement models. Our classification covers both the functional and technological aspects of these systems as well as the possibility for grouping services. In Section 3. we consider the parameters of two exemplary platforms as use cases for the two movement modes. Although they represent different principles of movement (i.e. legged and wheeled movement) these examples clearly show a common pattern of service parameters. The movement pattern presented here includes space and time range, speed, range of sensory monitoring, as well as parameters characterizing obstacle surmountability. Finally, in the Conclusion we address the applicability of our parametrization for the purposes of standardization and interoperability the main conditions for the service implementation based on a scalable group of moving devices.

## **Keywords**

Internet of Things (IoT), Autonomous and intelligent systems (AIS), Mobile autonomous assistants, Sensor networks

# Enterprise Data and Semantic Modeling: Conceptual Model of Information Technology Incident Management

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## Abstract

Knowledge management methods and their efficient implementation across the organization determine sound and resilient management of processes. This paper studies the semantic integration of enterprise data sources essential to service management processes. Implementing a semantic layer within the enterprise architecture uses various tools, methods, and techniques. The semantic conceptual model unifies and implements intelligent integration of multiple data sources across the enterprise, achieving consistency and more accessible interpretation. Specifically, we draw our attention to incident and problem management within enterprises. We propose an ontology – a conceptual model for the incident management process. The incident ontology presented as an intelligent data integration layer component aims to achieve operational excellence. Besides, this ontology is a fundamental part of the proactive process in problem management. An ontology as a logic-based system supports integrity validation. It infers new, no explicitly modeled facts in the problem domain, thus helping experts better analyze and understand the problem. We discuss the conducted experiment results with the proposed in this article conceptual model using the enterprise knowledge graph platform. It can be perceived as a framework for a query-answering system with components, including ontology schema, data mapping, and classification methods for data graph enrichment.

## Keywords

Knowledge management, knowledge representation, ontology, semantic model, hybrid classification model, enterprise semantic layer, enterprise knowledge graph, incident management, ITIL, problem management

# CAPEC Ontology

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## **Abstract**

CAPEC (Common Pattern Enumeration and Classification) is an effort coordinated by MITRE Corporation. Its aim is attack pattern database structured in taxonomies.

CAPEC is available as XML document from its project site.

CAPEC structure and content are under permanent change and development. It is still not mature database but may be never will.

CAPEC, CWE, and CVE are databases devoted to attacks, weaknesses, and vulnerabilities. They refer each other forming a knowledge ecosystem in cybersecurity area.

Traditional approach for knowledge presentation as information does not work well with conceptualizations under dynamics of this ecosystem and particularly of CAPEC.

In this paper an alternative approach to CAPEC knowledge presentation is proposed, as ontology. First, CAPEC structure and content are discussed and then ontology structure is introduced.

CAPEC as ontology opens doors to “open world” concept that is more adequate to ecosystem dynamics.

## **Keywords**

Cybersecurity, attack patterns, ontology, CAPEC, OWL

# CAPEC Ontology Generator

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## **Abstract**

CAPEC (Common Pattern Enumeration and Classification) is an effort coordinated by MITRE Corporation. CAPEC database is available as XML document from its project site.

CAPEC ontology is programmatically generated from its database. CAPEC ontology generator is implemented in Python.

## **Keywords**

Cybersecurity, attack patterns, ontology, ontology generator, CAPEC, OWL, Python



# An Improved Bulgarian Natural Language Processing Pipeline

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## **Abstract**

In this paper, we present a language pipeline for processing Bulgarian language data. The pipeline consists of the following steps: tokenization, sentence splitting, part-of-speech tagging, dependency parsing, named entity recognition, lemmatization, and word sense disambiguation. The first two components are based on rules and lists of words specific to the Bulgarian language, while the rest of the components use machine learning algorithms trained on universal dependency data and pretrained word vectors. The pipeline is implemented in Python library spaCy. It achieves significant results on all the included subtasks. The pipeline is open source and is available on GitHub for use by researchers and developers for a variety of natural language processing and text analysis tasks.

## **Keywords**

Natural language processing, language pipeline, word sense disambiguation

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