UNCERTAINTIES IN SUSTAINABLE EDUCATION

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ABSTRACT: *"What is the educational, engineering, economic, social impact in terms of sustainable development?" this is the central question of the present work that addresses the issue of uncertainty in sustainability. The role of transformation in sustainable learning must be considered. There are not many studies that examine the extent to which transformation and learning issues related to sustainable development can be integrated. It discusses the role of education in promoting the concept of sustainability and how the link between: 1. Quality education; 2. Education for sustainable development (education for sustainable development - ESD) and 3. Education on disaster risk reduction (disaster risk reduction - DRR - education). One goal of learning is adaptive capacity. Another question we sought to answer is: "How can we best prepare for change and what role will education play in this?" Key findings, drawn from a range of international contexts, include broad evidence that education providers want to approach sustainability from an integrative perspective. This approach requires more administrative resources to develop formal and hidden mechanisms of the curriculum. We believe it is necessary for educational institutions to transform themselves to serve as models of social justice and environmental stewardship to promote education for sustainability. Because education should also aim at modules that prepare young people for the future, we emphasized concern for sustainable education through a case study that presents a proposal to revitalize the social and cultural life of the Municipality of Târgu Mureș, by the LUMINEX team. Young people want a change for the better, being concerned about the future and sustainability. In conclusion, an additional consideration is the value that both creativity and flexibility have in relation to a person's adaptability.*

KEYWORDS: *sustainability, sustainable education, uncertainty in sustainability, adaptability, STEAM education*
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1. INTRODUCTION

Conformable Sustainable Development Goals of the United Nations in 2015, *"We are determined to take the bold and transformative steps which are urgently needed to shift*

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the world, on a sustainable and resilient path" (UN, 2015, Bebbington and Unerman, 2018; Kara, Zhou and Zhou, 2021), sustainability has become a major issue of postmodern society and organizations driven by a variety of political, social and environmental disputes, faced with social, ecological and ecosystem challenges, with many stakeholder viewpoints (Sousa Jabbour, Jabbour, Godinho Filho, & Roubaud, 2018).). Sustainable development is a macro, multi-level notion and offers the opportunity to promote inclusive, equitable, ecological ("green") and profitable markets, where sustainable principles can generate long-term value through the integration and balance of natural, social, human and financial, with the end result of human development. Understanding the relationships between economic activity, social well-being and environmental degradation is essential for achieving a sustainable future (UNEP, 2012).

2. EDUCATION FOR SUSTAINABLE DEVELOPMENT

Human society will strive to find a path to sustainable development while responding to climate change, extreme weather events and increasing pressure on natural resources and ecosystems. How can we best prepare for change and what role will education play in this? Education for sustainable development (ESD) aims to empower people with values, skills and knowledge that will help them become active agents of change in their own lives and in their wider society. "ESD pedagogies do more than facilitate the learning of knowledge – they promote the learning of skills, perspectives and values that sustainable societies require" (Laurie, 2016). Furthermore, this depends on disaster risk reduction (DRR) education that strengthens the capacities of individuals and communities to act with foresight to build resilience and to react to extreme events strategically and rationally to avoid disastrous consequences. An important challenge for education in addressing both sustainable development and disaster risk reduction is empowering people to collectively transform their realities to imagine and create a more resilient and sustainable future.

Given that population demands have grown considerably with global population (from 7 million around 4000 BC to over 7.8 billion -Worldmeters, 2020), per capita consumption (energy, food, water, fuels, etc.) has also increased, as has the value of global economic activity, quantified in Gross World Product, from $1 billion around 4000 BC. Hr, at about USD 78 trillion (Wikipedia 2020), there is a need to manage the resources of this land with greater responsibility, within very tight limits. How can this be achieved, except through education that must be impressed upon everyone, regardless of age, so that we all are able to accurately assess the current state of the earth, to be able to predict and estimate as accurately as possible future trends and not in the last turn to develop effective management strategies, with the constraints imposed by the laws developed for a sustainable development.

The concept of *"sustainability*" is closely related to that of sustainable development, but they are different. While sustainability means ensuring that the earth can meet the material and energy needs to support complex systems, including humanity, in the long term, having economic dimensions (the rate of resource consumption depends largely on the economy) and social dimensions (the ultimate goal is supporting human society, while sustainable development provides a vision of how human society could develop sustainably, placing a stronger emphasis on social dimensions such as intergenerational equity. Thus, sustainability is a core concept aimed at it makes the survival of human

existence on earth feasible with correct and enforced legislation for sustainable development.

The issues and issues involved in modeling, assessing, understanding and managing sustainability fall under what Rittel and Weber (1973) called "*wicked problems"*. For example, the uncontrolled release of reactive nitrogen in lakes, rivers presents the greatest global externality, which can threaten human health, ecosystem stability on a scale that is not fully recognized by world governments, so that solutions are confused by positive and negative impacts interconnected, which are often difficult to disentangle. Actions taken to showcase the role of reactive nitrogen in any of the 17 UN Sustainable Development Goals (good health and well-being; clean and affordable energy; clean water and sanitation; industry-innovation-infrastructure; sustainable cities and communities; responsible consumption and production ; climate action; life under water and on land) can accentuate the impacts related to this nitrogen in the other objectives. So, stakeholders and their conflicting perspectives can generate bad sustainability problems, so one of the major challenges in the sustainability system is uncertainty, which can be problematic. Examples of uncertainties in sustainability include defining and quantifying objectives, impact assessment methods and models, forecasting the future, and unexpected events.

According to (Walker et al., 2003), uncertainty can be defined simply as limited knowledge about future, past or current events. In the business strategy and planning literature (Marshall et al., 2019), four quadrants (*Table 1. Four states of risk forecasting knowledge*) are presented with different information leading to uncertainties, so that systems and sustainability issues can extend to the 4 quadrants regardless of whether we are talking about community, production, regional or global sustainability or the economy durable.

Known Known	**UnKnown Known**
Risk is known both abstractly (in correspondence to events witch do or may happen) and as aconcrete risk exposure whose portents or impacts can be described using available evidence.	Risk is well known abstractly, but individual or organisational experience of it nonetheless necessitates its management
Known Unknown	**Unknown Unknown**
It is understandood thet a particular type or category of risk deserves attention, yet there is lack of convincing evidence for its presence as a concrete risk exposure for the organisation at aparticular time.	Possible risks witch have not been imagined/ conceptualised produsedand evidence for whose relevance within some specific organizational context might exist embryonically as scattered information, but not as coherent risk knowledge

Table 1. Four states of risk forecasting knowledge

2.1. Types of uncertainties

In this book Marcheau presented four types of uncertainties (Marchau et al., 2019): At first Level- uncertainty is short-term where historical data can be used to predict the future using sensitivity analysis, at 2nd Level - uncertainty is encountered in system models that are relatively closer to the real world, such as uncertainties of production. Both fall into the "risks" category according to (Knight, 2021) and are associated with "optimality". At

3th level are the uncertainties for situations where there is a limited set of system models, outcomes or weights, and probabilities cannot be assigned to them using traditional scenario analysis (long-term sustainability assessment). Level 4 uncertainty is the deepest level of uncertainty, where there are multiple possible futures & outcomes, and there are unknown futures & unknown outcomes. This includes the systemic risk (a new concept of risk, which refers to the occurrence of an event that would not lead to injuries, but to a breakdown of the system, such as for example a global financial crisis that can be accompanied by the bankruptcy of major banks, which would lead to a collapse of the economy- (Renn, 2016), ontological and time-dependent uncertainty, and requires monitoring the present and adaptations over time. To deal with such uncertainties, the precautionary principle is used (it only indicates not to follow a certain path, instead it cannot positively guide decision-making to "do option X") and option theory.

According to (Taleb, 2010), these deep uncertainties are related to declining confidence in our ability to correctly anticipate future technological, economic and social developments, future changes in the system we are trying to improve, or time-varying multiplicity and preferences. of stakeholders on system outcomes or using low-probability but high-impact events such as a natural disaster, pandemic, financial crisis, terrorist attack, or truly new events for which there is no historical experience. (known unknowns and unknown unknowns, real surprises).

According to (Nielsen and Ulanowicz 2011), the role of ontological uncertainty refers to the emergence of new unpredictable or non-"pre-stable" types (Kauffman 2019), and any system that presents the necessary complexity, will have new behaviors from the interactions of the system's agents (there will be surprise events and other events that will never materialize). The realization of ontic uncertainty is not inherently a negative consequence, but rather has benefits, as it involves ontic openness that can bring new opportunities to any complex adaptive system, including humans struggling for sustainable development.

2.2. Education for sustainable development

This Type of education aims to enable students (learners) with capabilities and competencies to relate learned knowledge, skills and values to addressing and overcoming real-world challenges, being strongly focused on educational practice and recognized as a model that directly supports the implementation of quality education (Laurie, 2016; Didham, 2018). A key challenge is the development of lifelong learning skills needed to address sustainability in various contexts (UNESCO, 2017; Ofei, 2018).

Education for sustainable development is oriented towards whole system perspectives and aims to learn for change. In practice, this means an emphasis on cross-curricular and interdisciplinary approaches to teaching and a greater effort to link classroom learning to real-world application. ESD promotes a vision of quality education that is concerned not only with measurable learning outcomes and national standards, but rather with encouraging lifelong learning and developing learners' skills, values and competencies to become agents of change. It uses participatory and active learning methods that promote experiential learning, collective problem solving and democratic dialogue.

How can adaptive capacity be applied as a unifying learning objective to align efforts towards quality education, education for sustainable development (ESD) and education for disaster risk reduction (DRR)?

Adaptive capacity has been discussed in relation to adaptation to climate change, with similarities in discussions of resilience. While resilience is often used more in reference to whole systems and the ability of a system to recover and return to normal functionality following a shock, adaptability is regularly applied in reference to human capacity at the individual level, collective and institutional. Alexander explains how resilience in ecological systems is about maintaining system integrity, but in social systems it is more about the ability to cope better with extreme situations (Alexander, 2013). Folke et al. actually define adaptive capacity as "the ability of actors in a system to influence resilience" (Folke, 2010), and Lutz, Muttarak and Striessnig highlight that education has one of the most significant correlations with reducing vulnerability and improving adaptive capacity due to largely to the links of education with enhanced cognitive ability (Lutz, 2014).

2.3. Learning for adaptability

Learning for adaptability cannot be achieved through a training process alone. Instruction-based teaching can raise awareness of certain issues and even introduce specific skills, but without regular application of knowledge and skills by learners, they are unlikely to achieve significant proficiency with them. Sterling compares instrumental and intrinsic views of sustainability education (Sterling, 2010). The early approach/conceptualization of ESD presented an instrumental view that focused on raising awareness and promoting attitudinal change as a means of influencing learners towards pro-sustainability behaviours.

This learning, however, requires more than basic experiential or action learning, as mere repetition of the same practice in the same context is not sufficient to achieve true mastery of these skills. For learners to also develop and acquire competence in the key competences for sustainability (UNESCO, 2017), the educational approach must support the application and adaptation of knowledge, skills and values to a wide range of practical experiences and real-world problems. Pedagogical discussions of ESD practice are moving away from the focus on the acquisition of knowledge, skills and values, which was still common less than a decade ago, and towards a focus on effective skill development. However, there remains a lack of pedagogical discussion regarding the relationship between specific teaching methods and the resulting skill development.

2.4. Pedagogical aspects of learning for adaptability.

Both ESD and DRR education have a strong practice orientation to support the application of knowledge and skills in real-world settings, and equally both include an outlook towards social learning processes. For example, ESD is noted for its contributions in making connections between learned knowledge and local contexts (Laurie, 2016) and focusing on socio-cultural meaning-making processes (Lotz, 2013). A study of DRR education in 30 countries emphasizes the importance of learning that "brings knowledge to life, exercises skills, challenges attitudes and examines values and is an active, interactive, experiential and participatory pedagogy" (UNESCO,2012).

(Segalas, 2010) states: "the more active the learning, the more focused it is on the community and the more constructive, the more cognitive learning is intense, by the students". Five pedagogical aspects are identified and examined. The practical orientation of ESD is generally focused on action and experiential learning is supported. The

interpretive approach considers the meaning-making framework and encodingt he knowledge that pedagogy encourages. The social perspective considers what types of interaction between learners are supported by the pedagogical design. Purpose alignment considers what is the main purpose/use of learning encouraged by the pedagogy. The value base considers the basic principle(s) that underpin the pedagogical project.

Learning for adaptability requires the ability to relate learned knowledge to new situations through reflective evaluation and to act in accordance with the context of a given (and changing) situation. To support this, learning for resilience can be seen as having a practical orientation towards critical reflection and practice and an interpretive approach focused on recognizing patterns and identifying points of intervention within systems. Aiming to support individual and collective efforts to reimagine the future and envision sustainable and resilient pathways, the social learning capacity perspective for adaptive capacity aims to create communities of practice. To further strengthen the action-reflection cycle, learning for adaptability also demonstrates a value base framed around iterative and discursive meaning-making. Learning for adaptability ultimately aims to support effective and beneficial change at individual and societal levels, and this is supported practically with an alignment of goals towards resourcefulness, security and well-being (Lave, 1991; Wenger, 1998).

The Five Pedagogical Aspects of Learning for Adaptability (Table 2; Fig. 1) provides a working understanding to orient both educational policy and pedagogical design towards learning processes for the development and competent application by individuals and communities of key competencies in change efforts to achieve greater resilience and sustainability.

Pedagogical aspects	**ESD**	**DRR education**	**Adaptive Capacity**
Practical guidance	Action learning and experiential learning	Risk experience	Critical reflection and practice (ie critical praxis)
Interpretive approach	Systems thinking and holistic interpretations of knowledge	Factor analysis and risk analysis	Pattern recognition and identifying points of intervention within systems
Social perspectives	Cooperative learning and social learning	Collaborative resource and knowledge management	Community of practice
Goal alignment	Problem-solving and search for solutions/innovations	Risk reduction and self-protection	Resourcefulness, security and well-being
Base value	Socially aware and responsible citizens	Resilience and disaster prevention	Iterative and discursive meaning making

Table 2. Comparison of key pedagogical aspects for ESD, DRR education, and Adaptive Capacity.

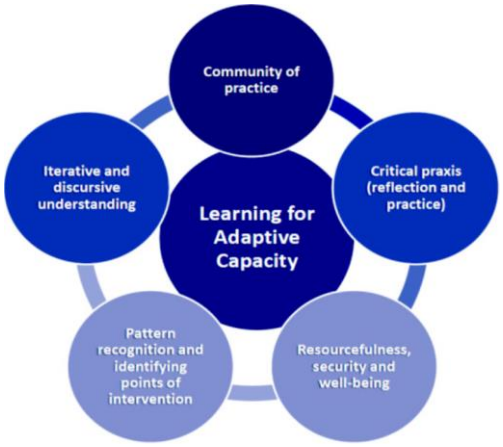

Fig. 1. Learning for adaptive capacity - pedagogical aspects.

Community of practice theory (Lave, 1991; Wenger, 1998), provides, as enabling conditions, an entry point for collective action and highlights the development of mutual engagement, reflexive exploration and a shared repertoire, while critical praxis (Ledwith, 2010; Habermas, 1984) supports an experiential learning cycle with active engagement in reflection and practice to reinforce the testing, application and adaptation of knowledge and skills. Establishing iterative and discursive understanding is based on a process of communicative action (Habermas, 1984), discursive communication (Dryzek, 1994) and *deliberative democracy* (Dryzek, 2000) in which people collectively discuss and reflect on their interpretations and through which opportunities to create new forms of understanding are possible. These first three aspects (i.e. community of practice, critical practice, and iterative and discursive understanding) are mutually reinforcing and have been identified as primary factors in achieving transformative social learning in an ESD context (Didham, 2015).

While community of practice can be understood primarily as a set of social conditions or a social process, both critical praxis and iterative/discursive understanding can be seen as facilitators of this process that depend on both skills, values and the competences of individuals, as well as the prevailing social institutions/systems. Together, these three pedagogies reinforce a learning process oriented toward discourse, reflection, and community practice that emphasizes both individual and collective learning, providing a foundation for the acquisition of competent application of sustainability competencies.

The other two aspects of learning for adaptability (i.e. pattern recognition and resourcefulness, security and well-being) focus primarily on individual learners – the skills they possess and the perceptions that shape them world views. A key competence for adaptive capacity is the ability to think holistically and think systematically (Didham, 2015), and the related skills to recognize patterns and identify points of intervention within systems support the appropriate and timely application of the capacity adaptation from both an ESD and a DRR perspective. Aligning goals towards ingenuity, security and well-being provides a combined vision for resilience and sustainability. There is a double

meaning to inventiveness in terms of social and ecological interpretations; the social dimension focuses on both individual and collective flexibility and ingenuity, while the ecological dimension focuses on increasing the abundance and resilience of natural resource systems. A simpler way of explaining this use of inventiveness would be "to make the most of the situation at hand." Security and well-being aspects are more directly linked as part of Sterling's three states of sustainability which starts with survival, then moves to security and finally to well-being, where each of the subsequent stages depends on the previous stage as a primary condition (Sterling, 2010). Aligning goals towards security and well-being has important connotations in the context of DRR education as well as ESD. The interpretive approach and alignment of proposed objectives provides a lens through which situation-based learning and understanding can be geared towards resilience and sustainability.

2.5. Some learning situations for adaptability in practice

A situation we can face at any moment is the disaster following an earthquake. In this regard, the students and teachers of Sendai National University of Education-Japan, who were taking classes for ESD, organized post-disaster educational activities in the disaster-affected areas, and in turn were guides to other students, stakeholders, other local communities who organized trips to those affected places and in this way were able to apply ESD theoretical knowledge, relating to their own experiences. In this way an interaction between theory and critical inquiry in the field results, including reflexivity and self-reflection. In the affected area, students felt the need to support the rehabilitation of the area.

Another example is the problem of landslides, polluted rivers, periodic flooding in many areas with human population settled near rivers, which can be considered as a waste disposal environment. This is where ESD and DRR come in to promote multi-stakeholder learning in affected communities for disaster risk reduction (e.g. removing houses from high-risk areas, littering, preparing rivers to be productive, safe and well-conserved). The goal is to elicit active, voluntary participation in a group involving the public and private sectors to support a "movement for change" centered on environmental education and disaster risk reduction (DRR). Pedagogical approaches can be by involving/incorporating knowledge from all stakeholders, strengthening the connection within the group and between groups of stakeholders on narrow or larger areas, using social networks, mobile phones, knowledge-based approach. The expected result must lead to more educated communities, with changes in attitudes from apathy to respect for the environment and a movement that can quickly spread to other communities that may be affected in turn.

Critical practice can lead to a deep examination of the realities that communities may face in post-disaster periods, but it can also lead to a "change movement" with all stakeholders to address the urgent sustainability issues that communities may face. vulnerable, applying theoretical expertise and identifying practical solutions. Students with training in ESD can use their ingenuity in post-disaster activities to solve real problems, reduce risk and help victims recover from the disaster. They can also develop strategies with concrete actions to achieve the desired objective, such as that after floods, the river is clean, safe, protected, productive.

The most educated, informed in the affected area are more likely to use the social structure to their advantage, to access legal and institutional support mechanisms to

achieve a level of security and well-being (alignment of objectives). Through two-way interactions between students, teachers and disaster victims, they can freely express their opinions, reach a meaningful understanding of reality, develop a more critical perspective of the situation, and those affected can redesign, use information and the resources obtained to redesign their future (value base).

3. ENGINEERING EDUCATION IN SUSTAINABILITY

Although UNESCO has advocated the critical role of engineering in achieving sustainable development (DS) (Pérez-Foguet et al., 2018), there has not yet been significant interest in studying the educational perspectives and research results undertaken in this area (Arefin et al., 2021;Thürer et al., 2018).

Rickinson and Reid (2015) argued that the synthesis of the literature on higher education for sustainable development should not be done only from a quantitative and positivist perspective by studying "what works". Rather, they suggest that literature syntheses require careful design to tailor research to the goals and objectives and needs of the field (Reid and Scott, 2013).

A realist perspective aligns well with the philosophical framework of Sterling's (2015) on sustainable education (SE) and urgently called for a paradigm shift in education to integrate culture as a driver of change in local and particular contexts. Within Sterling, SE can be used to connect concepts such as Environmental Education (EE) and Education for Sustainable Development (ESD) to Engineering Education for Sustainable Development (EESD), showing how the internal and external aspects of sustainability appear in life individuals and communities. Du et al. (2013)pointed out that engineering education should consider ES from a holistic perspective because educational pedagogies are based on certain cultural settings. Thus, research in this area would do well to investigate whether values, beliefs, and attitudes in engineering education actively position and engage students as social agents (Du et al., 2013;Sivapalan et al., 2016).

According to (Laura, 2021) educational mechanisms for sustainability are designed from a mechanistic and technocratic paradigm. Engineering education requires the inclusion of context-based sustainability initiatives that integrate cultural settings to promote new ways of thinking, being, and knowing where students experience and understand new realities that foster social engagement. This transformation requires the integration of subject-specific teaching knowledge and skills with transformative learning processes in which students can frame their own sense of sustainability in their personal and professional lives (Murray et al., 2014). As a result, this will cause a necessary educational paradigm shift in ES, aimed at promoting deeper learning, re-evaluating the connotation of being and becoming an engineer to involve social responsibilities as part of a cultural change. If the discipline is not ready to push this paradigm shift in education, engineering will never see an alternative and green educational paradigm (Sterling, 2015). The study (Laura, 2021) states that sustainable engineering education requires further research to understand the most appropriate strategies to develop inner, individual and collective attributes such as cultural change, ethics, collaborative assessment and motivation and political insight.

4. CHALLENGES IN STEAM EDUCATION FOR SUSTAINABLE ENERGY

If traditional education is largely a discipline-based preparation for the labor market, providing students with a specific set of skills for their future professions, in STEM these are usually technical skills in science, mathematics and engineering, without skills in the arts, sciences humanities and business. If arts, humanities and business skills are also taught, we will speak of STEAM education (STEM+Arts). While STEM focuses explicitly on scientific concepts, STEAM investigates the same concepts, but does so through inquiry and problem-based learning methods used in the creative process. Building STEAM programs in schools leads to ways of learning that make students more creative, empathetic and socially aware. When students are allowed to express their own individual creativity, they can identify with it. This allows them to incorporate science, technology, engineering and math as part of their larger interests. This creativity, linked to imagination, is increasingly seen as one of the most valuable skill sets needed by students emerging from university programs in the 21st century.

As the education system moves from product to process, there is a greater need to foster a skill set that encourages self-regulation, collaboration, and motivation (Roll, 2016). Preparing students for sustainable energy involves various collaborative methods that enable interdisciplinary communication in the exchange of ideas. Creating a holistic learning environment encourages greater inclusion and diversity.

5. EDUCATION ON DISASTER RISK REDUCTION (DRR)

(DRR) refers to the teaching and learning activities that aim to raise awareness about the potential hazards, vulnerability, and risks of natural and human-made disasters. It also includes the development of skills, knowledge, and attitudes necessary to reduce disaster risk, enhance resilience, and promote sustainable development.

Here are some key points to consider in education on disaster risk reduction:

- *Importance of early education*: Children and young people are among the most vulnerable to the impacts of disasters. Therefore, education on disaster risk reduction should start at an early age to help them develop a culture of preparedness and resilience.
- *Multi-disciplinary approach*: Education on disaster risk reduction should involve multiple disciplines, including science, engineering, social sciences, and humanities. It should also integrate different learning approaches, such as formal, non-formal, and informal education.
- *Community participation*: Community participation is crucial in education on disaster risk reduction, as it helps to build trust, enhance local knowledge, and promote ownership and sustainability of disaster risk reduction initiatives.
- *Communication and information-sharing*: Education on disaster risk reduction should also focus on effective communication and information-sharing strategies, such as using different media channels, developing communication plans, and establishing early warning systems.
- *Role of technology*: Technology can also play an important role in education on disaster risk reduction, including the use of simulations, virtual reality, and online resources to enhance learning and awareness.

Overall, education on disaster risk reduction is essential in promoting resilience, sustainable development, and disaster preparedness. It is a long-term investment that requires a collaborative effort and continuous learning and adaptation to the changing risks and challenges. Some references that support the importance of education on disaster risk reduction: The framework highlights the importance of education and public awareness in reducing disaster risk and building resilience (United Nations International Strategy for Disaster Reduction, 2015); "Education for Sustainable Development Goals: Learning Objectives" emphasizes the role of education in disaster risk reduction, and provides guidelines for integrating disaster risk reduction into education for sustainable development. (UNESCO, 2017); The report "Global Assessment Report on Disaster Risk Reduction" highlights the importance of education in building resilience and reducing disaster risk, and provides case studies and best practices from around the world. (UNDRR, 2019). The study "Temporal and spatial changes in social vulnerability to natural hazards" emphasizes the importance of education in reducing social vulnerability to natural hazards (Cutter, S. L., & Finch, C., 2008); The article "Sustainability education: Reviewing the roots, routes, and relevance of the field" highlights the need for education on disaster risk reduction as part of sustainability education, and provides examples of successful educational initiatives. (Gibson, R. B., 2015).

6. UNCERTAINTIES IN SUSTAINABLE EDUCATION.

Many references provide insights into the uncertainties and challenges facing sustainable education and offer suggestions for addressing these challenges.. Sustainable education, which refers to education that promotes sustainable development, faces several uncertainties. Here are some of the uncertainties in sustainable education.

- *Lack of consensus on what constitutes sustainable education:* There is no universal definition of sustainable education. Different countries and institutions define it differently, leading to confusion about what sustainable education entails. (Bardi, U., et al. , 2016).
- *Uncertainty about the role of technology*: While technology can be a powerful tool for sustainable education, its impact is uncertain. For example, some argue that technology can lead to more efficient use of resources, while others worry that it can lead to overconsumption and environmental degradation.(Gravani, K., & Johnson, S., 2019).
- *Political uncertainty*: The commitment of governments to sustainable education can be uncertain, leading to fluctuations in funding and support for sustainable education initiatives. (Jickling, B., & Wals, A. E., 2008).
- *Economic uncertainty*: Sustainable education requires significant investment, and economic uncertainty can make it difficult to secure funding for long-term initiatives. (Lélé, S., 2010).
- *Uncertainty about the effectiveness of sustainable education*: While sustainable education is widely recognized as an important approach to promoting sustainability, there is limited research on its effectiveness. This makes it difficult to assess the impact of sustainable education and to identify best practices. (Scott, W. R., 2013).
- *Uncertainty about the future of sustainability*: Given the rapidly changing nature of sustainability challenges, it is uncertain what the most pressing sustainability issues will

be in the future. This makes it difficult to design sustainable education initiatives that will be relevant in the long term. (Sterling, S., 2010).

Despite these uncertainties, sustainable education remains an important approach to promoting sustainability and preparing future generations for a sustainable future.

7. REVITALIZATION OF THE SOCIAL AND CULTURAL LIFE OF THE MUNICIPALITY OF TARGU MUREȘ. CASE STUDY -INVOLVMENT OF THE YOUN CITIZAINES

Through some ERASMUS+ projects, students can be involved in activities through which they develop their ideas, create their own experiences applying ESTEAM concepts, promoting gender equality, personal development, social inclusion and active citizenship. The UNIREA Hackathon event was organized by the ”UNIREA” National College, within the "HACKATHON EU" project 2020-1-ES01-KA202-082752. The event aimed to stimulate the expression of students' innovative ideas, to encourage teamwork, to contribute to the development of thinking based on the identification of creative and innovative problems and solutions.

Hackathon, a competition between several teams in which solutions were proposed based on applications of IT technology to various problems / social / community challenges, took place between 28-30.09.2022, for the duration of 48-60 hours, time in which the participating teams tried to bring the project to the most advanced stage of development.

On the first day of the competition, 29.09.2022, seven crews from classes XA, XI A and XIIA, mathematics-informatics profile, intensive computer science, from the "Unirea" National College were actively involved, each carrying out a project that had the theme: *”Revitalization of the social and cultural life of the Municipality of Târgu Mureș*!”

The proposed solutions were: the modernization and greening of urban transport means, the digitization of urban networks, the efficiency of school transport, the creation of transport alternatives, the creation of appropriate technological spaces and centers that become sources of cultural events, the creation of protected ecosystems, which to be unpolluted green areas in the urban environment, ideas regarding urban aesthetics.

On Friday, 30.09.2022, the crews presented their projects to a jury. The LUMIX team, made up of Bălan Liliana, Cerceș Alexandra, Morar Iulia and Trifan Paula - students of the 11th grade A and Bândilă Darius, a student of the 10th grade A, ranked first, qualifying for the international competition, which will take place in Italy in march 2023.

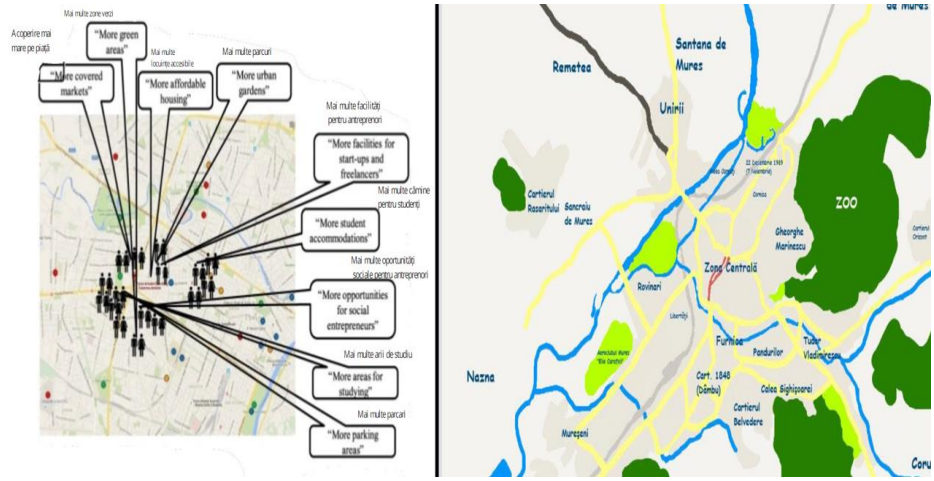

Fig. 2. Picture from Lumix Team presentation
Source: https://www.canva.com/design/DAFNlymDFy4/g0j8vDBlOHUmruEcad-uXA/view?utm_content=DAFNlymDFy4&utm_campaign=designshare&utm_medium=link2&utm_source=sharebutton

Culture is the spokesperson of civilization. The identified problem is the limited approach to the social and cultural life of the municipality of Târgu Mures, which makes the city of Tg. Mures doesn't seem like an offerer for young people. The team proposed a 5-year staged urban regeneration strategy, based on SMART objectives, so that the municipality reaches the standards of the 21st century. Târgu Mures is a medium-level city that has a lot of potential, which it does not capitalize on. Like any city in Europe, it suffers from problems such as traffic, pollution, chaotic development in peripheral areas. Besides all this, it does not have a very lively social and cultural life. Too few events are organized that support the social component, which is conceived by ensuring the possibility of the manifestation of local communities in identity spaces, which can contribute to strengthening the feeling of belonging. Unity in diversity.

The medicine and IT sectors already represent a basic segment in university education in Târgu Mures. Thus, the diversification of the educational offer will attract the young population. Once students are attracted to the city, in order to keep them in the city's labor market, you must offer them opportunities in terms of jobs. An important step is the application of a policy at the local level to encourage the arrival of investors. The provision by the municipality of infrastructure, utilities and land on the outskirts of the city will ensure a tendency for companies to orientate themselves towards the area of Târgu Mureț Municipality. These will increase the competitiveness of enterprises, leading to the acquisition of new and sustainable technology, implicitly to sustainable development and increased resilience.

Once these ideas are implemented, traffic problems are accentuated. ”How many times have you waited for the bus at the station for dozens of minutes in a row? or were you late because of traffic?” *Find Way* is a proposal application that shows in real time where the buses are, thus decongesting the traffic. the use of public transport becomes easier and the time of waiting in traffic is shortened, also this application will be the standard for future

buses, ecological buses, which ensure the autonomy of travel from the renewable photovoltaic source or by installing two gas tubes obtained from waste processing municipal by pyrolysis, 1 kg of waste results in approximately 1 l of fuel. charging at the end of the line is much shorter than charging electric batteries. Also, the introduction of ecological buses will create approximately 450 jobs in the system and 600 in construction, keeping the idea of green transition. The bus shelters we all know will be replaced with smart bus stops, these will be closed spaces equipped with photovoltaic panels to ensure the current needed to charge electronic devices and use some units without air heating/cooling. Depending on the season, these bus stations will have a jukebox that will issue free tickets if you do 15 squats, promoting the sport, also both on the buses and in the bus stations there will be posters to promote the events.

One of the proposals is the VISUAL CHANGE. The renovation of damaged buildings is considered by accessing European funds, by introducing street art, such as mural graffiti, artistic interpretations and the rehabilitation of public institutions (hospitals, schools, etc.) The first thing that a young person who has just arrived in our city looks for is a LIVING SPACE. Looking at our city, we see a lot of old blocks, which have a damaged, less pleasant appearance. If you wouldn't see yourself living in them, then why would young people from other parts do it?

It is proposed to replace the sober and monotonous appearance of the buildings built during the communist period.

On the facades of the buildings, young volunteers can contribute to the stylization process of the city, thus having the chance to express themselves, both through graffiti and mural art. Graffiti is seen by a multitude of people as an act of vandalism, but it is a way of expression as valid as that on a sheet of paper with a simple brush.

These are just some of the ideas of the Lumix team. The proposals have been appreciated and will be sent to those interested in sustainable change. Through this example of projects, we can say that young people are ready for change and want change.

8. CONCLUSIONS

Learning for adaptability is an educational goal for ESD and DRR education that can support their improved pedagogical design and strengthen links with quality education – particularly in its orientation towards intrinsic learning and the relevant application of knowledge, skills and skills learned to address real-world challenges and problems. "Essentially, ESD challenges policy makers to go beyond the links between ESD and content-oriented educational priorities and to consider how education can contribute to greater sustainability in economic, labor market and industrial sectors" (Benavot, 2014).

When considering how to improve the quality of general education (especially in terms of sustainable development and DRR), there are four main objectives that must be addressed: 1) applying a well-developed curriculum, 2) improving the quality of teaching methods, 3) establishing a safe and effective learning environment and 4) that inspires cooperative learning (based on organization, according to well-established operational objectives and aimed at developing interpersonal communication skills. Of students' interactions, competences and social compartments) and transformative (in which we change the way we learn) (Ofei, 2014). It is possible to link each of the quality education

goals to the learning goal for adaptability. Implementing a well-developed curriculum focuses on what people learn.

In terms of adaptive capacity, it should ensure the inclusion of relevant content and knowledge related to DRR and sustainable development (ESD). Deep learning is supported by deep investigation of individual subjects, but is also reinforced by critical practice, which enhances the connections between classroom learning and real-world practice. In addition, deep learning can be supported with progressive learning objectives that ensure the development of knowledge and skills over time through iterative and incremental improvements. Working at the intersection of quality education, sustainable development and DRR.

The key aspects of learning for adaptability presented will require investigation in applied educational studies to further clarify and validate their functionality in real-world practice. There are other dimensions that may be explored, such as the development of individual capacity and how these would apply in the context of adaptive capacity. Important factors in adaptive practices would be psychological constraints and emotional skills to cope with change, and further work reflecting the links between adaptive learning and the development of psychological and emotional skills to cope with the upheavals created by transformative learning would be important. and adaptive change. An additional consideration is the value that both creativity,

The involvement of young people in activities to raise awareness and generate solutions is a premise of the fact that education can lead to sustainability.

Proposals for learning for adaptability solutions in education

Learning for adaptability is the process of acquiring knowledge, skills, and attitudes that enable individuals and organizations to adjust to changing circumstances, opportunities, and challenges. It involves building the capacity to learn, unlearn, and relearn, and to apply this learning to new and unfamiliar situations. Some key points to consider in learning for adaptability are:

- *Lifelong learning*: Learning for adaptability is a lifelong process that involves continuous learning and development. It requires individuals to be open to new ideas, perspectives, and experiences, and to seek out opportunities for learning and growth.
- *Interdisciplinary approach*: Learning for adaptability should involve an interdisciplinary approach, drawing on diverse sources of knowledge and expertise, and promoting cross-disciplinary collaboration and innovation.
- *Problem-based learning*: Problem-based learning is a useful approach to learning for adaptability, as it involves engaging learners in real-world problems and challenges, and encourages them to apply their learning to solve these problems.
- *Feedback and reflection*: Learning for adaptability also involves feedback and reflection, where learners receive feedback on their performance, reflect on their learning, and identify areas for improvement.
- *Technology and innovation*: Technology and innovation can also play an important role in learning for adaptability, providing new and innovative learning opportunities, tools, and platforms.

Overall, learning for adaptability is essential in the face of the increasing pace of change, uncertainty, and complexity of the modern world. It requires individuals and organizations to be agile, flexible, and resilient, and to develop a mindset of continuous learning and adaptation.

- Incorporate interdisciplinary learning: As mentioned, interdisciplinary learning is a key aspect of learning for adaptability. To incorporate this into education, schools and universities can design courses and learning experiences that draw on multiple disciplines and encourage cross-disciplinary collaboration.
- Emphasize problem-based learning: Problem-based learning is another useful approach to learning for adaptability. In this approach, students engage in real-world problems and challenges, and are encouraged to use their learning to solve these problems. This approach can help students develop critical thinking skills, collaboration skills, and adaptability skills.
- Encourage feedback and reflection: Feedback and reflection are essential aspects of learning for adaptability. To encourage this, teachers and educators can provide regular feedback on student performance and encourage students to reflect on their learning and identify areas for improvement.
- Use technology and innovative teaching methods: Technology and innovative teaching methods, such as simulations, virtual reality, and online platforms, can also be used to support learning for adaptability. These tools can provide students with new and innovative learning experiences, and help them develop digital literacy skills, which are increasingly important in the modern world.
- Promote lifelong learning: Finally, education should promote lifelong learning, as learning for adaptability is a lifelong process. This can be done by encouraging students to pursue further education and professional development opportunities, and by providing access to resources and support for ongoing learning.

By incorporating these proposals for learning for adaptability solutions in education, schools and universities can help prepare students for the changing world and equip them with the skills and knowledge necessary to adapt and thrive in a rapidly evolving environment. Hager, P., & Hodkinson, P. (2009) discusses about the importance of interdisciplinary learning and transfer of learning in promoting adaptability and flexibility, Savin-Baden, M., & Major, C. H. (2013) provides insights on the use of problem-based learning and its effectiveness in promoting adaptability and critical thinking; So, H. J., & Kim, B. (2009). In ”Learning and teaching in online environments: Overview and issues. Journal of Educational Technology Development and Exchange ” discusses the use of technology and online platforms in supporting learning for adaptability. We can see that interdisciplinary learning, problem-based learning, feedback and reflection, technology and innovation, and lifelong learning are all key elements in promoting adaptability and flexibility in education.

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