

## MATHEMATICS AND QUALITY EDUCATION AS PART OF THE SUSTAINABLE DEVELOPMENT AGENDA

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### Abstract

In the 21<sup>st</sup> century, the term “sustainable development” is increasingly relevant due to pressing global challenges such as global warming, air pollution, water, and soil, as well as the misuse of technology and other technological resources. Integrating sustainable development into mathematics teaching involves considering its impact on the world—the natural environment, society, economy, and technology. This paper explores how well the concept of sustainable development is understood and integrated into the daily lives of high school seniors. The data, processed using SPSS, was collected from online questionnaires completed by 197 senior students from vocational and general high schools. The results show that 40% of the students lack knowledge about sustainable development. Additionally, this study confirms the hypotheses that early childhood education (preschool) correlates with better preparation for school start ( $\chi^2 = 11.275, p = 0.004$ ) and that mathematical literacy correlates with linguistic literacy ( $\chi^2 = 20.774, p = 0.000$ ), both of which are components of sustainable development. The findings suggest that mathematics education at all levels should incorporate these objectives into its curriculum to achieve sustainable development goals. This approach will help future generations understand their role and responsibility in advancing the concept of sustainable development, thus securing their future.

*Keywords:* mathematics education, sustainable development, quality education

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### Introduction

Sustainable development is a process that has no borders. Sustainable development can only be achieved with equal respect for the principles of environmental protection and the development principles of a society. The extent and manner in which a country will use its natural wealth in the function of sustainable development depends on its national policy, the integral component of which is education for a correct attitude towards the environment. The concept of sustainable development represents a new development paradigm, a new strategy, and a philosophy of social development.

Education for sustainable development is education for life or everyday behavior and actions. It implies the acquisition of knowledge, but it is generally known that knowledge without values and attitudes is not enough. A willingness to engage and act by one's own beliefs and principles is necessary. Therefore, education for sustainable development should not be just another topic in the curriculum, which remains at the level of theory, but should be aimed at acquiring competencies through action. In the process of rapid global changes, a well-known goal is to enable students to participate in social processes for sustainable development. It is of essential importance to allow them to develop their competencies, which would be reflected in improved mutual cooperation in all spheres.

## **Mathematical competence as a condition for quality education**

The National Strategy for Sustainable Development (2009-2030) is based on the principles of sustainable development accepted at the global level, defined at the UN Conference on Environment and Development (Rio de Janeiro, 1992), and was adopted in our country in 2010. In the national strategy, among other things, one paragraph highlights the importance of the need for significant improvement and strategic direction of the education sector, but in the seven strategic determinations of the document, there is no concrete proposal for the way of realizing the education about sustainable development. What should be emphasized is that education about sustainable development lasts a lifetime, students should be educated with a sense of responsibility for the state of nature starting from local to global levels, environmental problems should be recognized as their problems, and they are encouraged to take appropriate measures. To achieve the set development goals and tasks, comprehensive changes are needed that will increase the quality of education. (National strategy for sustainable development in the Republic of Macedonia part I / II 2009 - 2030)

Hence, it is no coincidence that quality education is one of the seventeen goals of sustainable development. It covers the following targets:

- To ensure that by 2030 all girls and boys have acquired free, equal, and high-quality primary and secondary education, which will further enable the achievement of appropriate and effective results;
- To ensure that by 2030 all girls and boys have access to quality early childhood development, care and preschool education, as preparation for primary education;
- To ensure that by 2030 equal access is given to all women and men to affordable and quality technical, vocational and tertiary education, including higher education;
- To significantly increase the number of young people and adults who have appropriate skills, including technical and professional skills, with the aim of employment, obtaining decent jobs and entrepreneurship by 2030;
- To eliminate gender differences in education and ensure equal access to all levels of education and vocational training for vulnerable citizens, including persons with special needs and vulnerable groups by 2030;
- To ensure that all young people and a significant number of adults, men and women, have achieved language and mathematical literacy by 2030;
- To ensure that all students will acquire the knowledge and skills needed to promote sustainable development, inter alia, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and understanding of cultural diversity and the contribution of culture to sustainable development by 2030;
- To build and improve school facilities that will be adapted to the requirements of children, and persons with disabilities and will consider gender differences, ensuring a safe, non-violent, inclusive and effective learning environment for all;
- To significantly increase the number of scholarships in developing countries, especially in the least developed countries, small island developing countries and countries in Africa, for enrollment in higher education institutions, including vocational and technical training for information and communication technology, technical, engineering and scientific programs, in developed countries and in other developing countries by 2030;
- To significantly increase the supply of qualified teachers, including through international cooperation for teacher training in developing countries, especially in the least developed countries and in small island developing countries by 2030.

Considering that within the framework of this paper, the focus is on mathematical education and quality education, part of the agenda for sustainable development, we will refer to the basic characteristics of mathematical literacy. Mathematical literacy is defined as the ability to recognize mathematical problems, understand and engage in mathematics, and create well-founded judgments about the role of mathematics, needed in the present and future personal, work, and social life with peers and family members as a constructive and interested citizen. A mathematically literate individual can successfully solve a mathematical problem presented through a situation or reality.

However mathematical literacy is not easy to measure. As Deborah Hughes-Hallet (2001) explains in her article "Mathematics and Democracy": "One of the reasons why mathematical literacy is difficult to study is that it includes, in addition to algorithms, the so-called full insight. Some algorithms are certainly necessary, but learning or memorizing algorithms alone is not enough. Full insight is an essential component of mathematical understanding. Such complete insight implies an understanding of quantitative relationships and the ability to identify those relationships in an unfamiliar context, its acquisition, inclusion, deliberation, judgment, and above all experience." (Hughes-Hallet, D. 2001)

So far, current school curricula unfortunately rarely emphasize full insight and do little to actively support its development at any level. The development of a full understanding of mathematics should be actively supported, starting even before the beginning of primary education. Many countries have begun to take seriously the problems associated with overemphasizing the algorithm and neglecting the full insight.

Necessary knowledge of mathematics includes a thorough knowledge of numbers, measures and structures, basic operations and an understanding of mathematical concepts and terms as well as the questions to which mathematics offers answers. The individual should have the ability to apply basic mathematical principles and processes to everyday situations, at home or at work, and to follow and evaluate a sequence of evidence. They should reason mathematically, understand mathematical proofs, communicate in mathematical language, and use appropriate tools and aids. A positive attitude towards mathematics is based on the respect for truth and the desire to seek reasons and assess their validity. (Pandiloska-Grncharovska, 2020)

### **Research methodology**

The topic defined in this study has been very slightly dealt with in our surroundings; therefore, even finding of sources for this topic has been difficult. This study aims to research the knowledge of high school students about sustainable development as well as their habits and skills that are part of the agenda for sustainable development. For this reason, the research instrument that we used included an online questionnaire that was carried out with students in the last year of secondary school. The schools involved are gymnasiums and vocational secondary schools. To comply with the rules and to create a habit for development, the questionnaire was distributed by giving the QR code where the students, by scanning it with their phones, accessed the questionnaire and completed it. In this way, the paper was saved, and the students gained new experience in the research process. Students who did not have internet access were connected by using other students' internet hotspots. The collected data were processed with the help of the SPSS program. We present the obtained data as follows:

The questionnaire was completed by 197 students, of which 63% were female. Based on the type of school, 34% were from gymnasiums, while the rest were from vocational secondary schools. In the question related to the reason for choosing that specific high school, the student's answers were given in Fig. 1.

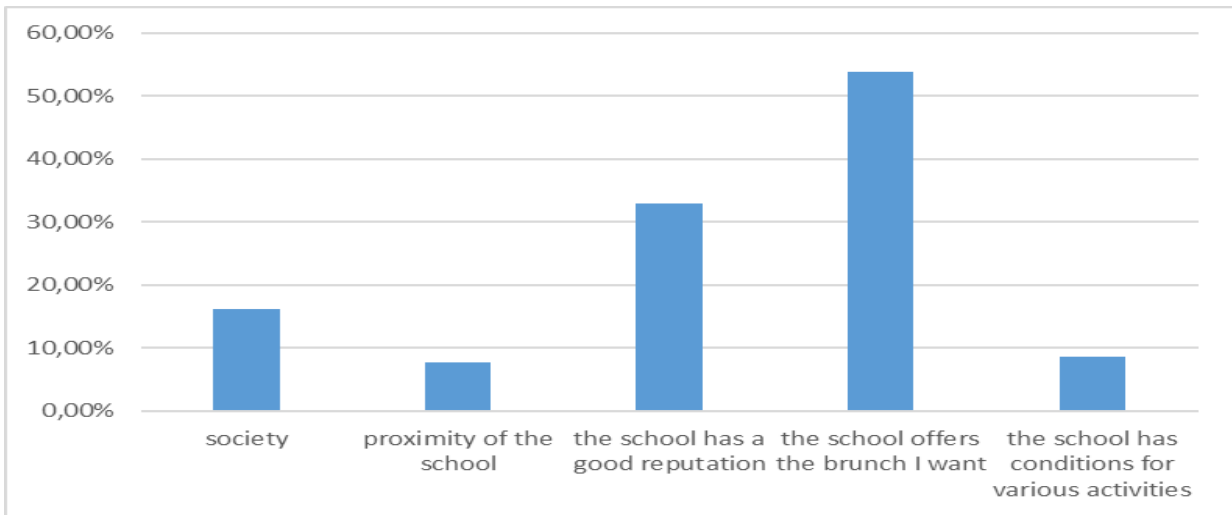


Figure 1 The reason why students chose this school.

From the table, it appears that the reason why the students had chosen that specific school was related to their favorite courses. This is how 53.8% of the students answered. Then there is the good reputation of the school, which 33% of the students opted for, and 16.2% of the students chose the school because of their friends. This data is important because students look for attractive courses and schools with a good reputation because they have to prepare for new, attractive, and tempting professions that probably do not exist yet.

The notion of sustainable development is a concept that is examined in this paper; therefore, the students were asked if they had heard of this concept. Of the total number of students, approximately 60% of them had heard about it, while the rest had not. Knowing that it is a very important topic for the future of young people, educational institutions must consider the development of knowledge and skills of young people so that they can ensure and develop conditions for their future and the future of society, economy, and the world as a whole. Fig.2 provides the data on where the students got the information about the meaning of sustainable development.

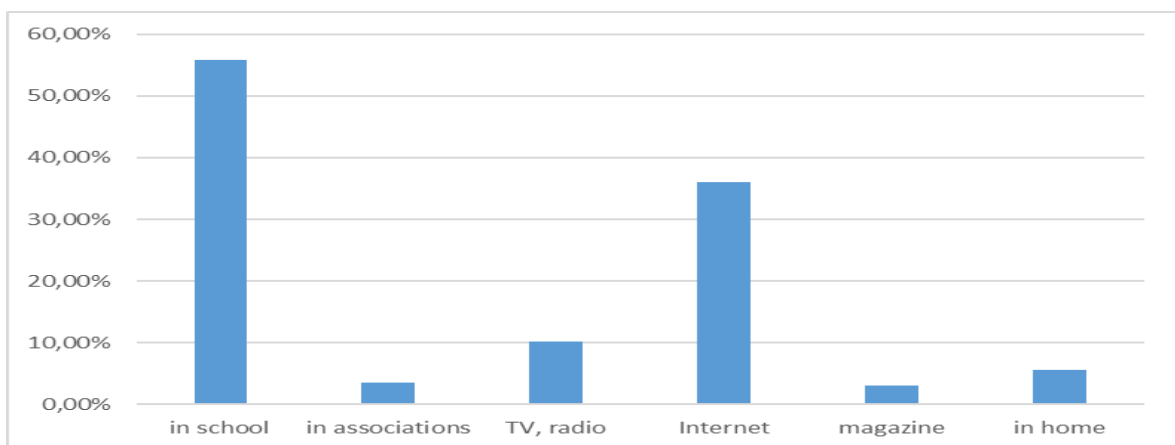


Figure 2. Where did students hear about sustainable development?

The school is the place where most students have heard about sustainable development; this percentage of students is 55.8% of the total number of students who completed the questionnaire. In second place comes the Internet, the inexhaustible source of information in the time we live in. The number of students who received information about sustainable development from the Internet is 36%, while the percentage related to other sources is small.

Since schools are seen as the place where students are informed and develop their skills, then they should do even more to increase and develop the skills and habits of young people with regard to sustainable development.

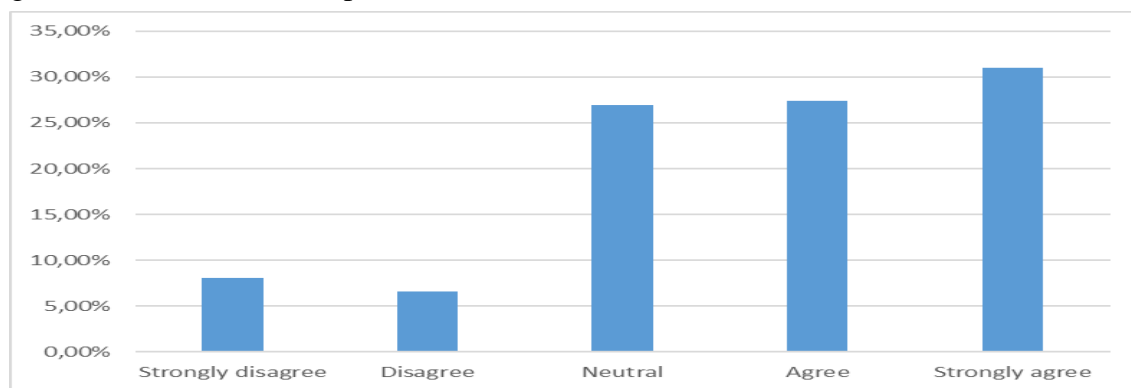


Figure 3. Students' opinions about the quality of their education.

In the question “What is the opinion of the students regarding the quality of their education?”, the answers are presented in Fig.3 from which it can be seen that 31% of the students think that their education is qualitative, while 27.4% agree that they have quality education. Of the total number of students, 26.9% have no opinion on the quality of their education at all. In addition, 33% of the total number of surveyed students were completely satisfied with the results of their learning, 31% were satisfied, and 25.4% were not determined.

For quality education in the framework of the agenda for sustainable development, it is necessary to ensure the same conditions for all students to attend preschool education; therefore, in this paper, we have obtained data whereupon 67.5% of students have attended preschool education which represents a significant percentage. The curriculum of preschool education also includes the subject of mathematics, which means that the child is introduced to the subject of mathematics in a systematic, organized, and planned manner from preschool age, and this is the stage to prepare the child for the next schooling phase. The children's psycho-physical preparation for school, as well as their skills and prior knowledge, are important factors for their attitude towards school, society as well as towards the subject of mathematics itself. Using pre-school education, the student may be evaluated continuously, starting from the earliest age, which also ensures better success and development of thinking skills (Iljazi.T, 2013). The increase in the number of children attending preschool education will lead to the reduction of adaptation problems at the beginning of regular schooling. If preschool education is the education that prepares the child for regular education, secondary schools prepare students for their future professions or continuing education at university. Regarding the question of whether they will continue their education at the university level, 80% of students answered yes, the percentage is approximately the same for those who do not plan to continue and those who have not yet decided. The question arises as to how much the state plans the necessary professions for this society and how many young people will practice the profession for which they completed their education. Of the graduating students, 69.5% of the respondents, think that in our country there is a faculty that meets their requirements, while the remaining percentage is divided into those who do not know and the rest saying that no faculties meet their needs. The ambition of future professionals to open a private business is represented by 68.4%, and if supported by society or the state, it would mean that they would stay here and not leave the country.

Linguistical and mathematical literacy is also a characteristic that the generations of the 21st century must have. How much the students participating in this study possess these qualities, can be shown from the answers they provided, which show that 73% of the total number of

students think that they have adequate language knowledge, while 65.5% of the students think that they have possess mathematical literacy; 15.7% think that they do not possess linguistical and mathematical literacy, and the rest do not know if they possess this knowledge at all. Although the surveyed students are part of the generation of the 21st century where information grows and is distributed at a dizzying speed and a century where information processing skills, critical thinking, and creativity are required, based on the students' answers, we can see that only 14.2% of them are involved in any training from the field of information and communication technology. This percentage is very small considering that technological applications have been included in almost every sphere nowadays.

After processing the data and the results obtained in this paper, we managed to prove these hypotheses:

H<sub>1</sub>: The designation for private business does not depend on the school that the students attend.

#### Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	3,123 <sup>a</sup>	2	,210
Likelihood Ratio	3,337	2	,189
Linear-by-Linear Association	2,751	1	,097
N of Valid Cases	197		

a. 0 cells (0,0%) have expected count less than 5. The minimum expected count is 9,72.

Figure 4. Hypothesis H<sub>1</sub> verification

Figure 4 presents the validation of the hypothesis because the statistical value obtained is 3.123, which is less than the critical value and  $p < 0.05$ , where we conclude that there is not enough evidence to reject the null hypothesis and we conclude that there is no correlation between the school that the students attend and their definition of business.

H<sub>2</sub>: The attendance of preschool education is correlated with the better preparation of students for the beginning of their schooling.

#### Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	11,275 <sup>a</sup>	2	,004
Likelihood Ratio	10,660	2	,005
Linear-by-Linear Association	10,640	1	,001
N of Valid Cases	197		

a. 1 cells (16,7%) have expected count less than 5. The minimum expected count is 3,63.

Figure 5. Hypothesis H<sub>2</sub> verification

Figure 5. presents the validation of the hypothesis because the statistical value obtained is 11.275 which is greater than the critical value and  $p < 0.005$ , with which we conclude that there is sufficient evidence to reject the null hypothesis and prove that preschool education is correlated with the best preparation of students for the beginning of their schooling.

H<sub>3</sub>: Linguistical literacy is correlated with mathematical literacy.

Figure 6 presents the validation of hypothesis H<sub>3</sub>, because the statistical value obtained is 20,774 which is greater than the critical value  $p = 0,000$ , with which the evidence is sufficient to reject the null hypothesis and prove that linguistical literacy is correlated with mathematical literacy.

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	20,774 <sup>a</sup>	4	,000
Likelihood Ratio	19,207	4	,001
Linear-by-Linear Association	16,315	1	,000
N of Valid Cases	196		

a. 3 cells (33,3%) have expected count less than 5. The minimum expected count is 3,95.

Figure 6. Hypothesis H<sub>3</sub> verification

Figure 6 presents the validation of the hypothesis H<sub>3</sub>, because the statistical value obtained is 20.774 which is greater than the critical value and  $p=0.000$  with which the evidence is sufficient to reject the null hypothesis and to prove that linguistic literacy is correlated with mathematical literacy.

### Conclusions and recommendations

The situation in the world about the sustainability of human activity and survival on the planet is alarming, which is why the UN created the Global Development Goals, which are guidelines for governments to change policies and practices to slow down negative trends. Due to the seriousness of the challenges facing society, children and young people must have knowledge and skills for sustainable action, which is achieved through the education process. These current global topics should encourage sustainable development content to be integrated into our education system by involving educational workers more significantly in their work. This also applies to the subject of mathematics, which, in addition to being able to serve as an aid to other subjects, must include knowledge related to sustainable development in the school curricula of every level. This will enable students to create habits, skills, and attitudes related to sustainable development. Mathematical concepts begin to be part of organized and planned life from kindergartens and preschool education; therefore, preschool education as part of the sustainable development agenda, should be insisted on being mandatory for everyone because in this way better quality preparation is possible for regular schooling that was also proven in this paper. If the ambition of young people is considered by state institutions, helping them to create jobs through the creation of private businesses, the youth will be motivated not to leave the country. Also, educational institutions and policymakers should have on their agenda the creation of qualitative educational facilities that will be part of the realization of the goals for sustainable development.

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