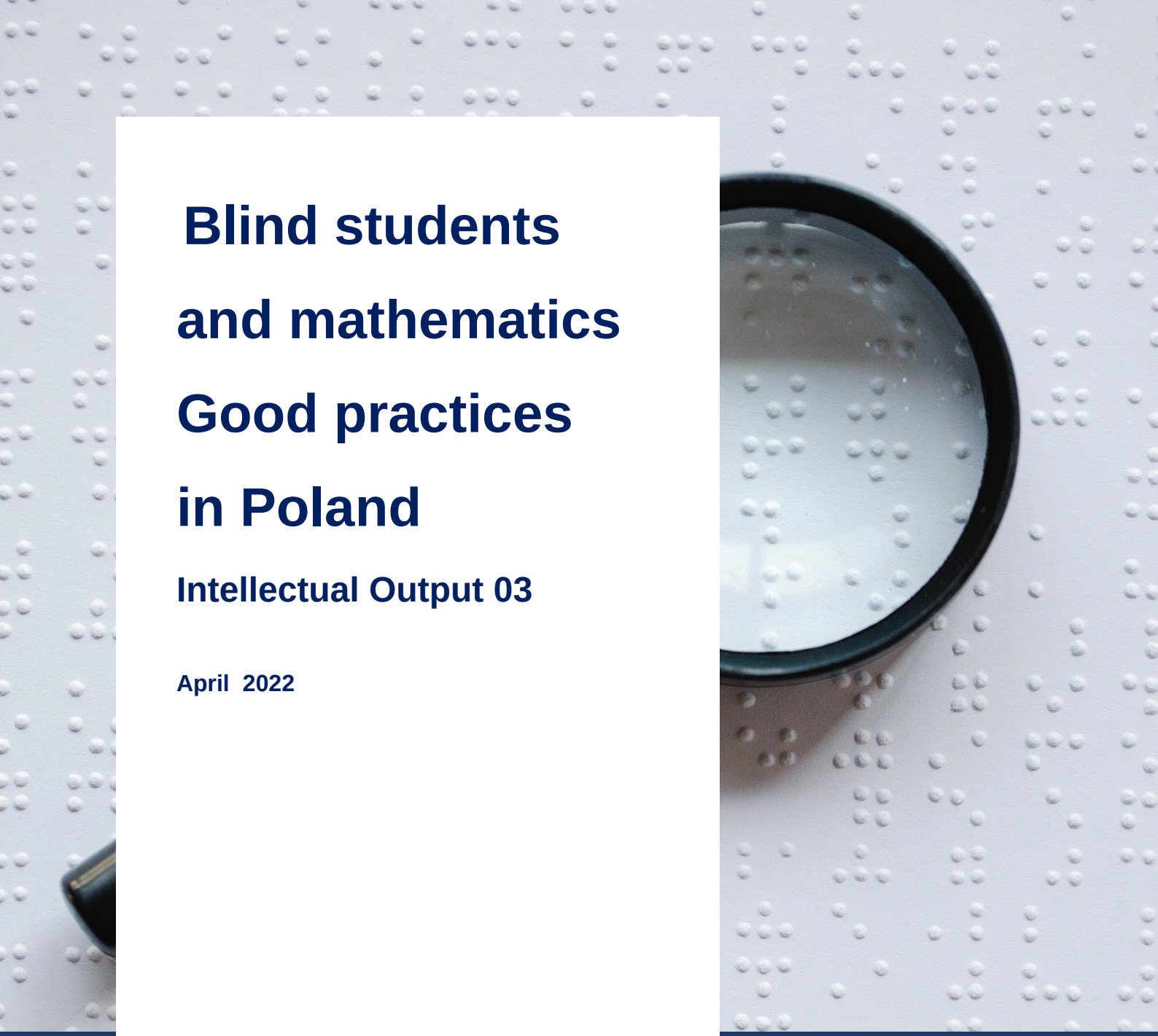

# Blind students and mathematics Good practices in Poland

## Intellectual Output 03

**April 2022**

**PROGETTO DDMATH**
**Digital learning in mathematics for blind students**
**ERASMUS+ Program**

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**DDMATH PROJECT**

**Digital learning in mathematics for blind students**

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# Intellectual Output 03

**April 2021.**

Project within the ERASMUS+ program – School Education Gateway – Action KA2 - Strategic partnerships for digital education KA226 – Convention n. 2020-1-IT02-KA226-SCH-09557

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# 1 Introduction

In Poland primary education of visually impaired children is mainly based on special education centres. However, it is also possible to observe a growing number of blind and partially-sighted students in the mainstream schools, the majority of which are, however, the so called integration schools. The first integration division for very young children (preschool level) was established in Warsaw in 1989. From this time on integration schools have appeared all over the country. The idea is to place students with different kinds of disabilities in special classes, where both able-bodied and disabled students work together, but those with special needs receive additional support. The number of students in a class is lower and special assistance is provided by the supporting teachers. Such teachers are either graduates of special pedagogy departments of universities or at least get respective qualifications at special courses organised at a regional level by higher schools of pedagogy.

Both – special education centres and other schools attended by pupils with visual impairment receive financial support from the government which is meant to cover the cost of manuals published in Braille and/or large print. It is the school that applies for the didactic materials needed for a given school-year.

Mathematics has always been considered to be an important but at the same time difficult discipline for the blind, requiring special attention and skills on the part of the teacher and effort on the part of the students. That is why the latest developments in this field, focussing on the application of new software and electronic equipment (in the first place well-adapted PC) is of utmost importance.

## 2 Statistical data

According to the report of the Central Statistical Office in the school-year 2016/2017 [1] the total number of visually impaired students in Poland at all levels of education (from primary through secondary to higher schools) amounted to 7506, of which 251 were blind and 7255 – partially-sighted. Only 75 blind students (about 30%) attended the mainstream schools, while the majority received education in special education centres. As regards the partially-sighted the situation was quite opposite: 6539 out of 7255 attended the mainstream schools, including the integration ones.

Unfortunately, it was not possible to obtain equivalent figures for the following years, most probably because of the changing structure of education centre governing bodies as well as a significant split among the NGOs of and for the visually impaired. Some figures were available from the major organisation of the blind, which, however, reveals only the data covering its members. Nevertheless, they confirm the same tendency as regards inclusion and a proportion of the blind in relation to the partially-sighted in education.

Here are some figures from the Polish Association of the Blind for the school-year 2019/2020, quoted here just to illustrate the proportions (they refer to the members of that particular organisation only):

- the number of students in mainstream primary education – 825
- the number of pupils in special schools for the blind and partially sighted - 206

It can be noticed that the number of students with visual impairment has been growing, showing a higher increase in the population of the partially-sighted and a decline in the number of the blind.

At the same time the number of students in special schools, both blind and partially-sighted, has slightly decreased, the tendency being stronger in the population of the partially-sighted. This phenomenon can definitely be recognised as a step forward in the process of inclusion regarding education.

The change is possible due to improving readiness of the mainstream school to a difficult task of working with visually impaired students, including the qualifications

of the teachers, technical equipment available as well as the skills of students in the area of IT.

# 3 Assessment

Assessment is an important integral component of an education process. Independent of the favourable conditions in which visually impaired students can get access to the material and effectively study a given subject, it is also necessary to work out and offer suitable assessment procedures and techniques. In Poland visually impaired students sit for their examinations, whether the entrance, intermediate or final ones, using the standard examination sheets adapted to their disability. And thus partially-sighted students are provided with large print texts, enlarged and simplified graphic forms, while the blind get Braille texts and convex drawings. During the examination students may use special equipment, such as a Perkins-type brailler, well-adapted PC, cubarithms etc. Besides, well-adapted lighting is ensured for a partially sighted person if needed, and the exam duration can be prolonged by 30 minutes. It is also possible to ensure an assisting teacher who can help the student with reading the instructions and/or writing the answers. If the assisting teacher is present, the examination has to be recorded. Students very seldom use PC to write their exams in mathematics.

The assessment of visually impaired students is carried out according to the same criteria as that of able-bodied ones. It is estimated that the average grading in mathematics at a lower secondary level has been by about 10% lower as compared to the average. Over the last five years the number of visually impaired students choosing mathematics as the so called leading (extended) subject when graduating from the secondary school has been very low (just 10-15%), which may suggest that visual impairment is a serious obstacle to acquiring a sufficiently high competence in this subject. It also turns out that the difficulties encountered by the blind are even greater than those experienced by the partially-sighted.

It is worth to point out to a sophisticated examination facility designed by the students. In 2018 three talented students from the special school for the blind in Kraków managed to develop an IT friendly environment to be used during the examinations. The kit consists among others of Latex text editor and Latex-Access Module (http://latex-access.sourceforge.net/). The students themselves adapted Latex-Access modules to the read-out of the Polish text and conversion of

mathematics in Latex to the Braille Mathematical Notation. The software had been tested for 1.5 year before it was used during the examinations. It proves to be useful not only for the blind users, but also for the teachers who very often do not know Braille.

The fact that computer techniques are very seldom employed by the visually impaired students in managing mathematics is most probably due to their insufficient competence in the area of IT and inadequate adaptation of the software needed. Another serious obstacle is lack of resources necessary to equip schools and individual students with computers, Braille displays and adequate software.

# 4 Didactic aids and techniques used for teaching mathematics to the visually impaired students

The basic tools used by the partially sighted are different types of magnifiers, indispensable for hand-writing and/or interpreting figures. There is a wide range of magnifying tools available – from computer-based accessories with large screens to the portable ones varying in size. It is also advisable to modify the colour and contrast according to the individual requirements of a partially-sighted student. Attention should Be paid to the appropriate lighting conditions. Some more sophisticated magnifiers provide an opportunity to focus the camera on the blackboard. Interactive blackboards have also proved to be a valuable aid during the classes of mathematics, especially because nowadays they are available in many schools. Some, although very few students use PC editor for writing and reading mathematical texts.

Among the blind students there is a growing number of those who do not know Braille. They encounter greater difficulties with writing and reading mathematics. Special plugins built in the screen readers, such as JAWS and NVDA are helpful, but in this case the speech output is available only in English. In order to write mathematical formulas with a computer they can use an equation editor in MS Word.

It is possible to write equations using only keyboard shortcuts. However, although a blind person can write an equation, he/she has a big problem with reading it, because the screen reader plugins that support this MS Word functionality are available only in English. A blind student can also use a text linear notation AsciiMath [2]. An alternative solution is PlatMat application and Euromath systems[3].

So the majority of blind students write mathematics with a Perkins-type brailler. Their basic resource for studying mathematics is a braille manual, adapted to the Braille system by one of the special adaptation centres and financed by the ministry of education. However, there is only one manual published for a particular education level (class) at a time, while the range of written materials applicable for each course is wide and the teachers can choose any of them according to their

preference. Additionally, Braille manuals ordered are released with a significant delay – of up to six months.

That is why blind students very often do not have a chance to use textbooks during the classes. They can be provided with some Braille materials if a school is equipped with a Braille embosser. But printing in Braille also requires special knowledge and experience on the part of the teacher as well as adequate software, such as Tiger Software Suite [4] or Duxbury [5]. The Polish manuals are prepared in the Braille Mathematical Notation (BNM) [6] based on the Helmut Epheser's International Mathematical Notation, known as the Marburg Notation. Automatic conversion between this notation and other formats, such as MathML or Latex proves to be difficult, especially if the output is to be in Braille. Such a BNM-to-MathML converter working in both directions has been included in the Braille formula editor in the framework of PlatMat and Euromath projects mentioned above.

In the PlatMat and Euromath systems the student can write formulas using the Braille keyboard connected to a computer or the qwerty keyboard modified to function in the same way as a brailler. It is possible to apply the Polish Braille Mathematical Notation or the English UEB notation. After the formula has been saved, it is converted to MathMl and then displayed on the teacher's screen. The inverse operation is also possible, so that the teacher writes formulas by inserting graphical mathematical symbols in the editor and the program converts them to Braille or a vocalised form read by the synthetic speech. Euromath also provides some other facilities, such as a simple graphics editor available for a blind person or a mathematical formula navigator. With the navigator student can view a formula in Braille piece by piece and recognise its structure moving through as on the tree. The Euromath system has been unavailable for several months due to funding expiration, but a new version is currently being launched.

More advanced students have been successful in using Latex, but considering its complexity and a great effort needed to get familiar with a new programming language, this technique is accessible at a higher level of mathematical education.

There are also other, partly accessible solutions helpful in teaching mathematics to the blind, just to mention Geogebra, a tool quite popular among the

primary school teaches [7]. It is an internet-based system applicable to most of the mathematical branches such as geometry, equations, differential calculus and others. The program is available also in Polish. Some features allow to customise the graphic interface for the needs of visually impaired students. Some common tools, such as a calculator, are also accessible to those who are using screen readers. However, most Geogebra applications are not fully accessible.

Another interesting solution is an online application known as Desmos Graphing Calculator [8]. The system focuses on learning graphs of functions and geometry. Among others it offers a possibility to draw a graph based on a given formula and then play the graph as an audio signal generated from the drawing. So a blind student can draw a function graph by himself, listen to it and thus learn its shape and other properties by means of the sense of hearing. Although the system is fully accessible to both the partially sighted and blind, unfortunately it is only available in English.

# 5 Conclusions

To conclude, it should be noticed that although the process of inclusion in education is in progress, in Poland the majority of students at the lower level of education attend special or integration schools. An important obstacle appears to be an insufficient level of computerisation (lack of equipment, special software and training opportunities for teachers). For studying mathematics and science visually impaired students mainly rely on traditional tools and techniques, such as (braillers, cubarithms, braille and large print materials). Unfortunately, the number of students continuing education at a post-secondary level in mathematics and science is decreasing because of all the above mentioned discrepancies. Technological progress expressed by developing modern resources, mainly Lambda program and Euromath platform will hopefully change the situation for better. Works are in progress in the two directions:

1. customisation of Lambda,
2. further improvement and implementation of the Euromath platform (https://app.euromath.uph.edu.pl).

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