

Teaching Mathematics to Students With Visual Impairment in Inclusive Education Schools in Jordan

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Abstract

The students with visual disabilities is considered part of Jordanian society, and the Jordanian Constitution guaranteed that they are provided with all rights, including education. The study aimed to investigate the teaching of mathematics to students with visual disabilities in inclusive schools in Jordan. The researcher used the qualitative approach by conducting an interview with a mathematics teacher with long experience in teaching mathematics in inclusive schools. The results of the interview showed that there are ways and methods for teaching the content of mathematics curricula to students. People with visual impairment, and there is a positive impact and benefits of integrating students with visual impairment into inclusive schools, although there are some challenges facing students and mathematics teachers.

INTRODUCTION

Worldwide educational systems have taken notice of inclusive education (IE), and numerous scholars and educators have made it the subject of their research. According to Mitiku, Alemu, and Mengistu (2014), the foundation of IE is offering regular students a classroom system alongside those for students with special needs. Mariga, McConkey, and Myezwa (2014), said the IE is a strategy that seeks to provide all students, regardless of their unique needs, with equal learning opportunities. It is a method that seeks to provide special education chances for students in ordinary school system. Ainscow and Casar (2006) described as follows by Halvorsen (2002, 12): "The situation in which students with disabilities receive special education determined by the individualized learning program within the contexts of the core curriculum and general school activities and are supported in age-appropriate general education classes in their home schools." UNESCO has defined IE as: ensuring and guaranteeing the right of all students with disabilities to access, attend, participate and succeed in their local regular school.

According to Erkilic and Durak (2013), IE needs a number of prerequisites to be implemented effectively and successfully. These prerequisites include thorough institutional restructuring, which creates a suitable learning environment for all included groups. He emphasized the significance of offering a curriculum that accommodates each student's unique learning demands. This aligns with the findings of Mariga et al. (2014), who stated that IE requires adapting situations, behaviors, teaching strategies, curriculum, and the learning environment to fit the needs and expectations of every student. In the opinion of Sharma (2015), for students to feel autonomous and a part of the school, there needs to be a significant overhaul of the curriculum and the learning environment in

ordinary schools. Here, it is important to emphasize the necessity of taking action to provide enough inclusive schools that serve their intended purpose.

Numerous studies contend that IE techniques have the ability to improve equity in educational access by removing existing obstacles. It is believed that increasing learning opportunities for students with disabilities, particularly in mathematics, will improve their performance and decrease the achievement gap in the discipline (Matobako and Jita, 2022). In addition to placing students with disabilities in ordinary schools, Ediyanto, Zulkipli, Sunandar, Subanji, Wahat, and Iliško (2023) asserted that IE requires that these students actively participate in the curriculum and mathematics learning activities with other students.

The goal of inclusive education is to provide a learning environment that accommodates both quiet and special needs students. Such a hearing impairments, motion disabilities, visual impairments (VI), autism, and other conditions are classified as having special needs (Ghunaimat, 2023); students with visual impairments experience visual problems (Kourkouta, et al, 2017). This causes a lot of difficulties in daily life, such as issues with schooling. According to Ayanniyi et al. (2013) and the World Health Organization (2013) defined "students with moderate vision impairment and students with severe vision impairment and blindness are included in the category of people with visual impairment". Students with visual impairments can study in a variety of systems, including inclusive education schools (Cakmak et al., 2013).

According to research and educational studies in this area, students with visual impairments (VI) who attend inclusive schools tend to perform rather poorly academically in mathematics (Beal & Shaw, 2008). This may cause them to fall short of their peers who are regular students in terms of academic achievement (Ukeli & Akem, 2013). Slow learning is a common issue that affects students with VI and can only be partially addressed with the use of specialized teaching techniques, resources, and instructional strategies (Bartz, 2020). Different levels of visual impairment may have an impact on how students participate in class activities. For instance, reading mathematical symbols and equations may take longer with certain particular instructional aids (Van Leendert et al., 2019).

IE includes a group of approaches to teaching mathematics, the most prominent of which is: The first approach, providing learning opportunities for all, looks at providing equal opportunities for all students to access the mathematical content to be learned (Knipping et al., 2017). The second approach, differentiated learning opportunities, takes place within different educational outcomes or levels, where each student works according to his or her abilities and capabilities (Schottler & Hasel-Weide, 2017). The third approach, action-oriented learning, emphasizes that learning is based on scientific and practical experience, and the acquisition of a deep understanding of the mathematical content (Knipping et al, 2017). The fourth approach, joint participation, looks at engagement from students in a joint mathematical activity (Schottler & Hasel- Weide, 2017). The fifth approach, meaningful context for all students, and using mathematical tasks with a realistic context that develops students' motivation towards learning mathematics (Scherer, 2017). The sixth approach, cooperative learning, gives students an opportunity to work together, exchange mathematical knowledge and increase communication between them (Knipping et al., 2017).

A summary of some of the teaching strategies employed by math teachers was given by Ediyanto et al. (2023). These strategies were supported by earlier research on teaching mathematics to students with VI, such as the study by Nahar, Sulaiman, and Jaafar (2022), which confirmed an interactive application for learning Braille mathematics to assist VI students in Bangladesh. Brawand and Johnson (2016) looked into efficient ways to teach mathematics to visually impaired students. In the study of Nazemi, Murray, & Mohammadi (2012), mathematical formulas were presented to VI students audibly. Mackowski et al. (2022) looked into how students with visual impairments learned mathematics using computer assistance as a way to assess and boost motivation. Fatimah et al. (2022) ascertained how flipped learning may enhance VI students' learning results in mathematics during the epidemic. Louise (2013) said. Tonal representations, tactile devices, integrated approaches, auditory aids, and tactile representations are examples of general teaching strategies for sixth

graders, besides writing and reading printed text differs greatly from writing and reading mathematical text. One could argue that mathematics is a language unto itself.

Mathematics teachers use a set of educational tools and methods that facilitate teaching mathematics to students with visual impairment in inclusive schools. Brawand & Johnson (2016) indicated that the abacus helps students with visual impairment in solving arithmetic problems in mathematics. Audio media can also be adapted to assist visually impaired students in the learning process (Nazemi, Murray & Mohammadi, 2012).

Louise (2013) mentioned a group of tools that include mathematical aids for students with VI, such as the Cramer Abacus device, which has been adapted to help them learn number concepts and perform mathematical operations; Raised clock faces, geometric zones and volume aids, and wire shapes for matching levels and volumes; Braille rulers, compasses, and protractors. Students can use Speech-Plus talking calculators, which speak by voicing inputs and results out loud. Talking clocks, spelling aids, and 3D models are also available where VI can manipulate objects virtually. For mathematical writing, students use Braille (Nemeth code), and students may use tape recorders to take notes, draft musical scores, or listen to recorded texts or other recorded programs. Visually impaired students can also benefit from special optical aids such as glasses, contact lenses, small telescopes or magnifiers, and books available in large print.

Students with VI have challenges learning mathematics even with the availability of helpful resources and instructional strategies. According to several studies, studying mathematics can be challenging for students with VI (Mejia et al., 2021). According to Hamzah, Maat, and Ikhsan (2021), they have trouble learning mathematical symbols and concepts. It makes sense that compared to ordinary students, many VI students lack expertise using mathematical concepts to communicate in daily situations (Emerson & Anderson, 2018). Gorlewicz et al., (2020) indicated that certain mathematical disciplines including visual information, such as statistics and geometric shape representations, provide challenges for students with visual impairments.

The IE process for students with VI faces a set of challenges and limitations. Taub, McCord, & Ryndak (2017) mentioned the necessity of providing prescribed and valuable curricula through a planned curriculum that achieves educational practices in a meaningful way and achieves learning opportunities for all. Taub (2017) stressed the need to provide the necessary support and resources that enable students in IE schools to engage in general learning activities. considered that assistive computers are the most important aids that facilitate understanding numbers and mathematical operations for students with VI students, especially in the lower grades.

Students with VI require more time to finish coursework and tests. While some systems permit an extra 25% of the exam time given, others only permit 1.5 times. Reading Braille takes a lot longer than reading print, obviously. In the classroom, communication between teachers and blind students presents another difficulty. In order to solve problems and write formulas and expressions during class, students utilize Braille notebooks and math notes. In this case, a teacher supervising student work must be proficient in both Braille and the necessary mathematical notation to interpret the students' written work. Sadly, in cases when the instructor is unfamiliar with this writing custom, the student will have to read aloud his recorded solutions after the teacher has spoken with him and dictated the exercise's content. The teacher's capacity to work with multiple students at once is limited by this one-on-one method of instruction, which takes a lot of time (Manitsa & Doikou, 2022).

Durmuay and Ergen (2021) noted that IE is very important to improve self-confidence in learners with special educational needs. Their study found that participating teachers were using a variety of teaching methods, which included demonstration, group work, and activities such as games/plays/drama in the mathematics classroom. However, time constraints did not allow them to assign individual activities to the students. Hence, additional time was needed to give students the opportunity to participate in individual activities. In this regard, breakout sessions are often waived for individual support, which takes place in the supportive education room rather than the mathematics classroom.

The responsibility of math teachers to make that VI students education the same mathematical material as their peers without disabilities (Prasetyawan & Fitriana, 2019). Das (2021) concentrated especially on teaching mathematics in IE classrooms. He emphasized that math teachers need to have a strong cognitive structure and the skills necessary to adapt their classroom activities so that they can create rich learning opportunities that meet the needs of all students, including those who are VI students and ordinary students. They also need to be aware of the various educational needs that students have when learning mathematics.

To be ready to serve in IE, math teachers must complete professional development (Prediger et al., 2017). According to Scherer (2019), the instructors' university courses do not prepare them to work with students who have special needs or to be involved in IE schools. For this reason, the professional development program for teaching mathematics in inclusive schools needs to assist in addressing heterogeneous groups.

One of the problems facing the educational system today is inclusion, which makes it more important to create subject-specific curricula and related plans for teacher certification, including professional development courses. Understanding the unique learning processes of the teachers taking part in a professional development program is crucial to planning one methodically and successfully (Prediger et al., 2017). Asserting the efficacy of inclusive education in schools is influenced by the attitudes of teachers toward this practice. The following roles are anticipated of formal education teachers in accordance with the norms and criteria for educational practice: 1) Modifying the national curriculum's content; 2) Creating reasonable, attainable goals for every student; and 3) Employing a range of instructional techniques. 4) Making use of various communication strategies. 5) Providing entertainment and games that are acceptable. 6) Give students with special needs in the classroom more time to do their homework and other learning activities.

We highlight a few studies that looked into how mathematics is taught to students with VI in IE schools through a review of previous studies. The opinions of middle school instructors regarding inclusive education methods for students with visual impairments were elucidated by Salih (2022). by conducting 24 interviews with math teachers and employing qualitative research methods. The use of technology makes the learning process for students with visual impairments Sight Easy and Permanent, but it was also found that math teachers who have students with VI in their classrooms needs support to increase their professional competence in developing tactile or visual teaching materials during the instructional planning process and teaching according to both ordinary and visually impaired students. supporting VI students to socialize with their sighted peers.

Wieckert (2021) revealed that there is no significant difference in the development of students' self-concept regardless of whether they are VI or not. The results of the study also showed that when students engaged in activities that require them to measure their competencies, this enables them to build a realistic self-concept. Weikert (2021) encouraged teachers to create enabling environments for students to assess their mathematics competencies. It is reported that this method helped teachers prepare lessons that were more inclined to use the different physical senses instead of focusing on visual learning methods only. It is clear that a diversity of teaching methods benefits not only learners with VI, but also all students in IE classrooms.

The difficulties in instructing visually challenged students in mathematics in blind schools were highlighted by Oyebanji, & Ubong, (2021). This study included 80 participants—60 visually impaired students, 10 mathematics instructors, and 10 special mathematics teachers, were surveyed and interviewed in order to gather data. The findings showed that government and non-government organization provide funding to visually challenged students. Meal, accommodation, and a few school supplies from their school; extended periods for tests and math classes. However, it was discovered that both the educational materials and the system of education assessment employed had problems.

The experiences of a group of math teachers working in an IE school in Ghana's south were investigated by Forster et al. (2021). and to highlight the difficulties that educators have in light of

their lack of formal training in working with students who have special needs. The design of the case study was illustrative. A semi-structured interview guide with both closed- and open-ended questions was used to gather data. It was discovered that the participating teachers had to overcome several obstacles, one of which was their lack of expertise in working with students who had special needs. Due to the challenges some teachers and students encounter when utilizing Braille to support teaching and learning, another issue that has been identified concerns the assessment of students with visual impairment.

Louise (2013) investigated how visually impaired students were taught mathematics, in Margarita Hugo Schools for the VI students in Masvingo Province, Zimbabwe. Data were collected using interviews with teachers. His study revealed that sixth grade students learn the same curriculum as their ordinary classmates in IE schools. Only primary teachers have some training in special needs education while secondary teachers learn on the job. His study showed some challenges in implementing learning in IE schools, such as a severe shortage of special equipment for students due to lack of funding as students do not pay school fees. Both students and teachers showed very low motivation.

The Ministry of Education, which established the National Center for Inclusive Education, is in charge of ensuring that inclusive education is provided in Jordan. This includes reviewing curriculum to ensure that it is inclusive of students with disabilities, including those who are visually impaired, and offering a university course on the process of integrating students with disabilities into general education. It was competent The Center can accommodate 24,000 students with impairments, including 240 students with vision impairment, through Jordan's ten-year strategy (2020–2030) for IE by establishing 6 government schools in the governorates of Karak, Ajloun, and Amman. It is against human rights, fundamental needs, the right to education, integration into society, independence, and the ability to choose and make decisions to deny visually impaired kids an inclusive education. In light of this, the Jordanian Constitution declares that "the state guarantees work and education within the limits of its capabilities and guarantees tranquility and equal opportunities for all Jordanians." It also protects the right to education for everyone. Therefore, regardless of their circumstances, requirements, or limitations, all sectors of society are guaranteed access to education under the Jordanian Constitution.

Based on the above, the study aimed to identify the teaching of mathematics to students with VI in IE in Jordan and all school levels, and to identify the technical methods and methods of teaching mathematical content (According NCTM (2000): number and operations, algebra, geometry, measurement, and probability), tools and methods used to teach mathematics to students with VI, and the difficulties and challenges facing mathematics teachers in IE. This study is considered one of the few studies - according to the researcher's knowledge - that have been implemented in Jordan regarding IE schools, especially for students with VI. The study sheds light on this category (visually impaired) and the possibility of integrating them into education, and not isolating them from their rights to education. Through the finding, the study provides assistance to mathematics teachers and educational specialists regarding the possibility and requirements of teaching mathematics.

METHODS

This study reports on a qualitative study conducted in which an interview was conducted with a mathematics teacher who has 7 years of experience in teaching mathematics in an inclusive school teaching mainstream students and students with visual impairment. The teacher began teaching in 2017, obtained a bachelor's degree in mathematics from Yarmouk University - Jordan, and enrolled in a range of courses and activities related to IE, dealing with students with VI, and managing special classrooms. In addition to how to use educational methods and tools to implement teaching and assessment strategies for all students, including students with visual impairment.

An interview was conducted with one of the mathematics teachers (Israa), by asking a set of questions about teaching mathematics to students with visual impairment by integrating them into the

classroom environment with ordinary students. Answers were coded and arranged into themes after citing pictorial evidence. The study questions focused on the following: How to teach mathematics to students with visual acuity through inclusive learning, what tools and methods are used in teaching, what are the difficulties in learning mathematical content for students with visual acuity, what are the difficulties in learning mathematical content for students with visual acuity? What are the challenges facing mathematics teachers in teaching inclusive students? Visual, what are the mathematics teacher's requirements for inclusive teaching, especially with students with visual inclusion?. Ethical issues were adhered to before and during this study. No students with visual impairment were mentioned due to the sensitivity of the research because it includes vulnerable groups.

The interview questions were as follows:

1. How is mathematics content taught to students with visual impairment in inclusive schools, and what are the tools and methods used in this? (Numbers and operations, algebra, geometry, measurement, probability).
2. What are the challenges facing mathematics teachers in teaching mathematics to students with visual impairment in inclusive schools?
3. What are the requirements that mathematics teachers need to teach mathematics to students with visual impairment in inclusive schools?
4. What are the benefits of teaching mathematics to students with visual impairment in inclusive schools?

RESULTS AND DISCUSSION

We thanked Esraa for conducting this interview, informing her of the purpose of the study, and informing her that all answers are confidential and for scientific research purposes only. The interview started.

1- How is mathematics content taught to students with visual impairment in inclusive schools, and what are the tools and methods used in this?

Esraa explained in detail how to present mathematics content to students with VI. Below is an explanation of that, supported by some of the tools used.

The concept of numbers and their symbols is taught in stages, starting with learning the numbers from 1 to 5, then from 6 to 9, then the numbers from 10 to 20, and here the idea of spatial value begins, where the first digit represents the ones, and the second digit represents the tens, then moving on to the numbers from 21. To 99, then moving to numbers from 100 to 999, and the third digit shows thousands. And so on. Tactile, audio, and Braille language are used.



Figure 1. Braille Board.

As for the addition process, in the beginning the student learns to add two single numbers by using some realistic methods, for example: your pen and add your colleague's pen to it, how many pens do you have? $1+1=2$, then moving on to add a single number and a complex number, for example: there is in The row has 12 seats and we add 3 seats to it. How many seats become in the row? $12 + 3 = 15$. The arithmetic abacus is used to add tens, for example: $40 + 30$. The student

places 4 making up tens and a group consisting of 3 tens and the result becomes 70, and here The load property begins to add up.

Esraa explained teaching the process of subtraction is the opposite of the process of addition, after providing realistic examples. For example, from one of the previous examples, there are 12 seats in the row, 3 of which were moved to another hall. How many seats are left, $12 - 3 = 9$. The process of repeating the process of addition and subtraction is done through practicing many examples, and the variety of use of educational methods such as abacus, Braille language, tangible tools, and others.

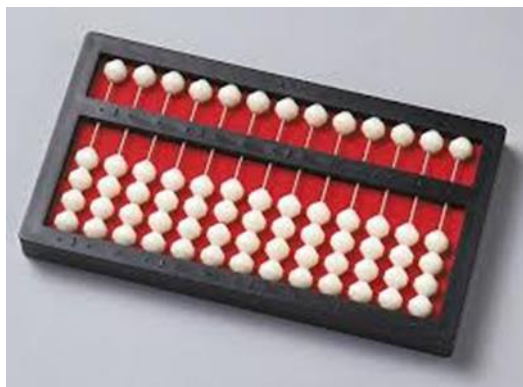


Figure 2. Arithmetic abacus VI

As for the multiplication process, it begins with the multiplication tables for the basic numbers (1,2,3), where the student learns the multiplication table for these numbers up to the number 5, for example: 1×3 , 2×3 , 3×3 , 4×3 , 5×3 . The student understands the concept of multiplication, which is the repeated addition of any $4 \times 3 = 4 + 4 + 4$, that is, repeating the number 3 times. This solidifies the student's memory in the student's memory, helps him retrieve it easily, and makes it easier for him to comprehend the product of multiplication of other numbers. For example: $6 \times 3 = 3 + 3 + 3 + 3 + 3 + 3$, and here he can move on. To multiplication tables for larger numbers.

Esraa added: It is also possible to use some multiplication aids, such as memorizing the multiplication table with the number 11 by repeating the number multiplied by 11 twice, for example: $11 \times 4 = 44$. And so it is with some tables, such as the multiplication table with the number 10. The reciprocal property of multiplication can also be explained, and this makes it easier for the student to memorize the product of numbers in other tables, $6 \times 4 = 4 \times 6$.

After the student is able to add, subtract, and multiply numbers, first explain the concept of division using realistic methods by dividing the complete groups into smaller groups. For example: You have 4 pens that you want to divide equally between 2 of your classmates, $2 = 2 \ 4 \div$, that is, two pens. For every student. Then the student learns to divide complex numbers by single numbers, for example: $36 \div 3$, and thus the student learns from the concept of division to the concept of remainder. The use of educational methods in multiplication and division varied, such as Braille, tangible tools, and others.

As for learning measurement, a graduated ruler is used to measure the lengths and quantities of things, and Dean's pieces can be used to extract the concepts of length, weight, area, volume, parity, and larger and smaller relationships. As for classification, the student is given a group of geometric shapes and classifies them according to common characteristics. As for learning algebra, you can use Dean's cubes, Braille, and learn about equations and their linear, quadratic, and cubic types.

Students begin learning geometry with the concept of a point by drawing it on a Braille unit and the student recognizes it. The mathematics teacher explains that it is a point and the simplest geometry concepts. Then the teacher draws two far apart dots on the Braille board and asks the students to connect a line between them. The teacher explains that it is a straight line consisting of at least two dots. Thus, with curved lines, parallel and perpendicular lines, straight segments, and rays,

the teacher shows the distinctive characteristics of each line. A prominent graduated protractor can be used to measure angles, and indicate the properties and types of all angles: acute, right, and obtuse. The student learns about the types of two-dimensional shapes by displaying concrete shapes, or by using a Braille tablet. It begins by presenting a parallelogram shape, and the teacher asks to state the properties of the shape, the number of its sides, the measure of its angles, and the sum of its angles. Then the rhombus is introduced, then the rectangle, then the rhombus, then the trapezoid, then the triangle. The characteristics of each shape are explained separately and then move on to the next figure. French cubes or special geometric tools can be used for students with visual disabilities. Realistic examples are used to help students acquire the concept of a circle, such as using paper cut into a circular shape and a circular coin. Students understand the concept of a circle, Braille compasses can be used to draw it with specific measurements, students learn about the length of the diameter and the radius using a graduated ruler, and use a graduated protractor to measure the central and circumferential angles. Grids can be used to learn models and how to build them, as they develop mental perception and awareness of the two- and three-dimensionality of mathematical shapes.

Esraa indicated: "Students with VI are like normal students, as they find it difficult to acquire some mathematical concepts, such as the concepts of equivalence, advances in the subtraction process, decimal fractions, percentage, proportion, exponents, time, square roots, differentiating between quadrilateral geometric shapes, and geometric theorems. Algebraic equations, solving verbal problems, properties of parallel and perpendicular lines, and measuring volumes of solids".

2- What are the challenges facing mathematics teachers in teaching mathematics to students with visual impairment in inclusive schools?

Esraa presented a set of difficulties facing mathematics teachers in the teaching process in inclusive schools, which are: The lack of a special mathematics curriculum for VI students, as the current mathematics curriculum lacks an accompanying curriculum that suits the needs and requirements of visually impaired students. Do not use inappropriate evaluation methods. Failure to provide sufficient and appropriate requirements for inclusive education, such as: infrastructure, funding, class size, lack of time, lack of training of mathematics teachers, and lack of educational supervision. It showed that there is a weakness in the facilities and regulations necessary to enroll visually impaired students in inclusive education schools. She also complained about the lack of quality programs used, which reflects negatively on the school administration, mathematics teachers, and parents

Esraa said: "Visually impaired students are not interested in learning mathematics in general due to the nature of the subject and the difficulty of some mathematics contents, like the rest of their normal students."

3- What are the requirements that mathematics teachers need to teach mathematics to students with visual impairment in inclusive schools?

Regarding the requirements for this, Esraa called for ensuring the right of visually impaired students to obtain education by providing the requirements for their access to inclusive education schools and providing educational programs that support inclusive education, in addition to continuing to train and qualify mathematics teachers to work in inclusive education and keeping pace with developments occurring in the field. Inclusive education. Providing the necessary means and requirements for teaching VI students. Using strategies for teaching mathematics and evaluating their learning appropriate to visually impaired students, while taking into account individual differences among students

Esraa stated: "Preparing the psychology of visually impaired students to accept disability and self-satisfaction through awareness lectures and giving them priority in participating in school and community activities, and their need for health, psychological and social care."

4 - What are the benefits of teaching mathematics to students with visual impairment in inclusive schools?

Esraa demonstrated the benefits of inclusive education in teaching mathematics from several aspects, for example: providing learning and teaching opportunities for VI students with a degree of fairness and equality with their normal student peers. Accommodating the largest possible number of visually impaired students. Ridding families and communities of feelings of guilt, negligence and frustration. Providing a social and academic climate for visually impaired students and normal students. Enriching the inclusive education environment with diverse and different teaching and evaluation methods and strategies that suit all students. Esraa expected that inclusive schools are less expensive than special education schools for visually impaired students

Esraa discussed the benefits of inclusive education for students with VI: empowering them with society, and making them feel that they are an integral part of society. Increase self-confidence and refine personality. Ability to deal inside and outside school. The ability to communicate with others and express themselves.

The benefits that accrue to mathematics teachers: practicing different teaching and evaluation strategies, encouraging peer learning, group learning and cooperative learning, and a sense of accomplishment and motivation towards their students.

Esraa presented an invitation: "To prepare visually impaired students and qualify them for work, to deal with others, and to make them productive citizens, by providing them with knowledge, mathematical skills, creative thinking skills, and critical thinking in a way that suits the requirements of the twenty-first century."

CONCLUSION

The results of the study showed a set of conclusions as follows:

1. Teaching mathematics to students with visual impairment requires a set of teaching strategies appropriate to each mathematical field.
2. There are positives for teaching students with visual impairment in inclusive schools.
3. It requires teaching mathematics to students with visual impairment in inclusive schools.

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