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THEATRE IN MATHEMATICS

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# **TIM – Theatre in Mathematics Methodology Manual**

## TIM – Theatre in Mathematics Methodology Manual

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## 1. INTRODUCTION

The main objective of the TIM Methodology Manual is to explain where the TIM Methodology originates, and which is the approach of the authors. In the initial chapters an overview about the international trends in math education is given, and the correspondences between the TIM approach these trends is presented, as well as and the motivations that sparked the authors work on the TIM approach are described.

The chapter “Life skills and scholastic well-being” explains **how student’s life skills, that are promoted by the theatre workshop**, are strictly interconnected with the students’ wellbeing and their learning.

The TIM methodology originates from the assessment and combination of two complementary approaches: “**Mathemart – Playing with mathematics in the theatre workshop**” and “**Process Drama – change of roles, perspectives, and role aspects in teaching mathematics**”. The TIM Methodology draws on the **Social and Community Theatre Methodology**. So, Chapters 5, 6 and 7 are dedicated to these founding elements of *TIM – Theatre in Mathematics* methodology: the Social and Community Theatre, Mathemart and Process Drama are described in their characteristics, as well as how they have been used in teaching mathematics by the partners of the TIM Project.

The last Chapter describes how Mathemart and Process Drama have been combined and implemented in the TIM methodology in order to create a flexible methodology to support math teaching in the classroom.

## 2. THE TIM PROJECT: A NEW METHODOLOGY FOR MATH TEACHING

The TIM Methodology originates from a three years-long collaboration of an international team of drama, math teaching, education and wellbeing professionals from Italy, Norway, Portugal and Greece. During the TIM – Theatre in Mathematics Project, the team worked together to reflect, exchange good practices and create a new methodology to teach mathematics using drama in the classroom, that has then been tested and implemented in schools in the four partners' countries, with the support of teachers and educators.

The TIM – Theatre in Mathematics Methodology originates from the assessment and combination of two complementary methodologies: “Mathemart – Playing with mathematics in the theatre workshop” and “Process Drama – change of roles, perspectives, and role aspects in teaching mathematics”. Mathemart is an innovative pedagogical approach that consists in teaching mathematics through the Social and Community Theatre (SCT) methodology of the University of Turin. Mathemart uses SCT to get students involved in the game of mathematics by means of theatrical games and activities: an overall approach that includes mind and body, inborn creativity and engagement. This theatrical setting conveys a creative, playful and trusting atmosphere, enabling students to freely explore without judging what they are doing, learning from mistakes in a sequence of trial and error. Process Drama, developed by the HVL University of Bergen, aims at changing the teacher dominated pattern of communication by introducing and exploring roles and role aspects (the sceptic, the curious, the authority, the mediator) to create more student active learning processes, emphasizing the ability to change roles and perspectives in a learning process with arguments more than just answers. The TIM Methodology is built considering the 4 partner countries education systems in order to have a flexible and adaptable tool to each national and regional context.

The TIM – Theatre in Mathematics Project gave birth to three methodological tools that provide trainers and teachers studying or using the TIM methodology (or who received the TIM training) with a series of guidelines necessary to implement the TIM Methodology in the classroom:

- **The TIM Methodology Manual**
- **The TIM Toolkit: activities and exercises**
- **The Assessment and Evaluation Toolkit for teachers**

### 3. A NEW APPROACH TO MATHEMATICS

Learning mathematics in school has traditionally been a manner of relentless rote rehearsal, drills, and memorization (Skemp 1976). This is about to change. Twenty-first century mathematics educators approach math with utterly different methods. New trends in the education system show a shift where not only “outcomes” are valued but also “process”. Instead of “getting” mathematical content knowledge from teachers, students are prepared to be intellectually curious to establish their own understanding. It is important for teachers to elicit students to ask questions and encourage them to figure out the answers, rather than giving them instructions. An important part of this is the students thinking behind their participation, and how this relates to classroom culture. The dual process theory explains how thought arises in two different ways, often called system 1 and system 2. Kahneman (2003) relates system 1 to intuition and system 2 to reasoning.

Within system 1, choices relate to what is easily available and often come fluently without deeper thought. Within system 2, choices are based on deliberate reasoning and thinking through alternatives and consequences. But system 2 rests on deep thought, and it is typical for humans to try to avoid such demanding processes and, instead, use intuition. But arguably, mathematical insight might be developed within system 2. Consequently, activating students’ system 2 during teaching seems to be crucial. It is about empowering students to take a more active role in their own learning process. In this way education systems around the world have been moving from defining mathematics as sets of facts, in the direction of emphasizing developing skills that go across multiple subjects.

This way of teaching is designed for helping students master content, think critically, work collaboratively, communicate effectively, learn how to learn, and develop academic mindsets. This kind of deeper learning indicates students are developing and using their mathematical knowledge and skills in a way that prepares them for real life.

Competencies needed in society have evolved, requiring skills that will remain pertinent in a rapid changing world. To be successful in 21st-century profession, personal and civic life, students need skills such as: analytical reasoning, complex problem solving and teamwork. This is in line with WHO Life skills (UNICEF 2012) that includes psycho-social competencies and interpersonal skills that help people make informed decisions, solve problems, think critically and creatively, communicate effectively, build

healthy relationships, empathize with others, and cope with managing their lives in a healthy and productive manner. Learning mathematics through drama-themed activities is one approach to let students meet mathematics in different ways and to help students better understand mathematics concepts and reduce mathematics anxiety.

Our approach is to use ideas and tools from drama, such as roles and role categories, to develop a way to help teachers change their teaching towards the new trends. By using roles, and particularly role categories, the teacher can construct a dialogue in the classroom where the students are given tasks or guidelines on how to participate. To create a discussion, to get deeper into ideas and concepts and reasons, one needs people that ask questions, that challenges, and at some point, weigh the different arguments to decide what is best or correct. For example, a teacher might ask a student to talk about an answer he or she found. Then the teacher can call on the students that are given the task (or role category) to be curious, to ask questions until they understand the thinking or reasoning behind the answer. Then the teacher can ask another student that had another result to talk about it, and then again call upon the curious to ask until they understand. Then the teacher can ask those given the role category of being democratic leaders to decide what is correct and not, or easiest to understand. In addition, one could use sceptics to challenge some of the suggestions during the discussion. In this way, the teacher constructs a dialogue where the students ask questions, explain, and decide what is correct and not, based on arguments.

Such dialogues are in line with the newest trends of actively participating students, activating system 2 and through this building a deeper and relational understanding of mathematics. Also, using such constructed discussions for a while will probably lead to the students' taking roles by themselves. But to make such constructed dialogues work, both teachers and students need to learn how to play roles and to change perspective. This is where process drama comes into play.

Another part of our approach is the use of games and theatrical activities that are metaphors of a mathematical concept. This process can also activate system 2. If during a theatrical game some mathematics is required and the answer is not immediate it obliges the students to think about it and find its own strategy to find a solution. This obligation is well accepted by the students because finding a solution enables them to be part of the game. So, this process is fostered by the pleasure of playing (instead of

sitting at the desk) and makes the students active participants in the lesson and more active for their own learning.

The same dynamic takes place when theatrical activities that are a metaphor or a representation of a mathematical concept are proposed. In this case the students are invited to understand the metaphor, or the representation used and the rules that regulate it in order to be part of the activity. Again, an active participation due to a strong motivation occurs and it leads to a deeper understanding of the concepts used.

Furthermore, both kinds of activities engage the students in groups (either class or subgroups), and this again requires the students to share, mediate, explore new concepts and solutions collectively and it requires the use of the system 2.



#### 4. LIFE SKILLS AND SCHOLASTIC WELL-BEING

Following recognition of educational life skills programs, the World Health Organization (WHO, 1993a) identified psychosocial skills as factors central to the promotion of health and well-being of children and adolescents. Three categories of psychosocial skills are distinguished: emotive, cognitive, and relational. The term life skills refers to the skills that enable an individual to meet the needs and changes of daily life (WHO, 1993a). There is a growing body of theory and research behind the rationale for describing the benefits of skills-based health education. Through decades of research and experience, the behavioural sciences, pedagogy, and child development have amassed knowledge about the processes of growth, knowledge, learning, and the means to acquire skills, attitudes, and behaviours in children and adolescents. Prominent in this field is Albert Bandura's theory of social learning or social cognitive learning (1977).

The decision to prioritize the promotion of life skills at school derives from the awareness that these competences will become part of a shared repertory of the psychosocial skills children and young people will need to confront the difficulties that will come with the changes and expectations awaiting them (Bombi, Baumgartner, 2002). It has been shown that life skills training within the school curriculum has a positive influence on the development of all levels of communicative skills (with peers, teachers, parents). The development of life skills improves psychological well-being and enhances self-esteem. Finally, as demonstrated in other studies, life skills training reduces aggression and depression and increases self-confidence and sense of responsibility (Nabors et al., 2000). Within its social cognitive paradigm, Bandura's constructivist learning theory provides the framework for programs in skills-based health education (WHO, 2003) through interactive and participatory approaches to teaching and learning. Among the personal factors that enable individuals to determine events and express their own potential, a "sense of self-efficacy" is the strongest and most pervasive in many life situations (Bandura, 1997).

The teacher is the principal agent in classroom learning, a mediator of knowledge and teaching experience, as well as a facilitator of emotional aspects that can facilitate or inhibit students' learning processes (Feuerstein, 2005; Ravizza, 2008). Given the emotional variables in learning, a range of evidence indicates that the emotional sensitivity the teacher demonstrates toward a student's learning difficulties is one of the major variables that predicts the onset of anxiety in students (Niss et al.,

2011; Pantziara et al., 2011). Studies have shown that a teacher's theoretical and practical knowledge, and so the use of certain techniques for teaching math (e.g., problem solving, individualized support, error correction at the end of the lesson, etc.) can increase positive feelings in class (Caviola et al., 2017). An outstanding teacher is one who develops the ability to motivate critical thinking in others (colleagues, students, etc.) in order to take on individual changes and complex challenges, marshal the resources of students and the school community to create contexts of creative and innovative learning (Fullan, 2002; Inchley, Guggleberger & Young, 2012; Griebler, Rojatz & Simovska, 2012; Saraanen, 2012).

The application of the TIM methodology allows the teacher to monitor the development of life skills in their own class together with other factors such as:

- the self-efficacy perceived by the teacher about his mathematics teaching strategies;
- pupils' feelings toward their teacher and their classmates;
- pupils' beliefs toward their mathematics self-efficacy.

In the toolkit, the teacher will be able to find a glossary of useful terms and various evaluation tools suggested by the pedagogical and psychological literature. Consultation with an evaluation expert is desirable if the school wishes to adopt them in full.

Appendix 1 shows the three main tools used to evaluate the constructs described above and the descriptions of the validated scales used and the self-assessment grids constructed during the action research phases.

## 5. THE SOCIAL AND COMMUNITY THEATRE METHODOLOGY

### 5.1. THE ORIGINS OF SOCIAL AND COMMUNITY THEATRE (SCT)

Social Theatre is a theatrical approach that starts in Italy and originates from the experiences of social animation, theatre animation and dramatherapy in the second half of the XX century. The first experiences of Social Theatre aimed at using drama to support and promote the wellbeing and the empowerment of individuals belonging to disadvantaged or vulnerable groups<sup>1</sup>. Progressively, Social Theatre interventions started to become increasingly more focused on the educational impact of capacity building based on theatre approaches and on the *"promotion and development of communities as a way to support processes of individual and collective empowerment and as forms of expressive and communicative research starting from the identities of groups"*<sup>2</sup>.

The general theory of Social Theatre was developed in the 1980s at the Catholic University of Milan, with a focus on drama workshops with groups as well as performative and festive dramaturgy. These studies analysed the theatrical process – from training to performance – and its pedagogical and social interaction potential. Research also focused on the transformational power of the ritualistic and symbolic dimension of theatre, and on the personal and relational resources that can result from its socio-affective dynamics.

Starting from these studies, in the early 2000s the Social Community Theatre Centre of the University of Turin further explored these concepts and experiences, creating the Social Community Theatre methodology, which is mainly focused on the communitarian dimension and on the intention of Social Theatre to include the local community in their work with groups<sup>3</sup>.

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<sup>1</sup> Rossi Ghiglione, A. (2011) "La formazione in teatro sociale e di comunità all'università di Torino: un progetto culturale regionale" in «Comunicazioni sociali», n. 2, © 2011 Vita e Pensiero / Pubblicazioni dell'Università Cattolica del Sacro Cuore, 229-240.

<sup>2</sup> Rossi Ghiglione, A., Pagliarino, A. (2011) Fare teatro sociale. Esercizi e progetti. In Dino Audino (ed.), 11. Translated from Italian by the author of the present contribution. *"promozione e lo sviluppo di comunità come sostegno a processi di empowerment individuali e collettivi e come forme di ricerca espressiva e comunicativa a partire dalle identità dei gruppi."*

<sup>3</sup> Rossi Ghiglione, A., Fabris, R., Pagliarino, A., (2019) *A Social Community Theatre Project. Methodology, Evaluation and Analysis*, Franco Angeli, Milano (ed.) Open Access <http://ojs.francoangeli.it/omp/index.php/oa/catalog/book/394>, 37.

The Social Community Theatre methodology uses performing arts and performative languages (singing, playing, music, dance, words, etc.) as well as processes or events (workshops, celebrations, etc.) to create cultural activities where individuals can express themselves artistically, work on the development of interpersonal and intrapersonal relationships and promote the participants' wellbeing. Social and Community Theatre allows participants to create symbolic representations of themselves or the world through shared experiences in order to produce a transformation of reality and themselves.

The approach of Social Community Theatre originates from the following principles:

### **Body: self-awareness and wellbeing**

In theatre, just like in other performing arts, the human being has a central role.

Starting from the 1960s, theatre research has focused on how theatre professionals must train in order to prepare for their artistic performance. Social Community Theatre workshops do implement these techniques, especially during the initial work with the group. These activities stimulate self-perception, foster creativity, promote physical and mental awareness, thus allowing the rethinking of one's personal habits and promoting the communicative and expressive potential of the body. These activities are used by Social Community Theatre to promote the participants' wellbeing. Training self-awareness and body expressivity allows us to effectively use energies, build a positive self-image, foster the ability to build relationships and promote emotional and relational wellbeing. A stronger self-awareness means a more solid emotional literacy and therefore, the promotion of empathy, which is the foundation of social skills.

### **The "chorus": diversity and trust**

The collective nature of theatre determines its ability to allow and promote the inclusion of different points of view. In Social and Community Theatre the natural ability of theatre to create a "chorus", is used to build bridges between cultural, social and personal differences and therefore represents the possibility to work for an inclusive community.

The trust that is built within a theatre group allows free expression and the acceptance of differences. In fact, creating a safe space is the first concern of a Social Community Theatre facilitator. In such an environment, participants become aware of their having rights as well as responsibilities,

and as a consequence, they can grow both from a social and personal point of view.

### **Play and rituals**

Play is a central element in theatre: it has rules, specific timings and spaces, it is enjoyable and free from judgment. In the theatre workshop, participants play to have fun and, at the same time, they are aware that throughout play you also learn. Playful activities are a place of cognitive and moral development that allow participants to train for real life's challenges: they can discover new alternatives, dive into new experiences without fear, forget the psychological pressure of performing efficiently and unlock their creativity.

### **Roles and Stories**

Many theatre activities consist of "as if" games where participants play with different identities or engage in role playing. Taking on a different role allows participants to explore other experiences and perspectives. In Social Theatre these activities are used to foster the ability to imagine new possibilities in real life and to accept and understand the other and their point of views. At the same time, roles taken up by participants often interact in story telling activities where new realities or current situations are enacted. Thus, they can either build a new common vision or further understand a certain reality, strengthening the identity of the participants and their relationship with each other.

## **5.2. THE SCT WORKSHOP**

In Social and Community Theatre, experiential theatre workshops are the best tool to meet the purpose of enabling participants to develop skills and competencies through the educational potential of theatre.

The theatre workshop follows a precise structure where time, interactions and actions are exactly defined and need to be carefully planned and reflected upon by the person who conducts the workshop. This person must have full awareness of these principles in order to take them into account both before and during the workshop sessions<sup>4</sup>.

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<sup>4</sup> Rossi Ghiglione, A., Pagliarino, A., (2011) Fare teatro sociale. Esercizi e progetti, Dino Audino (ed.), 49.

An SCT workshop has a precise structure characterising the phases of the workshop as a whole, as well as the different moments in the individual workshop session. The group works in a dedicated place, usually empty or as “neutral” as possible, so that it can be perceived as different from the places the participants are usually in. The group (a maximum of 30 participants) is engaged in a sequence of activities and games for a variable amount of time (from 1,30 hours to one full day). The activities are carried out both individually and in group, and involve the physical, cognitive and emotional sphere<sup>5</sup>.

### **The structure of a SCT workshop**

An SCT workshop normally includes 10 to 20 sessions. The first sessions will be mainly dedicated to group building, the exploration of relationships among participants, creating an atmosphere of trust through playful activities. In the following sessions more space can be dedicated to exploring the expressive potential of the body (both for individuals and the group), as well as activities that promote creative listening skills within the group. This requires a higher level of trust that should be developed in the first part of the workshop. The final sessions include activities that allow the exploration of specific themes and new artistic languages. This phase is usually also dedicated to the creation of a final artistic product.

### **The structure of an SCT workshop session**

During the first part of the workshop, the group is accompanied into the session’s space and time dimension through a series of activities, such as a moment of informal welcome, a formal contact with the beginning ritual, the creation of a “contract” with the group. Here, some contents and times of the session can be shared and negotiated with participants, the facilitator communicates working times and allow participants to share specific needs.

The second part is dedicated to exploration through activities that might include different artistic languages, techniques, etc. For example:

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<sup>5</sup> Rossi Ghiglione, *Arte, benessere e cura. La potenza del teatro* in “Lo scandalo del corpo. Studi di un altro teatro per Claudio Bernardi” a cura di C.Bino, G. Innocenti Malini, L. Peja, 251-262 in © 2019 Vita e Pensiero / Pubblicazioni dell’Università Cattolica del Sacro Cuore p.255.

- individual training activities where participants, conducted by the facilitator, explore and become aware of their voices and bodies as a tool for expression and interaction with others;
- group training, where the whole group is involved in a collective exploration to understand how group harmony and reciprocal understanding can increase the expressive potential of both groups and individuals;
- dramaturgical exploration and scenic creation, with activities that allow the group to represent and bring to life their visions and ideas on specific themes. These can include improvisation, the creative use of spaces and objects, storytelling, etc.

In the third part of the session, the facilitator leads activities to collect feedback on the workshop session and elements on how the group experienced it (e.g., wellbeing, new insights, reflection on the experience as a whole).

The session ends with a closing ritual that, just like the opening one, allows the group to cross the threshold between the extra-ordinary and the ordinary world, thus defining the confines of the experience.

## 6. INTRODUCTION TO MATHEMART

*Mathemart* is an innovative pedagogical approach to mathematics created by Maurizio Bertolini in 2011. As teachers were looking for new methodologies to teach mathematics, Mathemart was conceived as a new way of approaching mathematics by trying to bypass the fear of this school subject.

Learning difficulties and the fear of mathematics can have different causes and origins. Mathemart's approach is based on the fact that difficulty in learning math can derive from content-related and emotional difficulties (Haciomeroglu, 2019). Math anxiety is a negative emotional reaction to mathematics that can interfere with a person's ability to tackle math problems. It manifests through feelings of apprehension, tension, and distress when confronted with number manipulation and solving mathematical problems in real life situations. Recent studies have shown negative correlations between anxiety and math performance (Devine et al., 2012; Carey et al., 2019; Hill et al., 2016). If students are scared of mathematics, they cannot allow themselves to make mistakes. Their fear freezes their brain and logic skills, and they cannot think rationally.

Mathemart consists in teaching mathematics through the Social Community Theatre (SCT) workshop.

The SCT methodology and its setting (the theatre workshop) are used to allow participants to immerse in the game of mathematics by means of a global approach involving mind and body, inborn creativity and engagement. The theatrical setting creates a creative, playful and trustworthy atmosphere, thus enabling students to freely explore what they are doing without judgment. It encourages learning from mistakes in a sequence of trial and error.

A good theatrical setting can help students to forget their fear and to enjoy the possibility of learning by playing. In fact, in the Mathemart training, participants do not talk about mathematics, but rather experience the subject by playing with mathematical relations and rules. Only after experiencing one concept, they will be formalizing it.

Mathemart has undergone testing in primary and secondary schools in Italy since 2011. In particular, it has been tested in 7 classes of secondary school, featuring about 150 students from 11 to 14 years old. Each class took part in 10 – 15 meetings (1 hour each). The most important results acknowledged by the teachers are:



- Mathemart has been useful to explain topics that students couldn't understand during a standard lesson;
- New curricular topics introduced through the Mathemart method and only later discussed in a standard lesson were understood much more easily than usual;
- Students who feared mathematics would feel comfortable during Mathemart workshops and were active and absorbed;
- All students showed a high degree of involvement and enjoyment;
- The teachers involved were motivated to continue the Mathemart experiment.

### **Mathemart - Teachers' training**

In 2014, a teacher's training was started in the North of Italy. The training is structured in 2 levels: The first level introduces the methodology by giving some theatrical skills that allow teachers to understand and play with SCT language and tools. At the same time, teachers are provided with Mathemart games and exercises. By the end of the training, teachers are able to lead Mathemart classes with their students.

The second level features a deeper work in order to understand the principles on which Mathemart is based. The goal is to give teachers a deeper knowledge of the methodology in order to be able to invent their own Mathemart classes according to their own students' needs.

The main work areas of the training are arithmetic, algebra, geometry and creativity/problem solving.

The main results the teachers declared to have achieved are:

- new tools for personal awareness: body awareness, stress management and class management;
- a decrease in stress during the training;
- new tools for teaching;
- new tools for leading groups;
- a new format and language to deal with mathematics in non-traditional ways;
- tools for creating new lessons of "mathematics and theatre" in order to expand the set of activities learned during the training.

#### **6.1 A MATHEMART SET OF LESSONS WITH A CLASS**

A set of Mathemart lessons is usually composed by 10 to 20 workshops of 1-2 hours each.

At the beginning of the process (for the first 3-4 meetings) the main aim is to make the group familiar with the games and the theatre activities proposed, as well as to develop a common theatre language. During this phase the mathematical part is less important; the group is preparing the ground for the mathematical seeds that will be planted later. The main goal of this phase is to make the group comfortable with the theatre languages we want to use, before using that language to play with mathematics. Furthermore, this phase starts the process of group-building and the creation of trust between the facilitator and the group.

After this first phase, mathematics will take more and more space, and the workshop will be focused on activities that imply the use of it. The same games and activities previously introduced will be adapted to mathematical concepts.

Nevertheless, every time the conductor decides to use a new theatrical language or a new game, the purely theatrical part needs to be trained before introducing the mathematical one. Even though the main goal of Mathemart is to help students overcome their fear of mathematics, the facilitator should not underestimate the risks connected to the fear of theatre. The students should be able to focus only on the math part as this makes the task easier for them and ensures pleasure in carrying on the activity.

While planning a Mathemart workshop or a sequence of workshops, it is important to remember that both theatre and mathematics build competencies on top of other competencies. For example:

- for mathematics, one needs to teach math operations before the can teach expressions;
- for theatre, exploring the expressive possibilities of the body comes before exploring the expressive possibilities of the gesture; and it is important to explore the sound before exploring the use of words. This is why the facilitator needs to proceed gradually.

## 6.2 A MATHEMART WORKSHOP

The Mathemart lesson is developed according to the specific structure of a Social and Community Theatre workshop.

Since it is built on a specific methodology (SCT Methodology, see Chapter 5) it has a well-defined structure that can support teachers to plan the activities and to create new activities within a clear framework. Furthermore, a repeated structure helps students to understand what they

are doing, to gain confidence with the setting and the workshop's flow, and to feel more comfortable during the whole process. This facilitates the learning process.

### 6.2.1 PHASES OF THE MATHEMART (SCT) WORKSHOP

A single workshop has a clear structure where each phase has a specific goal. This structure helps the facilitator to build a coherent experience where the participants are accompanied step by step. It is an extra-ordinary practice, where the ordinary life is left outside, giving the participants the possibility to experience a new way of learning with body, emotions and the cognitive level.

**Contact and contract** - First phase: the facilitator meets the group and shares the structure and goals of the activity with them. This is a way to engage them and foster active learning, as well as making them responsible for their own learning process. It also communicates a sense of care for their needs and promotes trust between learners and teachers.

**Warm up** – Developing a common theatre language. Before approaching a math topic, the trainer must be sure that participants are comfortable with the theatre techniques, activities or artistic languages he/she wants to use. If they are comfortable with the theatrical language, they can have fun and enjoy the activity and approach to mathematics in an environment that is perceived as positive.

**Main activity** (main topic) - Here the group addresses and explores the maths topic.

There are mainly three kinds of main activities:

- mathematical Games, which come from theatre training activities. These games are adapted so that participants need to use maths to be able to play;
- drama or performative activities, where the participants experiment a mathematical topic: the participants play a role or perform a scene creating a metaphor or a representation of a mathematical concept;
- third: activities that make the participants reflect on mathematics as a language where each word has a very well-defined meaning.

**Cool down** - In this phase the facilitator helps students to go from action to reflection by explaining, expanding or formalizing the mathematical concepts addressed during the main activity.

**Feedback** - In this phase the facilitator creates an environment of mutual attention and listens to the students' needs and feelings. Here the group elaborates the workshop experience from an emotional and cognitive point of view in order to becoming aware of the whole process.

### 6.2.2 POINTS OF ATTENTION

**Tailor your lesson:** In order to ensure a pleasant experience for your group of students, you need to consider its characteristics and build your lesson around those. Furthermore, it is important to remember that in a Mathemart lesson there are at least two levels of learning: mathematics and theatre, and the group should always be comfortable with both.

**Observe and adjust:** Each workshop and each sequence of workshops is different. This is due to the fact that each group has different characteristics. It is important for the facilitator to be able to change plans based on the characteristics of the group, its individuals, and any factor that might become known during the workshops.

Many aspects can influence a workshop: the space, the internal dynamics of the group, the characteristics of certain individuals, the energy of the group on the specific day or time period, etc.

**Break down the activity:** Before introducing an activity, it is important to make sure the group has the competencies to do it without moving too far away from their comfort zone. Otherwise, the activity can become tiring, stressing or even frustrating. If a certain activity requires many competencies to be carried out, you can start by training those skills separately, and only later introduce the full activity. To make sure you understand the activity's level of difficulty, you can break it down into the competencies it requires. For example, if you want the group to work in subgroups and create scenes that will be performed in front of other group members, you can ask yourself the following questions: *Are they able to work in subgroups? To negotiate? To co-create? Have they experienced performing in front of an audience? Are they able to act like an audience*

*and still be engaged in the activity? Are they able to stay focused during a less dynamic activity?* etc. Based on your answers to these questions, you can plan many different activities to prepare the group for the subgroup activity/performance.

## 7. INTRODUCTION TO PROCESS DRAMA

Process drama is a structured, improvised acting form where teachers and students agree to examine a fictional world together: 'It is structured so that participants take on multiple roles, not just one character throughout the drama experience. It is framed this way to allow participants to consider multiple perspectives' (Landy and Montgomery 2012: 19). In this way, process drama differs from other kinds of drama, such as basic role-plays and dramatization.

Process drama is a genre of educational drama which focuses on collaborative investigation and problem-solving in an imaginary world. Process dramas use 'pre-texts' (photographs, newspaper articles, music, artefacts, etc. ...) to frame the investigation and raise questions for the students (DICE Consortium 2010).

The concept 'process drama' was introduced by Brad Haseman (1991: 19), defining it as "the distinctive form of improvisation which has emerged from schools", one of the characteristics being that the improvised drama was structured to arouse an artistic response from the participants. According to O'Neill process drama proceeds without a script, its outcome is unpredictable, it lacks a separate audience, and the experience is impossible to replicate exactly (O'Neill 1995: xiii). In the 1990's the concept "process drama" was referred to and used by Cecily O'Neill or Gavin Bolton about what in Scandinavia was used to be called "drama pedagogy".

Dramatic action is always a physical and concrete expression of a role. By playing a role, the acting participant transform thoughts and feelings into form, which make the action significant and symbolic (Schonman 2000). A process drama thus allows for the experience of being in someone else's shoes. According to Viv Aitken (2013: 50) role-taking implies more than just being someone else for a while. The exploratory and immersive character of such learning processes include expressing one's own thoughts, formulating in writing, asking your own questions, and answering questions from others, and participating in a dialogue with other participants.

Shifra Schonman adds that being in role also requires the avoidance of stereotypes and learning to interpret the fiction of drama in imaginative ways. "When students act in drama, they are typically involved in learning new ways of thinking and doing things. The activity of moving in and out of the 'as if' role helps students gain an understanding of different levels of meaning in dramatic actions (Schonman 2000: 951). The learning potential of drama is thus the interplay between the actual and the fictitious world,

and the reflection about how the two worlds are related, sometimes mixed, and sometimes the differences blurred.

One important characteristic of process drama is the break with the distinction in classical theatre between actors and audience, which also is found in late-modern performance theatre. Participating in role-plays and process drama can exercise the ability to set one's own egocentric attitudes aside, and for a while identify with another role and its attitudes. To play a role also implies a change of perspective: 'Transformation of the persona gives us a new perspective on an event: We learn more about it and this changes our knowledge about it' (Courtney 1991: 14). According to Dorothy Heathcote (1985: 61), this requires 'suspension of disbelief'.

The International EU-supported project DICE (DICE Consortium 2014) concluded that students who regularly participate in drama and theatre activities develop more empathy and are better capable of changing their perspective. They are better at both solving problems and dealing with stress. They are more likely to be key persons in the class. They show significantly more tolerance towards both minorities and foreigners, and they are more active as citizens, demonstrating more interest in elections and participating in public issues (DICE Consortium 2014). These are important findings that nevertheless do not exclude the possibility of opposite tendencies. Participating in art-based processes gives no immunity against developing destructive thoughts (Allern 1999: 197–202).

Gavin Bolton (2007: 53) shows that cultural and ethnic differences may create conflicts in drama, and that ideological and political interests of teachers and governments may influence drama work. He refers to Grady (2000), who warns against assuming that drama can do nothing but good, and he adheres to our warning that drama may be a part of destructive movements. Theatre can also be used as a tool for suppression – such as in British colonialism (Kerr 1995), theatre in Nazi Germany (London 2000) and the Nazis staging children's opera, cabaret and plays in Theresienstadt among other things (Landy & Montgomery 2012: xxv).

However, because the fiction points to a meaning beyond what is immediately explicit, drama and theatre provide openings for moral experiences, and may thus reveal our daily coldness and indifference towards others. Therefore, emotions play a more significant role in aesthetic experiences than in real life (Løgstrup 1995: 49). Several of the students in the process drama *Out of Syria* (Allern & Drageset 2017: 117) seem to have had such strong, emotionally engaging experiences, such as a boy

who stated, 'It has made me share more with others because I want to give them the same joy that I receive.'

## 7.1 STRUCTURING PROCESS DRAMA IN THE TIM METHODOLOGY

The idea of using drama to change the fear of mathematics and traditional teaching in mathematics is both related to exploring mathematics through drama and the need to change traditional teaching in math with teacher asking questions, students answering and teacher evaluating (Allern & Drageset 2017).

In the process drama *The Stone soup*, referred to below, we apply a dialogical, epic dramaturgy using the convention Teacher-in-role (TIR): arranging the incidents in episodes, switching between acting and reflections on the acting, and with elements from classical and contrasting dramaturgies. There is often, however, a classical tendency in the dramaturgy, with its the linearity of the progress of actions, but also a contrasting dramaturgy in creating change of perspectives and applying parallel actions.

### 7.1.1 ROLE CATEGORIES

Our adaption of process drama applied to mathematics is characterized by the use and emphasis on role categories, in order to change the traditional learning situation and promote more student active methods in mathematics. We have adapted the idea of *role categories* primarily for the participants and their collective role, and *role aspects* as building blocks for creating roles (O'Toole & Haseman 1989/2017).

In TIM we have used the idea of role categories to explore if the experience of role categories, such as the sceptic, curious, authority and the mediator can contribute to a more engaging student involvement in mathematics. In this learning process, we also refer to WHO's life skills, and therefor also explore if and how the role categories can work to improve life skills, and the challenges in trying to do so. Thus, role categories and role aspects are basic for how we structure process drama. We add that although we think the approach with role categories can be fruitful for other approaches to drama as well, it is not a necessary or mandatory criterion for process drama. We add it to process drama because of the intention of the project; to overcome the fear of mathematics and change communication patterns in the teaching of mathematics.

The Australian drama practitioners and theorists, John O'Toole and Brad Haseman (1989/2017: 3), argue that you do not need to be a skilled actor playing a role. We do all play roles in our social lives, in the sociological



sense of the word role, referring to the specialized capacity or function we have in our social lives (Goffman 1986; 129) as fathers, mothers, teachers, artist, astronauts, trainers, drivers, etc. But this is not enough to describe the meaning of a role in drama. The roles in a play are a part of a relation. Acting the role means to represent a viewpoint, and to represent viewpoint you do not costumes or props or change your voice or create funny ways of walking. To pretend to be a role is to identify with the values and attitudes defined to the role, and they might very well be quite different from your own values and attitudes. What you do when you play a role is to take on and experience a situation in another's shoe.

According to Viv Aitken (2013: 50) role-taking implies more than just being someone else for a while. The exploratory and immersive character of such learning processes include expressing one's own thoughts, formulating in writing, asking your own questions and answering questions from others, and participating in a dialogue with other participants.

We change roles as we interact with different people in different situations that can include activities in the imagined worlds of theatre, play, and drama. More significant than whether or not we are in role is whether or not participants assume that activities are happening solely in the everyday world. We may take on an imagined role, but we actually don't need fictional roles to create drama; what we must imagine is that we are elsewhere, in an imagined world. [i]

In line with UNICEF, we are referring to a life-skills based education, which "makes it clear that a life skills approach will be used to teach the subject matter, meaning that participatory teaching/learning methods will be used to help learners develop not only knowledge, but also the psycho-social life skills they may need to use knowledge to inform and carry out behaviour".[ii]

In its program on Mental Health, WHO argues that "life skills are innumerable, and the nature and definition of life skills are likely to differ across cultures and settings". It is stated, however, that "analysis of the life skills field suggests that there is a core set of skills that are at the heart of skills-based initiatives for the promotion of the health and well-being of children and adolescents". WHO's list of life skills is:

Decision making • Problem solving • Creative thinking • Critical thinking • Effective communication • Interpersonal relationship skills • Self-awareness • Empathy • Coping with emotions • Coping with stress. [iii]

In our understanding of life skills, there is a connection to the role categories we promote in drama and apply in the teaching of mathematics.

Role category	Life skill
The democratic leader/ positive authority (DLA)	Decision making – problem solving – effective communication – interpersonal relationship skills – coping with emotions – coping with stress – self-awareness.
The sceptic – the opponent	Critical thinking – effective communication – self-awareness
The curious	Creative thinking – empathy – coping with stress – interpersonal relationship skills
The mediator	Problem solving – empathy – interpersonal relationship skills – coping with emotions.

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[ii] [https://www.unicef.org/lifeskills/index\\_7308.html](https://www.unicef.org/lifeskills/index_7308.html) (Accessed 11.10.19)

[iii]

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[iv]

[https://apps.who.int/iris/bitstream/handle/10665/63552/WHO\\_MNH\\_PSF\\_93.7A\\_Rev.2.pdf?sequence=1&isAllowed=y](https://apps.who.int/iris/bitstream/handle/10665/63552/WHO_MNH_PSF_93.7A_Rev.2.pdf?sequence=1&isAllowed=y) (Accessed 11.10.19)

## 8. COMBINING MATHEMART AND PROCESS DRAMA TO A NEW METHODOLOGY

The general purpose of the Theatre in Mathematics (TIM) project has been to face the main obstacles in teaching and learning mathematics at European level. More specifically, the project aims at contributing to the improvement of mathematics teaching and learning, providing a new methodology to teach mathematics using process drama and theatre workshops.

Competence in mathematics is nowadays addressed as one of the key issues for self-fulfilment at both social and personal level and numeracy skills are considered as one of the priorities for educational cooperation at EU level. (Mathematic in Europe: Common Challenges and National Policies, EACEA P9 Eurydice - 2011). It is still a common pattern in classroom communication that teaching mathematics is characterized by the use of textbooks with classes dominated by the teachers, who ask questions and assess the students. The traditional, cerebral teaching is still understood as mediation or transferring knowledge, where learning means acquiring knowledge and specific procedures. This makes students passive listeners (Francke, Kazemi & Battey, 2007).

However, there is great consensus that cooperation creates learning and that productive classes are built on students' participation and thinking (Chapin et al, 2013; Fraivillig et al, 1999; Franke et al, 2007, Drageset 2015;). Research (Mathematic in Europe: Common Challenges and National Policies, EACEA P9 Eurydice - 2011) highlights that there are various factors influencing mathematics education, such as teaching methodology and its power to convey the mathematical concepts. Furthermore, students often show stress, anxiety and fear of mathematics, which affect the learning process. Research suggests that an appropriate teaching method and new approaches can overcome students' anxiety and fear, and, as a consequence, improve learning outcomes and offer new learning possibilities. The teacher and the teaching approach have a crucial influence on the process of teaching and learning mathematics.

Mathemart, developed by The Social Community and Theatre Centre in Turin throughout the last ten years, is an approach to teaching mathematics based on theatre exercises, workshops, and small play sequences. It draws on several sources, such as community theatre, group theatre, as well as psycho drama and is based on the Social and Community Theatre Methodology (cf. Chapter 4). Although it shares some of the same



background with process drama, the latter has developed into a specific genre, characterised by longer sequences of improvised playing, the absence of a script, unpredictable outcomes, the lack of a separate audience, and the impossibility for single experiences to be replicated (O'Neill). TIM uses an approach to process drama with role categories and role aspects that create a more active student response to learning. The idea of role categories will be used in teaching mathematics (cf. Chapter 6), thus process drama gives the students the necessary experience and acting competence to apply those categories.

Although TIM's aim is to combine Mathemart and process drama into a new methodology (TIM), these two approaches can be used either separately, combined, or as a continuation of one another. Similarly to research, where one uses specific methods to solve a problem or a challenge, Mathemart and process drama can be the answers to various questions and challenges. If one has one or two hours at disposal and wants to make a living exploration of a specific math task, exercises from Mathemart can be useful. Within the same amount of time one can also explore different perspectives to a specific math task using process drama and role categories. If one wants to work with roles and changes of perspectives, process drama gives you possibilities. When more time is available, one may vary and combine the two, or create a continuation where Mathemart is used in the warming-up and in some more activities within the frame of process drama.

Mathemart exercises may correspond to traditional theatre workshop exercises, but they are also upgrading and renewing them by introducing mathematics as a key component. From a drama perspective exercise, like sport, we do not define the activity as a play or game. For an activity to become drama, it needs some basic characteristics: a fiction, in which roles play with or against each other in a defined time and space. Exercises are exercises, and often very useful as such. If deeper exploration is needed, however, dramatic fiction, roles, and a clarification of time and space will be involved. From a mathematical point of view, Mathemart exercises also work to create a deeper understanding of a specific mathematical topic.

In summary, if one wants to approach a mathematical topic/problem from different points of view and/or wants to work on the communication patterns within the class, Process Drama is suggested.

If one wants to make the students live an experience where the mathematical concept or its metaphor is experienced through game or theatrical activity, Mathemart is suggested.

The same can be said about the third field within TIM: life skills. Life skills can be stimulated or activated both by using Mathemart or Process Drama, and also by combining the two. All in all, what one chooses depends on the question, the need, the challenge to be solved, and the competence of the teacher. It is important to underline the crucial role of the facilitator, who has to be aware of the life skills to be trained in relation to the activity proposed.

Some practical examples:

Here some examples on how to use Mathemart in combination with a process drama.

During the 'Stone soup' process drama (see Toolkit), when the participants explore how to share the soup, different ways of solving the question can be mediated by a Mathemart game. Here mathematics can be explored by using music and humour to express variety and the fun of making it happen, for instance with the activity 'Fractions' from the Toolkit.

Also, in the activities that follow the process drama, when participants are invited to analyse the mathematical processes used to solve the challenge given by the process drama, the teacher can use Mathemart activities to further explore specific math topics related to that challenge, in order to better understand how the families have solved the following task:

1. How to share the fish at the market
2. How to create a system of value between the different agricultural products.

The effort to represent the solution is often useful to understand the mathematical concepts on which the activity is based more deeply.

In general, there are two ways to consider the kind of approach we want the students to experience.

Let us take the Great Common Divisor (GCD) as an example. If one wants the students to use it and discuss about it from different points of view, one can create a Process Drama where the GCD is needed to reach a goal.

If one wants to introduce the concept of GCD or wants to show the concept to the students by using a metaphor, one can use the Mathemart activity 'Greatest Common Divisor' (see Toolkit). In this case, a discussion can happen after the activity where the role of the mediator is crucial to help the students link what they did during the activity with a more accurate formalization of the mathematical concept explored.

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## 9. APPENDIX 1: THE EVALUATION SCALES

This chapter contains the description of the evaluation scales included in the three main evaluation tools used in the TIM methodology.

### 9.1 PUPILS' QUESTIONNAIRES

The pupils' questionnaire is a useful tool for the teacher to detect the following constructs at the beginning and end of the school year:

- the level of anxiety related to mathematics;
- the emotional, affective and motivational aspects of learning mathematics;
- generic metacognitive control strategies;
- subjective beliefs about mathematics;
- the students' assessment of the mathematics teacher's teaching style;
- the students' evaluation of the well-being perceived in the classroom during the mathematics class.

As for the questionnaire composition, based on Cornoldi's "Mathematics and Meta-cognition" questionnaire (2006), two checklists were adopted, for a total of 15 items (first table). One detects the emotional, affective and motivational aspects of learning mathematics, the other detects generic metacognitive control strategies. From several studies about the "perception of ability" (self-efficacy), it emerged that a positive sense of self-efficacy guides the relationship between meta-cognition and performance (Coutinho, 2007) and having good metacognitive strategies is a success factor in the execution of an assignment. Furthermore, the positivity of the emotions that refer to learning and how to manage it effectively are linked to the attributions used by the pupil to justify their success or failure (Cornoldi, 2006). All this, for example, influences the problem-solving process and the development of personal beliefs of self-efficacy (ibid.).

From the same tool 9 items to detect the main metacognitive beliefs related to the solution of mathematical tasks were also adopted. These are divided into three categories: skill, discipline and learning (last table).

Moreover, to detect anxiety related to mathematics, the MeMa Anxiety Scale for Mathematics, by Cornoldi and Lucangeli et al. (2012), was

adopted. The Scale is the adaptation for primary and middle school pupils of the Mathematics Anxiety Rating Scale (MARS, English version), previously adapted to the Italian context by Sacconi and Cornoldi (2005). The Scale is made of 30 items that detect math learning anxiety, math assessment anxiety and generalized school anxiety. For the purposes of the project and to make it easier to administer the test, the battery of items related to generalized school anxiety (6 items) was deleted. In the end, the second table counts 24 items.

The questionnaire asks the student to express the "degree of fear" (from "low level of fear" to "high level of fear") they experience in different mathematical learning and assessment situations. The term "anxiety" has been replaced by that of "fear" to make some sentences more understandable to younger pupils. This checklist has been inserted to detect participants' level of mathematics anxiety during TIM workshops and will constitute a useful detection tool for teachers who want to use the TIM methodology. As a matter of fact, this tool can be used at the end of each school year, to detect the emotional impact on pupils by using alternative approaches in the teaching of mathematics.

Finally, two checklists were used to detect the general atmosphere perceived by the students during classes and their perception of the mathematics teacher's affective-relational style. The first checklist is taken from the questionnaire 'Well-being in the classroom', elaborated by M. Polito (2000) and is made of 13 items. The student is invited to express an opinion on some statements about their wellbeing in their current class and about self-esteem (fourth table). The second set of items comes from M. Polito's manual 'Activating the resources of the class group' (ed. Erikson, 2000) and notes the construct of pedagogical caring from the student's point of view. The 13 items allow students to describe their mathematics teacher's relational style (third table).

The questionnaire addressed to pupils can be used in its entirety or only in the parts of interest to the school or to the teacher. It is necessary to rely on an evaluation professional expert to correctly hand out the indicated scales and detect the results. In any case, it is suggested to use the original test annotation forms, which are attached to the Cornoldi and Lucangeli's manual (2006). It is possible, however, to use other validated tools to detect metacognitive and mathematic skills, classroom climate and math anxiety at the beginning and end of the school year.

## 9.2 TEACHERS' QUESTIONNAIRES

The questionnaire addressed to teachers consists of three sections, as listed below:

### Teaching Sense of Efficacy Scale

The Teachers' Sense of Efficacy Scale (TSES; Tschannen-Moran & Woolfolk Hoy, 2001) is a measure of people's assessment of their own level of success in teaching. In this measure, teaching is conceptualized as a complex activity and represents teacher efficacy as a multi-faceted construct. More specifically, teacher efficacy as measured by the TSES long (24 item) and short (12 item) forms has consistently been shown to represent three distinct, but related latent factors associated with three areas of teaching: Efficacy in Classroom Management, Efficacy in promoting Student Engagement and Efficacy in using Instructional Strategies.

We chose to adopt the extended version with 24 items and insert it in the PRE-questionnaire that was administered to teachers who participated in the training of trainers and to teachers who participated in the implementation of TIM in their schools. This, like all other tools, can be used as a logbook for the teacher to detect the improvement of their skills in classroom management of teaching and in the solution of problem behaviours. In the same way it can relate to all the other constructs which are also evaluated by the pupils. The questionnaire was used in its English version (in Italy, the team used the validated Italian version of V. Biasi et. Al., 2014).

### Mathematics Teaching Anxiety Scale (MTAS)

The Mathematics Teaching Anxiety Scale (MTAS) was originally published in Turkey (Sari, 2014). The validated version in English was used in this project to correlate mathematics teachers' anxiety with that of their pupils, as well as exploring correlations between anxiety and the teacher's teaching style. The Scale consists of 19 items describing two factors:

- Self-Directed Mathematics Teaching Anxiety includes 12 items pertaining to a teacher's own teaching practice and perceived ability;

- Pupil/Student-Directed Mathematics Teaching Anxiety includes 7 items pertaining to anxiety concerning pupils/students who fail assessments or do not reach curriculum/school targets.

### TIM knowledge, skills and competencies

The last section of the questionnaire includes the teacher's assessment on the knowledge, skills and competences they already had or have acquired through the training course on how to use TIM methodology. It is therefore a series of accessory self-assessment items, which the teacher can use as a tool for monitoring their own competence in the use of TIM.

Like the pupils' questionnaire, it is necessary to rely on a professional evaluation expert to correctly hand out the indicated checklists and detect the results. Other validated tools to detect teachers' efficacy or their feelings about teaching mathematics can also be used.

### **9.3 LOGBOOK FOR TEACHERS**

This tool was designed to accompany the validation process of the TIM methodology. However, it can be used to observe and tailor the lessons during the implementation of TIM, in relation to the development of life skills and the training of mathematical skills, described according to the OECD PISA 2015 approach.

The logbook also makes it possible to express critical considerations on the applicability of TIM, in relation to the limits and opportunities within the national education system.

All the tools included as annexes to the present manual are in English. In order to use them in another language, everyone has to provide for their own translation and validate it internally. A few translated versions have already been validated.